National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, CA 94035-1000

February 8, 2018

Reply to Attn of: JQ: 204-15

Ms. Yvonne Fong (*electronic copy*; *hard copy; CD copy)*
Moffett Field Project Manager
U.S. Environmental Protection Agency Region 9
75 Hawthorne Street (SFD-8-3)
San Francisco, CA 94105

Ms. Elizabeth Wells, P.E. (*electronic copy*)
Moffett Field Project Manager
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, 14th Floor
Oakland, CA 94612

SUBJECT: NASA Ames Research Center Area of Investigation 14 (AOI 14)
Non-Time Critical Removal Action
Final Removal Action Work Plan (RAWP) with Revised Final Protected Species Mitigation and Habitat Restoration Plan (PSMHRP)

Dear Ms. Fong and Ms. Wells:

In response to a request from the U.S. Fish and Wildlife Service (Service), NASA Ames has prepared a Revised Final PSMHRP. The revisions to the PSMHRP consist of editorial text changes to provide better consistency with the terminology of the project Biological Opinion issued by the Service.

The Revised Final PSMHRP is included as Appendix H to the Final RAWP. There are no other changes to the Final RAWP dated December 22, 2017. Copies of the Final RAWP (dated December, 2017) with revised Appendix H PSMHRP are being distributed for your files.

Please contact me at 650-604-1294 or kimberly.s.finch@nasa.gov with any questions.

Sincerely,

Kimberly Finch, P.E.
Restoration Project Manager
Environmental Management Division

cc: electronic copies:
Kevin Bricknell, Tetra Tech
Sean Carney, ERT
Tami Labonty, CDFW
Anne Mankowski, USFWS
204-15\D. Chuck

National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, CA 94035-1000

December 22, 2017

Reply to Attn of: JQ: 204-15

Ms. Yvonne Fong (*electronic copy*)
Moffett Field Project Manager
U.S. Environmental Protection Agency Region 9
75 Hawthorne Street (SFD-8-3)
San Francisco, CA 94105

Ms. Elizabeth Wells, P.E. (*electronic copy*)
Moffett Field Project Manager
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, 14th Floor
Oakland, CA 94612

SUBJECT: NASA Ames Research Center Area of Investigation 14 (AOI 14)
Non-Time Critical Removal Action
Final Removal Action Work Plan

Dear Ms. Fong and Ms. Wells:

NASA Ames is pleased to submit the Final Removal Action Work Plan (RAWP) for the AOI 14 excavation removal action. Note that the Final RAWP includes the following documents in appendices:

- Appendix A: Project Schedule
- Appendix B: Geophysical Investigation Report
- Appendix C: Construction Drawings
- Appendix D: Field Sampling Plan/Quality Assurance Project Plan
- Appendix E: Site Characterization Health and Safety Plan
- Appendix F: Stormwater Pollution Prevention Plan
- Appendix G: Revised Biological Assessment
- Appendix H: Protected Species Mitigation and Habitat Restoration Plan
- Appendix I: Responses to Comments

Please contact me at 650-604-1294 or kimberly.s.finch@nasa.gov with any questions.

Sincerely,

Kimberly Finch, P.E.
Restoration Project Manager
Environmental Management Division

cc: Kevin Bricknell, Tetra Tech
Sean Carney, ERT
Tami Labonty, CDFW
Anne Mankowski, USFWS
204-15\D. Chuck

FINAL

REMOVAL ACTION WORK PLAN

AREA OF INVESTIGATION 14

December 2017

Prepared for:

National Aeronautics and Space Administration,
Ames Research Center,
Moffett Field, California

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

FINAL
Removal Action Work Plan
Area of Investigation 14

Prepared for:

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, CA

December 2017

Prepared by:

Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, CA 94612

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS vi

1.0 INTRODUCTION 1

1.1 DOCUMENT ORGANIZATION 1

1.2 SITE DESCRIPTION AND BACKGROUND 2

1.3 REGULATORY FRAMEWORK 7

1.4 PROJECT PERSONNEL 8

1.5 SCHEDULE 9

2.0 REMOVAL ACTION BASIS AND DESCRIPTION 10

2.1 BASIS FOR REMOVAL ACTION 10

2.2 RESULTS OF GEOPHYSICAL INVESTIGATION 12

2.3 CONFORMANCE WITH ARARS 16

2.4 REMOVAL ACTION DRAWINGS AND SPECIFICATIONS 17

3.0 PRE-CONSTRUCTION ACTIVITIES 18

3.1 BIOLOGICAL RESOURCES 18

3.2 SITE CHARACTERIZATION 23

3.3 PROFILING SOIL FOR WASTE DISPOSAL 27

3.4 PRE-CONSTRUCTION PHOTOGRAPHS 27

3.5 PERMITS AND NOTIFICATIONS 27

3.6 UTILITY CLEARANCE 28

3.7 WATER DIVERSION OR DAMMING 28

3.8 CONSTRUCTION SUBMITTALS 30

4.0 CONSTRUCTION ACTIVITIES 31

4.1 SITE MANAGEMENT 31

4.1.1 Security, Access, and Traffic Control 31

4.1.2 Equipment and Personnel Decontamination Facilities 32

4.1.3 Temporary Utilities during Construction 33

4.1.4 Work Hours 33

4.1.5 Contingency Plan 33

TABLE OF CONTENTS (CONTINUED)

4.2 MOBILIZATION AND SITE PREPARATION 34

4.3 CONSTRUCTION MEETINGS 35

4.4 CLEARING AND GRUBBING 36

4.5 MONITORING WELL ABANDONMENT 36

4.6 REMOVAL OF CONSTRUCTION DEBRIS 37

4.7 EXCAVATION OF CONTAMINATED MATERIAL 37

4.8 GRADING AND SITE RESTORATION 39

4.9 DECONTAMINATION OF EQUIPMENT 41

5.0 POST-CONSTRUCTION ACTIVITIES 42

5.1 COMPLETION INSPECTIONS 42

5.2 FINAL LAND SURVEY 42

5.3 SITE CLEANUP AND DEMOBILIZATION 43

5.4 ECOLOGICAL MONITORING AND MAINTENANCE 43

5.5 POST-REMOVAL ACTION SUBMITTALS 43

6.0 PROJECT REQUIREMENTS 45

6.1 QUALITY MANAGEMENT PROGRAM 45

6.2 SAMPLING AND ANALYSIS PLAN 46

6.3 HEALTH AND SAFETY PLAN 46

6.4 PROTECTION OF BIOLOGICAL RESOURCES 47

6.4.1 Biological Assessment 47

6.4.2 Protected Species Mitigation and Habitat Restoration Plan 47

6.5 ENVIRONMENTAL PROTECTION PLAN 47

6.5.1 Stormwater Pollution Prevention Plan 48

6.5.2 Dust Control Plan 48

6.6 WASTE MANAGEMENT PLAN 49

6.6.1 Waste Profiling 49

6.6.2 Transportation and Disposal Coordinator 50

6.6.3 Transport and Disposal of Contaminated Soil 50

6.6.4 Vegetative Matter 50

TABLE OF CONTENTS (CONTINUED)

6.6.5 Debris Generated During Removal Action 50
6.6.6 Wastewater Disposal 51
6.7.7 Asbestos-containing Material 51

7.0 REFERENCES 52

FIGURES

FIGURE 1. NASA AMES LOCATION MAP 3

FIGURE 2. COMPOSITION OF NASA AMES 4

FIGURE 3. AERIAL VIEW OF AOI 14 5

FIGURE 4. FEATURES OF NAVY IR SITE 25 6

FIGURE 5. EXTENT OF NON-TIME-CRITICAL REMOVAL ACTION 13

FIGURE 6. APPROXIMATE DEPTHS OF ARTIFICIAL AND DEBRIS FILL 15

FIGURE 7. PROPOSED DECISION UNITS AND PREVIOUS SAMPLING LOCATIONS ... 25

FIGURE 8. LOCATION AND TYPE OF SURFACE CONSTRUCTION DEBRIS 38

TABLE

TABLE 1. CLEANUP GOALS FOR AOI 14 12

APPENDICES

A PROJECT SCHEDULE

B GEOPHYSICAL INVESTIGATION REPORT

C CONSTRUCTION DRAWINGS

D SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN)

E SITE CHARACTERIZATION HEALTH AND SAFETY PLAN

F STORMWATER POLLUTION PREVENTION PLAN

G BIOLOGICAL ASSESSMENT

H PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN

I RESPONSES TO AGENCY COMMENTS

ACRONYMS AND ABBREVIATIONS

°F	Degree Fahrenheit
µg/L	Microgram per liter
ACM	Asbestos-containing material
AGI	Advanced Geosciences, Inc.
amsl	Above mean sea level
AOI	Area of Investigation
ARAR	Applicable or relevant and appropriate requirement
BA	Biological assessment
bgs	Below ground surface
BMP	Best management practice
BO	Biological Opinion
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CQCM	Contractor Quality Control Manager
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DPT	Direct-push technology
DU	Decision unit
EE/CA	Engineering Evaluation/Cost Analysis
EM	Electromagnetic
EPA	U.S. Environmental Protection Agency
EPP	Environmental Protection Plan
ERT	Earth Resource Technology Corporation, Inc.
ESA	Endangered Species Act
FFA	Federal Facility Agreement
FSFA	Former soil fill area
GPS	Global Positioning System
GSR	Green and sustainable remediation
HSP	Health and Safety Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

IAG	Investigation area grid
ICAM	Interim corrective action measure
IR	Installation Restoration
ISM	Incremental sampling methodology
ITSI	Innovative Technical Solutions, Inc.
mg/kg	Milligram per kilogram
MOU	Memorandum of Understanding
MROSD	Midpeninsula Regional Open Space District
mS/m	milliSiemen per meter
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASA Ames	NASA Ames Research Center
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
nT	nanoTesla
NTP	Notice to proceed
NTCRA	Non-time-critical removal action
PCB	Polychlorinated biphenyl
PSMHRP	Protected Species Mitigation and Habitat Restoration Plan
ppt	Part per thousand
QAPP	Quality assurance project plan
QC	Quality control
QCP	Quality Control Plan
QMP	Quality management program
RAO	Removal action objective
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act
Regional Water Board	California Regional Water Quality Control Board, San Francisco Bay Region
SAP	Sampling and analysis plan
SMHM	Salt marsh harvest mouse
SMP	Site Management Plan
SP IAG	Stormwater pond investigation area grid
SWPPP	Stormwater Pollution Prevention Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TCLP	Toxicity Characteristic Leaching Procedure
T&D	Transportation and Disposal
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound
WATS	West-side Aquifers Treatment System
WET	Waste Extraction Test

1.0 INTRODUCTION

This Removal Action Work Plan (RAWP) describes activities to be conducted during implementation of a non-time-critical removal action (NTCRA) at Area of Investigation (AOI) 14. Tetra Tech, Inc. (Tetra Tech) prepared this RAWP under contract to the National Aeronautics and Space Administration (NASA). The primary purpose of the removal action is to prevent erosion of contaminated material from AOI 14 into adjacent wetlands. NASA intends this removal action to be the final action at AOI 14. The removal action consists of additional site characterization using incremental sampling methodology (ISM), excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. After excavation and ecological restoration, the site will be available for unrestricted use.

1.1 DOCUMENT ORGANIZATION

This RAWP describes how each element of the removal action will be implemented. Section 1 provides an overview of AOI 14 and the regulatory framework of the removal action, key project personnel, and project schedule. Section 2 describes the basis of the removal action, results of the geophysical investigation, and conformance of the removal action with applicable or relevant and appropriate requirements (ARAR). Sections 3, 4, and 5 describe the materials and methods that will be used to implement the removal action. Section 6 describes the project requirements identified in NASA's statement of work and other relevant plans and requirements. Section 6 also references the relevant appendices created to satisfy those requirements. The appendices to this RAWP include:

- Appendix A: Project Schedule
- Appendix B: Geophysical Investigation Report
- Appendix C: Construction Drawings
- Appendix D: Sampling and Analysis Plan (SAP) (Field Sampling Plan/Quality Assurance Project Plan [QAPP])
- Appendix E: Site Characterization Health and Safety Plan
- Appendix F: Stormwater Pollution Prevention Plan (SWPPP)
- Appendix G: Biological Assessment (BA)
- Appendix H: Protected Species Mitigation and Habitat Restoration Plan (PSMHRP)
- Appendix I: Responses to Agency Comments

Section 7 includes a list of the documents referenced in this RAWP. A table and figures with additional information are included throughout this RAWP. Construction specifications were prepared separately from this RAWP and supplement the information found in this document and the appendices.

AOI 14 is located adjacent to and is surrounded by Installation Restoration (IR) Site 25. In 2012, the Department of the Navy completed a remedial action at IR Site 25 that included excavation and off-site disposal of contaminated sediment. Because of the proximity of Navy IR Site 25 and the similarity of the remedial action at Navy IR Site 25 to the removal action at AOI 14, this RAWP includes similar plans and methods as those described in the Navy IR Site 25 remedial design/remedial action work plan (Innovative Technical Solutions, Inc. [ITSI] Gilbane Company 2012), as well as other similar plans and methods of relevant actions (specifically, Engineering/Remediation Resources Group, Inc. 2010).

1.2 SITE DESCRIPTION AND BACKGROUND

AOI 14 is located at the NASA Ames Research Center (NASA Ames) at Moffett Field, California, in Santa Clara County, approximately 35 miles southeast of San Francisco and 10 miles northwest of San Jose (Figure 1). NASA Ames is separated from San Francisco Bay by former salt evaporation ponds. The City of Mountain View is adjacent to the western and southern boundaries of NASA Ames, and the City of Sunnyvale is adjacent to the southern and eastern boundaries.

NASA Ames is one of several centers within NASA, a federal agency. It is an active facility with no plans for closure or transfer. NASA Ames consists of the NASA Ames Research Center campus and the majority portion of former Naval Air Station (NAS) Moffett Field. The Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics was established in 1939 on land adjacent to NAS Moffett Field and consisted of wind tunnels, hangars, aircraft operations, and other research facilities. In 1958, NASA was established under the Space Act, and Ames Aeronautical Laboratory became NASA Ames Research Center.

In 1991, the Navy Base Realignment and Closure Commission identified NAS Moffett Field for closure. In 1994, a majority portion of NAS Moffett Field was transferred from the Navy to NASA, excluding the military housing at Orion Park and Wescoat Housing, which was transferred initially to the U.S. Air Force and then to the U.S. Army. The Navy and NASA entered into a Memorandum of Understanding (MOU) that established roles and responsibilities for environmental restoration and ongoing environmental compliance at former NAS Moffett Field, which is a Superfund site listed on the National Priorities List (NPL) in 1987.

NASA Ames has a Mediterranean climate with dry warm summers and mild winters. Temperatures vary from an average high of 79 degrees Fahrenheit (°F) in July and August to an average low of 39°F in December. Average precipitation is 14.72 inches per year and occurs almost entirely between late fall and early spring. Most precipitation (an average of 2 to 3.5 inches per month) occurs in December, January, February, and March.

Figure 1. NASA Ames Location Map

AOI 14 is located at the northern end of NASA Ames (Figure 2) and includes the former soil fill area (FSFA), N217 area, and N217A fill area. AOI 14 is bordered by Navy IR Site 25 and the NASA Ames North Perimeter Road. Figure 3 shows the location of AOI 14 surrounded by Navy IR Site 25 and property owned by the Midpeninsula Regional Open Space District (MROSD).

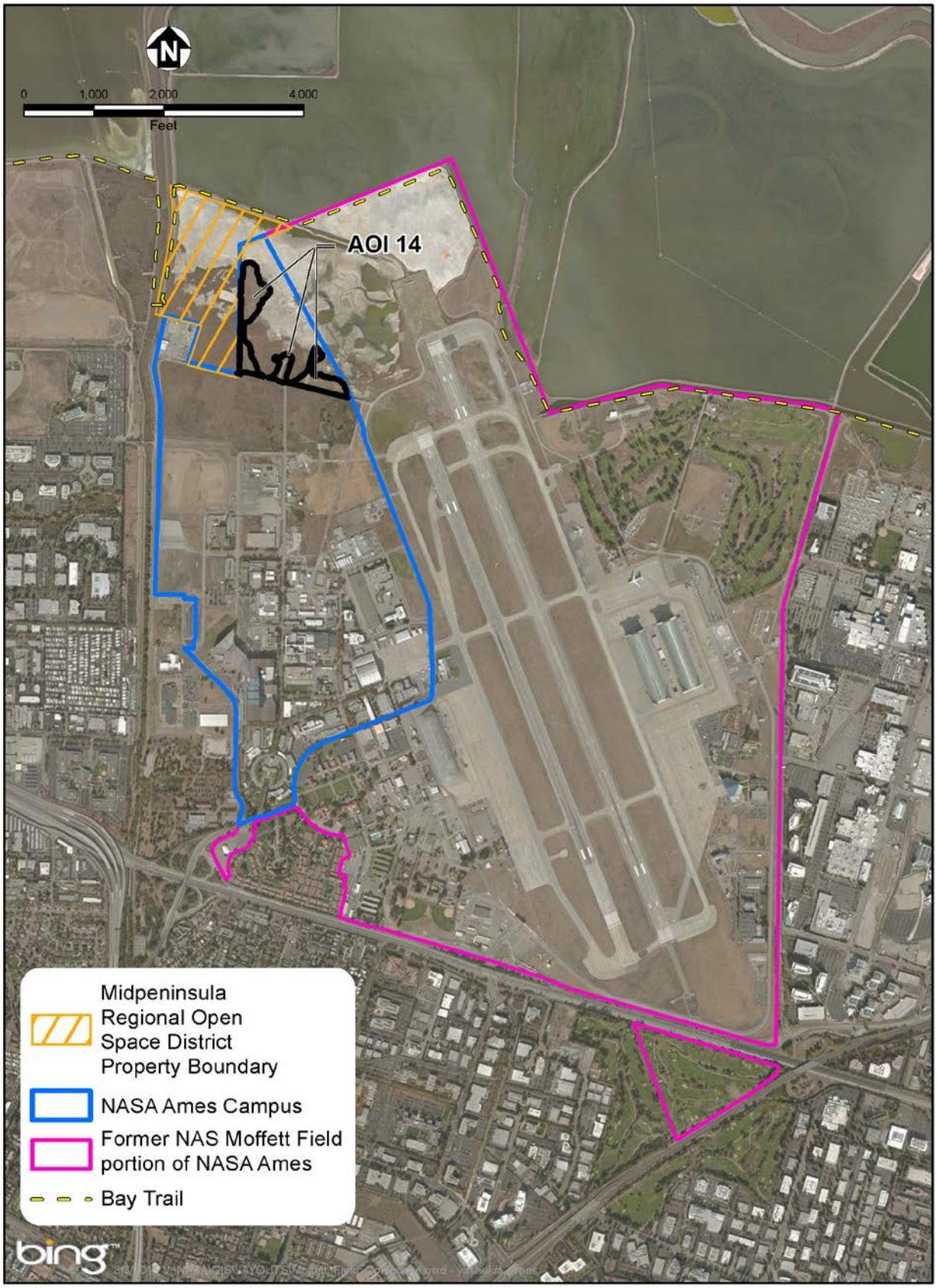


Figure 2. Composition of NASA Ames

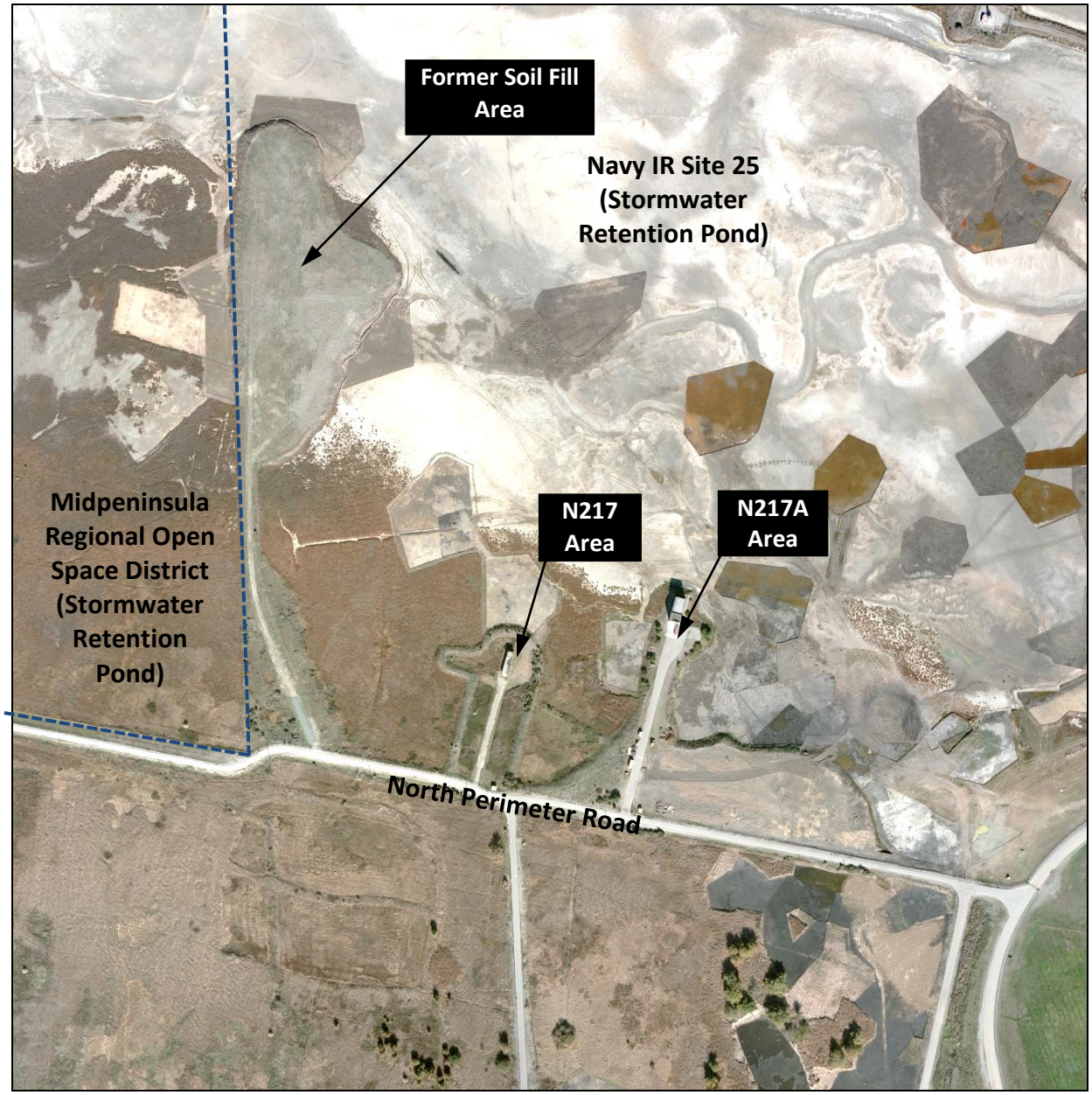


Figure 3. Aerial View of AOI 14

Note: The darker polygons are areas remediated by the Navy in IR Site 25. (NASA photograph #1-7525 date 2012)

Navy IR Site 25 includes the Eastern Diked Marsh (including the stormwater settling basin) and stormwater retention pond. The stormwater retention pond is divided into the central and northeastern basins, which are owned by NASA, and the western portion, which is owned by MROSD (Figure 4). The Navy conducted a remedial action at IR Site 25 in 2012 that included excavation and off-site disposal of contaminated sediment, focused restoration of wetland excavation areas, and ecological monitoring. The remedial action at Navy IR Site 25 targeted the most sensitive ecological receptors at the site as if it would contain tidal marsh habitat in the future. The Navy concluded that, after remedial actions were complete in December 2012, Navy IR Site 25 "presents no hazard to human health or the environment and is available for unrestricted use" (ITSI Gilbane 2013).

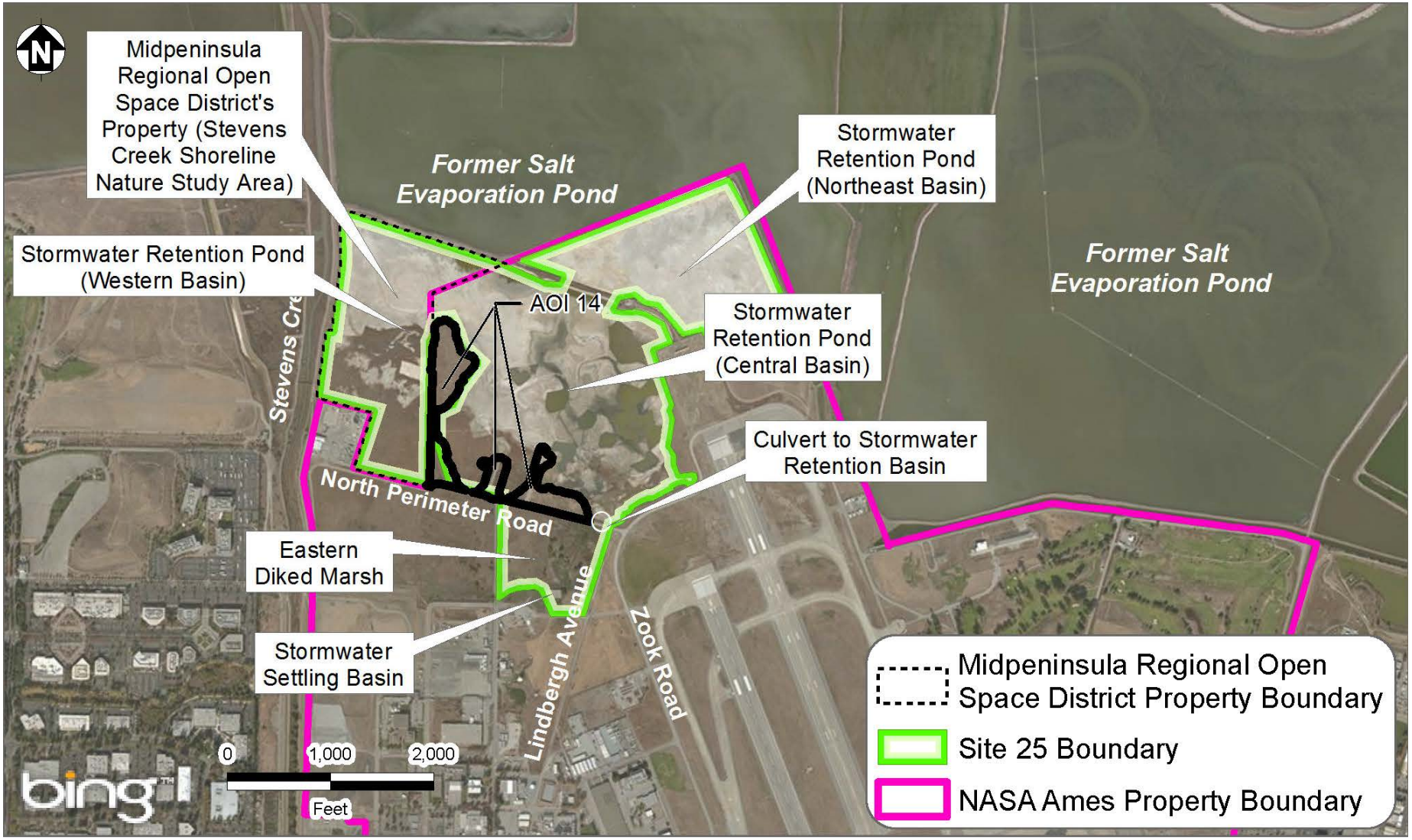


Figure 4. Features of Navy IR Site 25

Historical aerial photographs indicate that the N217 peninsula consists of native soil and that the FSFA and N217A peninsulas were constructed by depositing fill material on the existing surface of the stormwater retention pond. The peninsulas provide mainly terrestrial habitat and are adjacent to the wetland habitat of the stormwater retention pond, which supports wetland species. Wetland vegetation, including pickleweed (*Salicornia pacifica*), extends onto the lower portions of the slopes of the peninsulas before it transitions to upland species (Alderete 2013a). Groundcover varies across AOI 14 and includes tall grasses and low-lying brush. Special status species may occur at AOI 14 or in the adjacent wetland habitat, including federal or state-listed threatened or endangered species and state species of special concern.

The FSFA is not used, and access to this area is restricted by the NASA Ames security fence to the south and NASA's stormwater retention pond on all other sides. The two buildings on the N217 and N217A areas are currently used for periodic research, development, and testing of magnetic field equipment.

The fill material, which varies in thickness from 2 to 16 feet across the FSFA, extends over an area of approximately 270,000 square feet (6 acres) and is a heterogeneous mixture of gravel, sand, silt, clay, and miscellaneous construction debris. Construction debris consisting of reinforced concrete, asphalt, and metal (rebar, I-beams, and metal debris) is exposed at the surface along and adjacent to the slopes of the FSFA. The native soil beneath the fill material is primarily clay. Metals, pesticides, and polychlorinated biphenyls (PCB) detected within the FSFA are distributed non-uniformly throughout the fill, both vertically and horizontally. Site history and contaminant distribution suggest that the source of the contaminants is not an on-site source but rather a source from the original location of the fill brought to the site (Tetra Tech 2015).

1.3 REGULATORY FRAMEWORK

In 2013, the U.S. Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) 7003(a) Unilateral Administrative Order (RCRA-7003-09-2013-0002) requiring NASA to conduct immediate and long-term response actions for AOI 14 (EPA 2013). The stated purpose of the RCRA Order was to stabilize and address soil contaminated with metals, pesticides, and PCBs that threatened to discharge pollutants into surrounding Navy IR Site 25, which includes the stormwater retention pond that serves as actual and potential habitat for several ecological receptors. In response, NASA implemented an interim corrective action measure (ICAM) consisting of an erosion control barrier (silt fencing) along the base of the northern portion of the FSFA. Silt fencing was not installed around the N217 and N217A areas because contaminants present in these areas do not represent a risk to Navy IR Site 25 through erosion of surface soil (Earth Resource Technology, Inc. [ERT] 2014). The ICAM was completed in consultation with the U.S. Fish and Wildlife Service (USFWS) to monitor potential impacts to endangered species, habitat, and natural resources present in the area. NASA conducts monthly inspections of the ICAM and annual sediment sampling and submits quarterly reports to EPA and the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board).

NASA, EPA, and the State of California (through the Regional Water Board) signed a Federal Facility Agreement (FFA) for NASA Ames, effective March 11, 2015. AOI 14 is an identified

NASA site in the NASA Moffett FFA. The NASA Moffett FFA provides the roles and responsibilities of the parties for implementing response actions for NASA sites identified in the NASA Moffett FFA in accordance with applicable environmental requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), RCRA, and applicable state law. Under the NASA Moffett FFA, NASA is the lead agency for implementing response actions, and EPA and the Regional Water Board are the lead regulatory oversight agencies. NASA has the authority to undertake response actions, including removal actions, under CERCLA, Title 42 United States Code (U.S.C.) Section 9604 and Federal Executive Order 12580. EPA terminated the RCRA Order on the effective date of the FFA.

In September 2015, NASA submitted an engineering evaluation/cost analysis (EE/CA) that evaluated technologies and alternatives for the NTCRA at AOI 14 (Tetra Tech 2015). NASA completed an Action Memorandum in March 2017 to document the selected NTCRA (Tetra Tech 2017).

1.4 PROJECT PERSONNEL

Project personnel include representatives from NASA, Tetra Tech, other NASA on-site contractors, and the prime construction contractor. NASA contracted ERT as the prime construction contractor; however, this RAWP will refer to the prime construction contractor that will complete the majority of the construction activities as "Contractor" for simplicity.

Key NASA and NASA on-site contract personnel include the NASA Restoration Project Manager, and NASA's contract wildlife biologist and construction management support personnel. The NASA Restoration Project Manager will conduct NASA project management, provide oversight of technical issues and interface with NASA Ames personnel, the regulatory agencies, community representatives, and all contractors to ensure that project objectives are met. NASA on-site contract personnel will help coordinate and support construction activities with other NASA Ames personnel and agencies, including security and utilities.

Tetra Tech will complete the site characterization using ISM, which will further define the area and volume of excavation. Tetra Tech will procure the drilling subcontractor and laboratory, provide a summary of the incremental sampling results to the project team, and interpret the results for the Contractor.

The Contractor will be responsible for all construction activities, except as identified in this RAWP. The Contractor will procure additional subcontractors as needed to implement the removal action. Construction work will be overseen by a California-licensed Professional Engineer and USFWS- and California Department of Fish and Wildlife (CDFW)-approved biologists. The biologists will conduct biological surveys and oversee the implementation of conservation measures taken during the removal action and ecological restoration, and will confer with USFWS and CDFW as necessary. The Contractor will oversee subcontractors that perform specialized services such as trucking, air monitoring, environmental restoration, and road repairs and construction (if necessary).

1.5 SCHEDULE

NASA issued a notice to proceed (NTP) to Tetra Tech on October 3, 2016 for preparation of project planning documents and design site characterization sampling. The following tasks have been completed:

- October 11, 2016: A project kick-off meeting was held with the lead regulatory agencies.
- October 17 through 27, 2016: A geophysical investigation was conducted at the FSFA to estimate the volume of construction debris and soil types to support project planning documents.
- December 22, 2016: A draft SAP/QAPP for ISM sampling was submitted to the lead regulatory agencies and stakeholders.
- February 28, 2017: A BA was submitted to USFWS for formal consultation.
- March 21, 2017: The draft RAWP was submitted to the regulatory agencies and stakeholders.
- October 30, 2017: USFWS issued the Biological Opinion (BO) (USFWS 2017).
- November 8, 2017: NASA awarded the removal action construction contract to ERT.

The project schedule includes the sequence of events and approximate implementation timeframes for completion of the project. Appendix A presents a project schedule starting with submittal of the final RAWP in December 2017. ERT and Tetra Tech will conduct pre-construction field activities including biological surveys and incremental sampling, beginning in December 2017.

Excavation, transportation, and disposal of contaminated soil and sediment are scheduled to begin in April 2018 and continue until fall of 2018. The precise sequence, volume, and areas of excavation will depend on the ISM results and the presence or absence of special status species.

Final site restoration activities are scheduled to be completed in fall 2018. Acceptance by NASA of completion of field work is planned for December 2018. Ecological mitigation and monitoring of areas where sensitive habitat is disturbed during removal action activities will be conducted, and the areas will be restored following completion of the removal action. The habitat restoration area will be monitored for 5 years or until vegetative performance criteria articulated in the BO and PSMHRP (Appendix H) are met. A removal action completion report will be prepared at the completion of field activities, and a long-term management plan will be completed afterwards with final acceptance of both reports by regulatory agencies anticipated in March 2020.

2.0 REMOVAL ACTION BASIS AND DESCRIPTION

As previously described, the selected remedy for AOI 14 includes excavation and off-site disposal of soil and sediment with concentrations of contaminants exceeding cleanup goals and restoration of the excavated area to appropriate ecological habitat. This section provides general information on the basis for the removal action, including removal action objectives and cleanup goals, the results of the geophysical investigation, and the conformance of the NTCRA with ARARs, which were identified in the Action Memorandum (Tetra Tech 2017). Additional information on previous investigations, the streamlined human health and ecological risk evaluations, and development of the removal action objectives and cleanup goals can be found in the EE/CA (Tetra Tech 2015).

2.1 BASIS FOR REMOVAL ACTION

The area of AOI 14 subject to the removal action is contaminated artificial fill material and debris that was deposited in the northern portion of the FSFA peninsula. The N217 and N217A areas do not require remediation and are not included in the NTCRA based on the depths and limited extent of contaminants in these areas (Tetra Tech 2015).

The results of past investigations and the streamlined human health and ecological risk evaluations in the EE/CA have documented the release of the hazardous substances lead, total dichlorodiphenyltrichloroethane (DDT), and total PCBs within the northern portion of the FSFA at concentrations that will be addressed to protect human health and the environment (Tetra Tech 2015). (Total DDT concentrations were calculated by summing the detected concentrations of 4,4-DDT, 4,4 dichlorodiphenyldichloroethane, and 4,4-dichlorodiphenyldichloroethene.) The source of contamination at AOI 14 is contaminated fill from other areas at NASA Ames that was placed on native soil within the FSFA. There are no known records indicating the source of the fill, but it is believed to be from construction projects at NASA Ames.

Soil (including sediment within the stormwater pond) is the only exposure medium for the site; groundwater, surface water, and soil gas are not identified as potential exposure media. Groundwater was not identified as a medium of concern because fill material is not in contact with groundwater, and groundwater sampling results from monitoring well 10A01A, located on the FSFA peninsula, indicate that fill contaminants have not affected groundwater (Tetra Tech 2015). There is no surface water at AOI 14, and there is no surface water in the portion of the stormwater pond adjacent to the FSFA during the dry season. Rising water levels in the stormwater retention pond during the wet season could inundate the sides of AOI 14 and carry soil and contaminants into the stormwater pond. This pathway is currently controlled by the ICAM silt fence. In addition, transport of soil contaminants into surface water is not considered a significant exposure pathway based on the conclusions of the Navy IR Site 25 risk assessment (SulTech 2007). Therefore, surface water was not identified as a medium of concern for the removal action at AOI 14. The contaminants detected in soil and groundwater at AOI 14 are not volatile, except for trichloroethene detected in one groundwater sample collected from well 10A01A in 1995 at a concentration less than the federal and California maximum contaminant level. Therefore, soil gas was not identified as a medium of concern for AOI 14.

Potential human receptors at AOI 14 were identified as current and future industrial workers and hypothetical future residents. Although future residential use of the site is not anticipated, the residential scenario is considered for unrestricted future use of the site and to achieve a cleanup that is the final action for AOI 14. Concentrations of lead, pesticides (total DDT), and PCBs exceed screening criteria and may pose a potential risk to industrial workers and residents through incidental ingestion of soil, dermal exposure to soil, and inhalation of soil.

Potential ecological receptors include terrestrial plants, soil invertebrates, amphibians, reptiles, birds, and mammals that could be exposed if contaminated soil is exposed by burrowing animals or erodes to the stormwater retention pond. Exposure routes, or the points of entry of a chemical into a receptor, include root uptake and leaf sorption for plants, and dermal contact and ingestion of contaminated soil and food for animals.

The transport of contaminated soil from AOI 14 into the stormwater pond could cause concentrations of lead, total DDT, and total PCBs to exceed levels protective of wetland receptors. Potential ecological exposure pathways for chemical mobilization and transport within the site or to other off-site locations include (1) erosion and transport of dissolved chemicals or chemicals adsorbed to suspended particles and (2) biotic transfer of chemicals in plant and animal tissue from one area of the site to another or to off-site locations. Biotic transfer of contaminants at AOI 14 can occur through the movement and activities of animals. Contaminants in the tissues of mobile receptors such as insects and migratory birds may be carried off site and deposited at other locations in feces and corpses. In addition, chemicals may be transferred through the food web by incidental ingestion of contaminated soil or through ingestion of contaminated food items such as plants or prey.

The following removal action objectives (RAO) were identified in the Action Memorandum for AOI 14:

- Prevent erosion of soil where concentrations of lead, total DDT, and total PCBs exceed cleanup goals for the surrounding stormwater pond (Navy IR Site 25) to protect wetland receptors.

- Prevent exposure to surface and subsurface soil containing concentrations of lead, total DDT, and total PCBs above levels that are protective of terrestrial ecological receptors.

- Prevent exposure to surface and subsurface soil containing concentrations of Aroclor-1260 and 4,4-DDT above levels that are protective of industrial workers.

Numeric cleanup goals were identified in the EE/CA (Tetra Tech 2015) to be protective of human and ecological receptors (Table 1). The cleanup goals were set equal to the do-not-exceed remediation goals identified for Navy IR Site 25, which were developed for the protection of wetland receptors. The cleanup goals also address risk to terrestrial receptors (Tetra Tech 2015). These goals are also protective of human health because they are more conservative (less) than the human health screening levels for industrial workers.

Table 1. Cleanup Goals for AOI 14

Chemical	Cleanup Goal (mg/kg)
Lead	93.8
Total DDT[a]	0.109
Total PCBs[b]	0.210

Notes:

a Total DDT concentrations were calculated by summing the detected concentrations of 4,4-DDT, 4,4-dichlorodiphenyldichloroethane, and 4,4-dichlorodiphenyldichloroethene.

b Total PCBs was calculated by summing the detected concentrations of Aroclor congeners. Aroclor-1254, Aroclor-1260, and Aroclor-1268 were detected at AOI 14.

AOI Area of Investigation
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
PCB Polychlorinated biphenyls

The residual site-wide average concentrations at AOI 14 will be calculated and compared to the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors at Navy IR Site 25 (Tetra Tech 2015). The Navy IR Site 25 site-wide average remediation goals are 33 milligrams per kilogram (mg/kg) for lead, 0.016 mg/kg for total DDT, and 0.200 mg/kg for total PCBs. The residual site-wide average concentration at AOI 14 will be calculated using the results of the additional site characterization described in Section 3.2. Volumetric average concentrations of lead, total DDT, and total PCBs remaining in soil at the site after the removal action will be compared to the Navy IR Site 25 site-wide average remediation goals. If residual site-wide average concentrations of lead, total DDT, or total PCBs at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14 as part of this NTCRA.

This NTCRA addresses the northern portion of the FSFA where concentrations of lead, total DDT, and total PCBs exceed cleanup goals in samples collected from 1992 through 2014. This area is estimated to be 270,000 square feet (6 acres), and the estimated volume of fill is approximately 65,000 cubic yards (Section 2.2). This area is shown on Figure 5. The extent of the removal action is based on the geophysical investigation (indicating the full extent of artificial and debris fill) and may be further refined based on the results of site characterization (refining the extent of contaminated soil and sediment).

2.2 RESULTS OF GEOPHYSICAL INVESTIGATION

A geophysical investigation was completed at the FSFA from October 17 through 27, 2016. The results of the geophysical investigation are included in Appendix B and are summarized here. The objective of the geophysical investigation was to detect and delineate the apparent lateral and vertical extent of artificial and debris fill.

Digital geophysical mapping surveys consisted of electromagnetic (EM) and magnetic surveys and included the use of a Geonics EM31 and Geometrics G-858 cesium vapor magnetometer. An Advanced Geosciences, Inc. (AGI) SuperSting R8 was used for the electrical resistivity surveys.

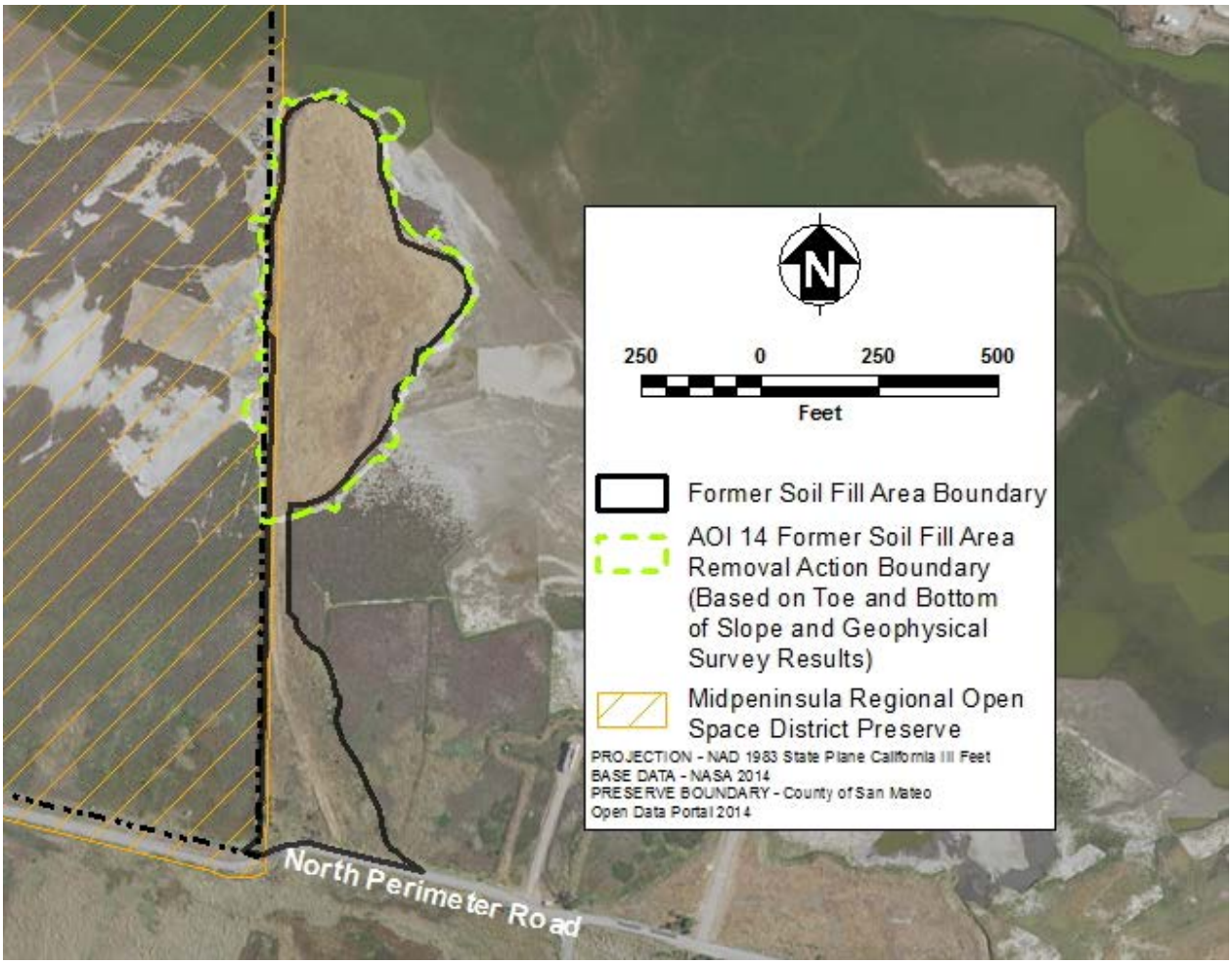


Figure 5. Extent of Non-Time-Critical Removal Action

The EM31 survey was used to evaluate terrain conductivity, detect EM anomalies likely associated with low-conductivity debris (for example, concrete, asphalt, and wood construction debris), and assess the presence of large, buried, metal objects and debris in artificial fill material. The EM31, which is capable of detecting both ferrous and non-ferrous metal debris, consists of a transmitter coil mounted at one end and a receiver coil at the other end of a 12.14-foot-long plastic boom. The EM31 measures ground electrical conductivity (quadrature phase component) in milliSiemens per meter (mS/m) and the ratio of the induced secondary magnetic field to the primary magnetic field (in-phase component) in parts per thousand (ppt). The effective depth of exploration for the EM31 in vertical dipole mode can be up to approximately 15 feet, depending on the target size and material, soil, and other site conditions.

The magnetometer survey was used to evaluate ferromagnetic metals (metal debris) and deep ferromagnetic objects in fill material. The magnetometer was used to detect magnetic anomalies by measuring the strength of the total magnetic field along transects. The magnitude and orientation of a magnetic anomaly depend on the material, size, shape, depth, and orientation of the target object as well as the proximity of other adjacent ferrous metal objects. The G-858 uses an optically pumped cesium vapor sensor and generally has a measurement sensitivity of 0.1 nanoTesla (nT) or 0.1 gamma.

Electrical resistivity profiles were completed at the site to assess the apparent vertical limits of debris fill associated with contrasts in electrical resistivity between debris fill and native material at depth. A total of seven 140-foot Sting electrical resistivity lines were used to assess the apparent vertical extent of the debris fill at the site. In general, the maximum depth of detection is typically one-third to one-fifth the length of the Sting line (approximately 28 to 47 feet).

The magnetometer survey detected the greatest density of magnetic anomalies within the northern portion of the FSFA. The interpreted apparent extent of artificial fill at the site, based on a combination of the extent of magnetic anomalies and the bottom FSFA slope, is approximately 6 acres. The portion of apparent artificial fill that contains ferrous metal debris is approximately 5.5 acres. Magnetic anomalies within the flat areas adjacent to the base of the FSFA slopes indicate apparent artificial fill extends beyond the toe or base of the slopes at several locations.

The unleveled EM31 quadrature phase data detected anomalous areas of low conductivity (high resistivity) in the northern portion of the FSFA, where a greater density and thickness of construction debris fill is present based on previous borings and site observations. The unleveled EM31 quadrature phase results and Sting electrical resistivity sections are both shown on Figure 6. Purple to dark blue EM31 quadrature readings represent high conductivity (low resistivity) values that indicate native material, and light blue to red EM31 quadrature readings represent lower conductivity (higher resistivity) values that indicate construction debris fill.

Electrical resistivity sections on Figure 6 also show a thicker and more electrically resistive apparent artificial fill layer where construction debris is suspected to have been buried at greater depths and quantities in the northern portion of the FSFA. Red and orange colors on the sections represent higher resistivity (lower conductivity) values, and dark blue colors represent lower resistivity (higher conductivity) values. The uppermost section of high resistivity (approximately 2.7 to 7,000 Ohm-meters) in the resistivity sections was interpreted as the apparent layer of artificial fill underlain by low resistivity (high conductivity) native clay material (approximately 0.1 to 2.7 Ohm-meters). Interpretation of the possible vertical extent of apparent artificial fill from the ground surface to native material is shown with a dashed black line symbol on the resistivity sections on Figure 6. The dashed black line also delineates native soils with higher resistivity underlying the low-resistivity soils at the bottom of the artificial fill. Based on the electrical resistivity sections, the artificial fill may extend to depths as great as 18 feet below ground surface (bgs) in the northern portion of the site and may be as shallow as 4 feet bgs in the southern portion of the site.

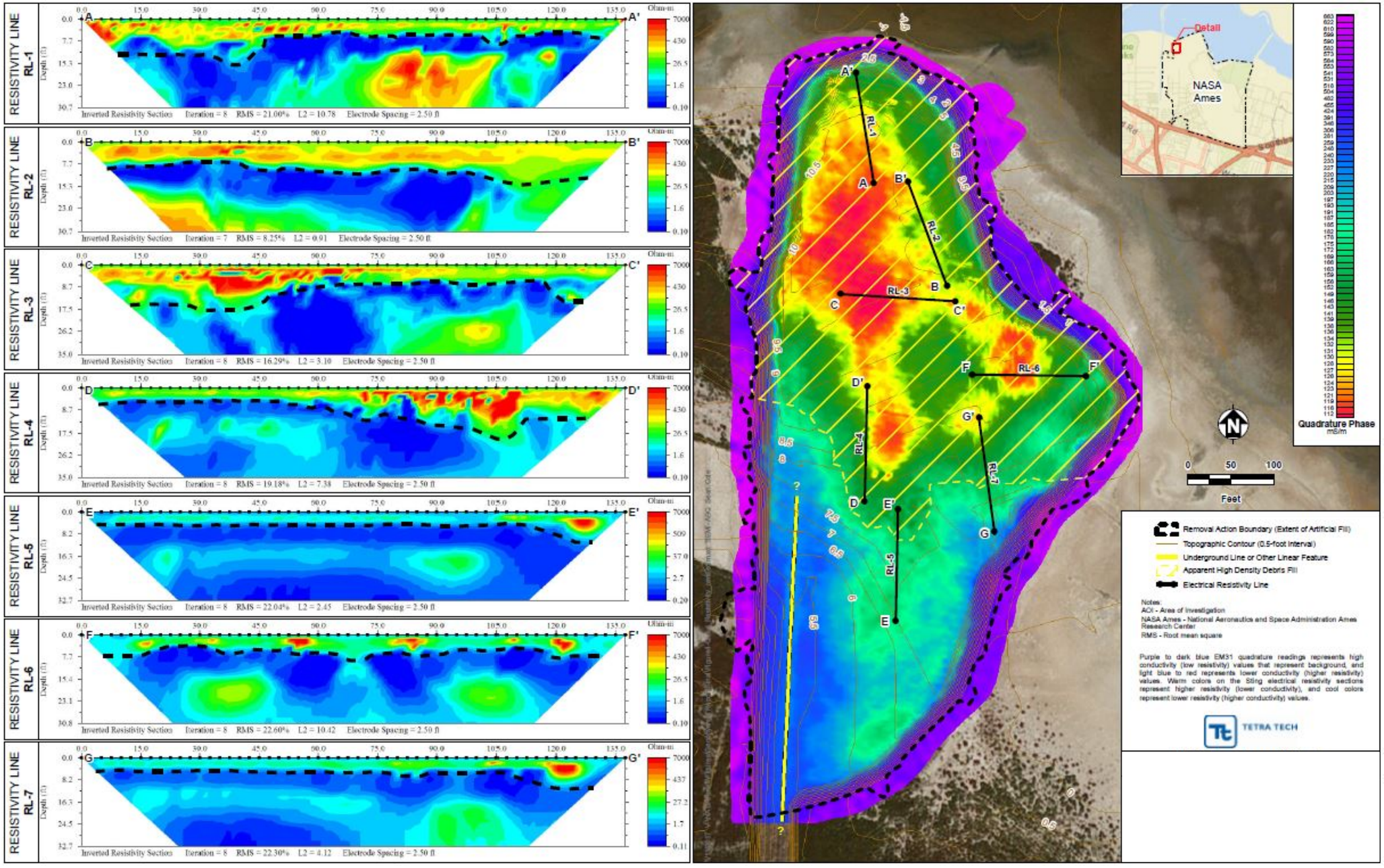


Figure 6. Approximate Depths of Artificial and Debris Fill

High resistivity areas and areas where high resistivity layers have a greater thickness in the Sting electrical resistivity sections correlate very well with low conductivity (high resistivity) areas detected by the EM31 in the northern portion of the FSFA. The apparent lateral extent of artificial fill interpreted from the geophysical survey results also correlates with the apparent extent of graded and disturbed fill material and soil piles shown in historical aerial photographs of the FSFA. The depths of apparent artificial fill based on geophysical results also correlate with the apparent depths of artificial fill observed in several nearby borings. Based on the interpolations of the electrical resistivity sections, the approximate volume of detectable apparent artificial fill within the removal action boundary is 65,000 cubic yards, with approximately 62,000 cubic yards of the fill containing ferrous metal and debris. The ranges of thicknesses of apparent artificial and debris fill interpreted from the electrical resistivity sections are presented in more detail in the geophysical investigation report (Appendix B).

2.3 CONFORMANCE WITH ARARS

The NTCRA will comply with the ARARs identified in the AOI 14 Action Memorandum (Tetra Tech 2017).

The chemical-specific ARARs for the AOI 14 NTCRA require characterization of waste for off-site disposal. Excavated fill material and sediment that will be disposed of off site will be characterized and sent to disposal facilities that have appropriate permits and licenses in place in compliance with the CERCLA off-site rule.

The location-specific ARARs protect federal and state threatened, endangered, and fully protected species. As described in Section 6.4, NASA evaluated the effects of the removal action on the federally listed species potentially present on AOI 14 in a BA and identified specific mitigation and conservation measures necessary to minimize the impacts. State-listed and fully protected species potentially present on AOI 14 were evaluated in the PSMHRP, which also identified mitigation and conservation measures to minimize impacts to biological resources. The location-specific ARARs also protect wetland resources. NASA described the anticipated impacts of the removal action on jurisdictional wetlands and identified restoration actions in the PSMHRP.

The action-specific ARARs contain requirements for excavation and temporary storage of excavated soil or sediment. In addition, NASA has identified the Toxic Substances Control Act risk-based disposal requirements as the basis for the on-site PCB cleanup goal. The risk-based disposal requirements allow for identification of site-specific goals and confirmation sampling and are predicated upon EPA approval. NASA Ames will submit information to EPA to provide the basis for the selection of 0.210 mg/kg as the PCB cleanup goal. Soil and sediment with concentrations of PCBs greater than 0.210 mg/kg will be excavated from the site and disposed of off site.

2.4 REMOVAL ACTION DRAWINGS AND SPECIFICATIONS

Technical drawings are presented in Appendix C. Construction specifications were prepared separately from this RAWP and supplement the information found in this document and the appendices. The drawings and specifications form the basis of the excavation, off-site disposal, and ecological restoration activities to be implemented in the field. The construction specifications also reflect NASA's management requirements for implementing this RAWP.

Information in the drawings include the approximate locations and depths of the excavation areas and general standards to be achieved. The drawings and specifications do not include specific volumes of soil or sediment to be excavated, nor do they contain a final grading plan for the site. Site characterization using ISM is currently planned for January 2018 to further refine the extent of the excavation and the volume of clean fill material (material with concentrations less than the cleanup goals) that will remain on site. Therefore, the drawings and specifications include general construction objectives and typical sections to describe each element of the removal action.

As described in Section 3.2, the ISM results will be interpreted and the specific areas, depths, and volumes to be excavated will be identified. The final grading plan will be developed based on the remaining volume of material at the FSFA after excavation is complete, as discussed in Section 4.8. The specific habitat restoration areas will be identified per the PSMHRP and in coordination with the NASA biologist and restoration biologist.

3.0 PRE-CONSTRUCTION ACTIVITIES

This section describes activities to be completed before excavation begins. The evaluation of biological resources and ISM sampling will be used to identify the area and volume of soil to be excavated. The site characterization will include a pilot study and full-scale ISM investigation.

3.1 BIOLOGICAL RESOURCES

NASA Ames will coordinate with USFWS and CDFW before, during, and after the removal action to avoid or minimize the impact of site activities on special status species at AOI 14. Biological resource evaluations relevant to the AOI 14 removal action include the following:

- Biological surveys conducted in November 2013 in relation to the ICAM implemented at AOI 14 (silt fence) (Alderete 2013a). After an emergency consultation with USFWS, NASA conducted surveys for California seablite (*Suaeda californica*) and burrowing owls (*Athene cunicularia*). The surveys consisted of walking the perimeter of the FSFA to look for California seablite along the silt fence line and ecotone between the flats of the basin and the slope of the peninsula. The top of the peninsula was then walked along transects spaced approximately 30 to 40 feet apart, depending on the height of the vegetation. Each open burrow was inspected for signs of burrowing owl occupancy (whitewash, pellets, feathers, and prey remains). No California seablite or burrowing owls were observed. Two locations had burrowing owl pellets, but no open burrows were found nearby. A potential salt marsh harvest mouse (SMHM) was observed.

- An evening burrowing owl survey conducted in December 2013. No owls were observed, and no new evidence of burrowing owls was identified (Alderete 2013b).

- Identification of western snowy plovers in the stormwater retention pond in December 2013 (Alderete 2013c).

- The BA, based on a site walk conducted in fall 2016, as discussed in Section 6.4, and NASA historical biological resource documents. The BA is intended to comply with substantive requirements of the Endangered Species Act (ESA).

- The BO, issued by USFWS on October 30, 2017, in response to NASA's request to initiate formal consultation on the NTCRA. The BO identifies conservation measures and habitat restoration criteria to be implemented as part of the removal action.

In addition to these previous evaluations, biological surveys will be conducted before and during NTCRA activities at AOI 14 by USFWS- and CDFW-approved biologists with expertise in identifying SMHM and other special status species, as described below. In addition to surveys, activities to be conducted in support of avoiding or minimizing impacts to special status species are described in general below for each phase of the removal action. A complete list of conservation measures is in the PSMHRP (Appendix H). The PSMHRP also contains the BO that

details USFWS requirements and conservation measures as an attachment (Appendix H, Attachment H-3). Activities associated with ecological restoration, monitoring, and maintenance are detailed in the PSMHRP (Appendix H).

Prior to the pilot study, the following activities will be completed:

- Anti-perch devices such as spike strips will be installed on the NASA perimeter fence along North Perimeter Road. The anti-perch devices will remain in place during and after the removal action to prevent predators from perching near SMHM habitat.

- No more than 3 days prior to surveying and marking the FSFA investigation area grids (IAG) (Section 3.2), a USFWS-approved biologist will conduct a walking survey of the FSFA and a visual survey of the surrounding environs to determine the presence or absence of special status species in the area. Locations of nests will be recorded using a Global Positioning System (GPS) (recording the point from a distance) or hand-drawn on a map. At this time, the biologist will survey the extent and condition of pickleweed that occurs along the FSFA slopes and stormwater retention pond, to a distance of approximately 50 feet from the removal action boundary.

- Prior to project activities, and to be continued on an ongoing basis as determined necessary by the USFWS- or CDFW-approved biologist, exclusion material will be placed at entrances of burrows atop the FSFA peninsula to prevent burrowing owls from establishing nests. Prior to installing exclusion material, the USFWS- or CDFW-approved biologist will inspect the burrows for presence of wildlife, including eggs and young, to ensure they do not become entrapped in the burrows.

- Pickleweed coverage will be surveyed using a handheld GPS instrument. Pickleweed condition (height and a visual estimate of cover [as a percentage]) will be recorded and photographically documented. Plant species observed within the removal action boundary will be recorded, and conditions atop the peninsula will be photographically documented.

- Once deemed clear of special status species by the biologist, vegetation within 50 feet of the edge of pickleweed will be removed by hand or cut to ground level (using non-motorized hand tools). Vegetation removal methods are outlined in the PSMHRP (Appendix H). The USFWS-biologist will accompany the vegetation removal crew to ensure that no SMHM are present.

- Once deemed clear of special status species by a USFWS-approved biologist, the upland portion of the FSFA peninsula (starting from the edge of the hand-cleared areas addressed above and from a distance of 50 feet from the uppermost pickleweed edge) will be mowed to stubble no higher than 1 inch. The USFWS-approved biologist will walk a safe distance in front of the mower to ensure that no SMHM are present. With the approval of the USFWS-approved biologist and once deemed clear of mice, mowing will be conducted as necessary for the duration of the removal action to maintain upland vegetation at a height of 1 inch or less.

- A USFWS-approved biologist will be on site daily during surveying and sampling activities and will remain on site for the duration deemed necessary by the biologist based on their best professional judgement on a case-by-case basis. Decision criteria for the biologist's presence on site will include the current nature of project activities, degree of noise or disturbance site activities are producing, intensity of activities, presence of species, or other factors. This conservation measure and a complete list of measures is in Section 2.0 of the PSMHRP (Appendix H).

- An exclusion fence will be installed and vegetation on the FSFA slopes will be removed, as described below:

    - After the IAGs are surveyed and marked (Section 3.2), the FSFA peninsula slopes will be surveyed by a USFWS-approved biologist for the presence or absence of special status species.

    - The layout of the exclusion fence will be marked in the field with stakes no higher than 3 feet to guide vegetation removal. Stakes will be removed after vegetation is removed, as described below.

    - Vegetation within the work area and within 4 feet of the exclusion fence (measured from the outside edge) will be removed to discourage mice from entering the work area. Pickleweed will be removed by hand and under the supervision of a USFWS-approved biologist. Pickleweed removal areas will be surveyed using a handheld GPS instrument to record the locations of the areas of impact. The layout of the exclusion fence and estimated areas of pickleweed removal for the pilot study are depicted on the construction drawings (Appendix C). The areas of pickleweed shown on the drawings are based on a July 2016 survey of pickleweed within 100 feet of the FSFA (NASA 2016).

    - A temporary exclusion fence will be installed as close to the anticipated work areas as practicable. The fence will extend around the entire FSFA, including the access road and contractor staging/laydown area on the southern end of the FSFA peninsula (see the construction drawings; Appendix C). The exclusion fence will be no higher than 3 feet to prevent raptor perching and will include low-density polyethylene sheeting, such as visqueen, to prevent SMHMs from entering the work area. The sheeting will be buried at least 4 inches bgs to prevent burrowing animals from entering the project footprint. Support posts will be on the inside of the fence (work area side). A portion of the fence along North Perimeter Road will be open during periods of activity to allow traffic and personnel to access the FSFA. This portion will be closed at night and during periods of extended inactivity and secured with sandbags or equivalent.

Prior to the full-scale investigation, the following activities will be completed:

- Biological surveys and FSFA peninsula vegetation removal will be completed, as described below:

  - No more than 3 days prior to IAG surveying and marking (described below) and full-scale investigation sampling, a USFWS-approved biologist will conduct a walking survey of the FSFA and a visual survey of the surrounding environs to determine the presence or absence of special status species in the area.

  - The USFWS-approved biologist will be on site daily during surveying and sampling activities and will remain on site for the duration deemed necessary by the biologist, using decision criteria stated above (under pilot study). Hand auger borings on FSFA peninsula slopes and in the stormwater retention pond in areas of pickleweed will be conducted in the presence of a USFWS-approved biologist. Additional conservation measures are described in the BA (Appendix G) and PSMHRP (Appendix H).

- Additional vegetation along footpaths will be removed, as follows:

  - The exclusion fence layout and vegetation clearing (4-foot buffer from fence line) conducted for the pilot study may exclude some single-sample hand-auger areas along the slopes. Sampling along the slopes will occur in the presence of a USFWS-approved biologist. To minimize disturbance, no pickleweed will be removed from these areas.

  - For safe access to hand-sampling areas within the stormwater retention pond, the exclusion fence will be modified to create an opening, and pickleweed will be cleared from a small swath (less than 10 feet wide) to create a footpath to the sample area. Pickleweed removal areas will be surveyed using a handheld GPS instrument.

Prior to excavation, the following activities will be completed:

- No more than 25 days prior and again 3 days prior to commencing site excavation, a USFWS-approved biologist will survey the FSFA via a site walk and will visually survey the surrounding area for the presence of special status species.

- The exclusion fence constructed before the pilot study may be relocated based on the anticipated excavation area, after results of the ISM sampling are evaluated. The ICAM silt fence will remain in place unless it hinders site activities; if the existing silt fence does hinder activity, it will be relocated farther outside the work area. In this case, the ICAM silt fence may be modified with sheeting to act as the exclusion fence, depending on the location of removal activities in relation to the existing silt fence.

- Prior to excavation, pickleweed will be hand-removed from areas requiring excavation and within 4 feet of the exclusion fence, under the supervision of the USFWS-approved

biologist. Pickleweed removal areas will be surveyed using a handheld GPS instrument. Pickleweed will not be removed from areas of the FSFA that do not require disturbance. Conservation measures are detailed in the BA (Appendix G) and PSMHRP (Appendix H).

- Other areas of the project footprint will be cleared and grubbed as necessary, including laydown or staging areas and upland areas of the FSFA. All clearing and grubbing activities will be conducted under the supervision of a USFWS-approved biologist. Clearing and grubbing may include removal of large bushes and surface debris such as concrete blocks and rebar. Areas not to be excavated will not be disturbed, except to remove debris that may pose a health and safety risk (such as exposed rebar).

- If the secondary laydown/staging area (at the N217A area) is used, the vegetation will be cleared and an exclusion fence will be erected using the same methods, materials, and biological monitoring described in this section and Appendices G and H for the FSFA.

- A USFWS-approved biologist will monitor mobilization, excavation, and loading activities and will provide guidelines to minimize impacts on the surrounding habitat.

- The USFWS-approved biologist will be on site daily (surveying the FSFA and surrounding environs for special status species) during removal activities and will remain on site for the duration deemed necessary by the biologist, using decision criteria stated above (under pilot study).

<u>Prior to ecological restoration (revegetation and monitoring), the following activities will be completed</u>:

- After final site grading, the USFWS-approved biologist will conduct a site walk to identify and document (using handheld GPS) the locations for restoration and reference vegetation monitoring plots and photographic documentation points. The final grading plan and site walk will support development of the final site restoration plan (Section 3.8). Reference transects will be selected that meet the cover and species composition requirements detailed in the PSMHRP and BO (Appendix H). Prior to the first year of monitoring, NASA will submit a summary of the vegetation community composition and cover of each selected reference transect to CDFW and USFWS.

- The USFWS-approved biologist will be on site daily (surveying the FSFA and surrounding environs for special status species) during restoration (planting and weed removal or treatment) and will remain on site for the duration deemed necessary by the biologist, using decision criteria stated above (under pilot study).

- Annual restoration monitoring of the restoration and reference sites will be conducted by a restoration biologist. Data from the reference site will be used to determine whether the restoration site is trending toward meeting restoration goals, as identified in the PSMHRP.

One or more USFWS-approved biologists will conduct a training session for all project personnel and visitors prior to the beginning of any ground-disturbing activities within the project footprint. All personnel or visitors entering the areas with any ground-disturbing activities must attend the training. The training will be developed and implemented by the USFWS-approved biologist, and a copy of the training module will be given to each person working on the project, with other copies to be made available in the Contractor's project management trailer.

To reduce potential impacts from infestation by non-native cordgrass (*Spartina alterniflora*), pepperweed (*Lepidium latifolium*), and other invasive, non-native, plant species from other sites, all equipment, including dump trucks and personal gear, will be cleaned of soil, seeds, and plant material at an off-site facility prior to arriving on site. Equipment, trucks, and personal gear will be subject to inspection. All infestations occurring within the removal action boundary will be controlled and removed to the extent feasible and according to the success criteria detailed in the PSMHRP, without substantially hindering or harming the establishment of native vegetation in the restored wetlands. Herbicide treatment will occur by a licensed qualified applicator, according to product labels, when no rain is anticipated, and, if applying by sprayer, on days with wind velocities less than 5 miles per hour. Herbicide used in or near the stormwater retention pond will be approved by EPA, the Regional Water Board, and CDFW for use in wetlands.

3.2 SITE CHARACTERIZATION

The site characterization will include a pilot study and full-scale ISM investigation. The SAP/QAPP for site characterization is included in this RAWP as Appendix D.

The pilot study has an expected duration of 10 days and is scheduled to occur in January 2018. The purpose of the pilot study is to establish the cleanup goal confidence interval that will be applied to all investigation decision unit (DU) sample results in each IAG for the full-scale investigation. The drilling subcontractor will provide three drill teams working concurrently to advance 270 direct-push technology (DPT) borings to native soil within three approximately 100-foot by 100-foot IAGs (Figure 7). Samples will be collected from the three IAGs with 30 increments, each in triplicate, from multiple depth intervals (each depth interval is a DU within the IAG). Each increment will be a boring (or segment of a boring) advanced using DPT to the bottom of fill, estimated at between 8 and 18 feet bgs. Borings will be approximately evenly spaced within the IAG, forming an approximate grid pattern.

Before the pilot study begins, a surveyor will conduct a detailed topographic survey of the top of the FSFA and stake the corners of the IAGs. After the IAGs are marked, the existing pickleweed areas will be surveyed by a USFWS-approved biologist (Section 3.1). An exclusion fence (described in Section 3.1) will be constructed as close to the anticipated work areas as practicable and will extend around the entire FSFA, including the access road and contractor staging/laydown area on the southern end of the peninsula. As described in Section 3.1, vegetation within the work area and within 4 feet of the exclusion fence (measured from the outside edge) will be removed to discourage mice from entering the work area.

The full-scale investigation has an expected duration of 6 weeks following the pilot study. The purpose of the full-scale investigation is to refine the vertical and horizontal extent of contaminated soil and sediment at AOI 14 and two adjacent locations in Navy IR Site 25 where concentrations of lead, total DDT, and total PCBs exceed cleanup goals. The following borings will be advanced during the full-scale investigation:

- Total of 660 borings to native soil (estimated between 8 and 18 feet bgs, depending on the location) within 21 approximately 100-foot by 100-foot IAGs located within the FSFA (referred to as Fill IAGs). Borings located on the perimeter of the FSFA will be advanced to native soil using angle-hole methods to obtain material representative of soil and fill within the sideslopes.

- Up to 30 borings (total for the FSFA) using a hand auger on the sideslope (to a maximum depth of 4 feet bgs) in IAGs located on the FSFA perimeter.

- Up to 30 borings (total for the FSFA) using a hand auger into the stormwater pond sediment (to a maximum depth of 1 foot) in IAGs where the IAG boundary extends into the stormwater pond.

- 30 borings using a hand auger into the stormwater pond sediment (to a maximum depth of 1 foot) in two areas adjacent to the toe of the FSFA slope; these two areas are referred to as stormwater pond IAGs (SP IAGs). SPIAG01 is approximately 660 square feet, and SPIAG02 is approximately 2,900 square feet (Figure 7), or a combined 0.08 acre.

During the pilot study and full-scale investigation, ISM samples representing separate depth horizons (DUs) will be collected from the following depth intervals at each fill IAG:

- One surface 2-foot depth interval (0 to 2 feet bgs)

- Four 4-foot depth intervals throughout the remainder of the fill material (2 to 6, 6 to 10, 10 to 14, and 14 to 18 feet bgs)

- Subdivision of 4-foot depth intervals into 2-foot DUs (in the full-scale investigation, these samples will only be analyzed if any individual 4-foot DU contains concentrations of lead, total DDT, and total PCBs that exceed cleanup goals)

ISM increment compositing will be conducted at a field location on the FSFA, and the samples will be analyzed for lead, dichlorodiphenyldichloroethene (DDE), dichlorodiphenyldichloroethane (DDD), DDT, and PCBs as Aroclors.

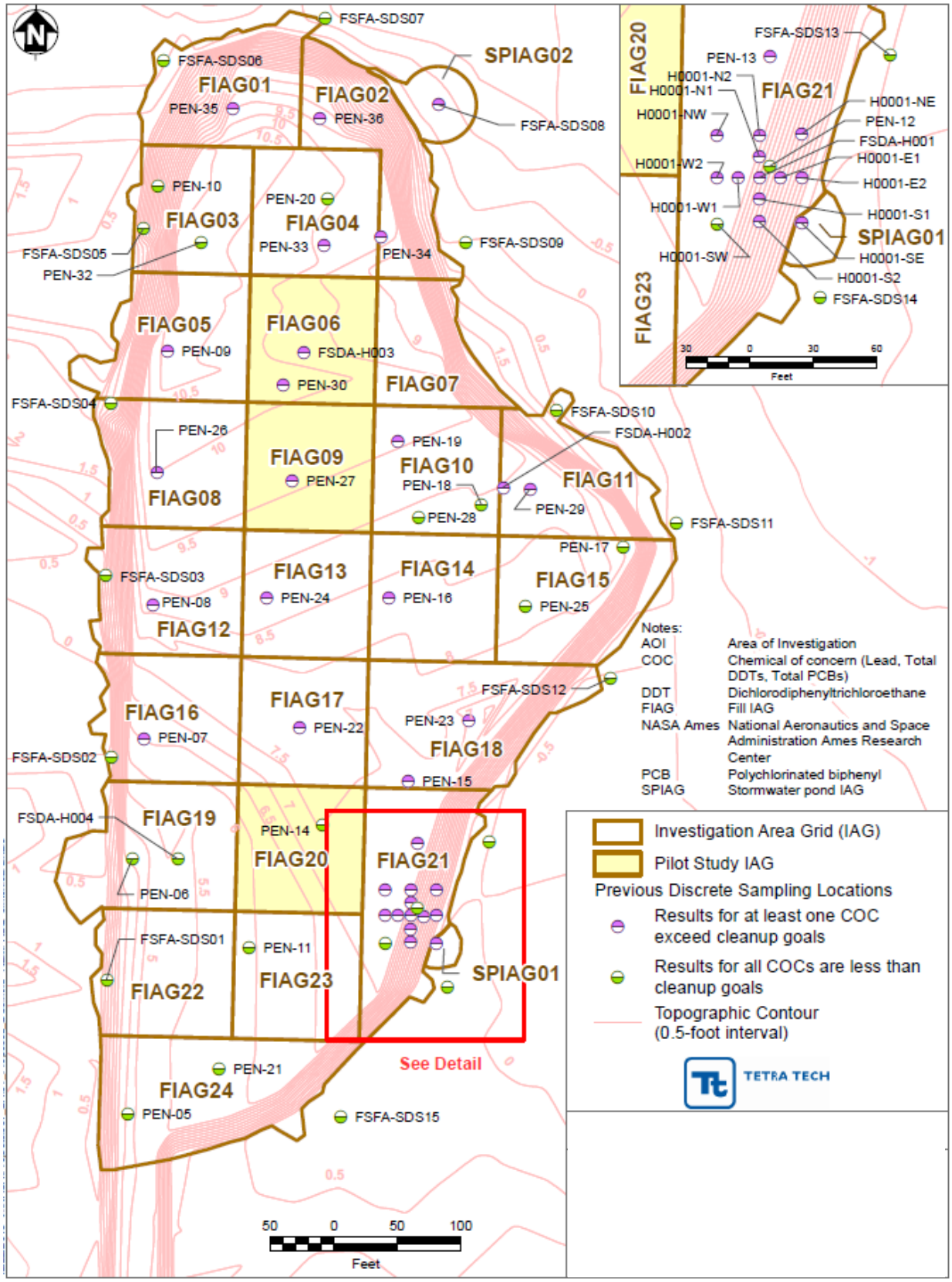


Figure 7. Proposed Decision Units and Previous Sampling Locations

Hand augers will be used to collect soil at Fill IAGs located on the perimeter of the FSFA and sediment in SP IAGs to represent the contamination concentrations in the sideslopes and stormwater pond sediment. From each increment location collected using these additional methods, a volume of soil equivalent to the soil volumes from each of the other increments will be incorporated into the ISM samples at the appropriate depth horizons (based on the vertical elevation of the sample location, which will be determined using land-surveying differential leveling methods).

Samples at the two SP IAGs will be collected to depths of 1 foot bgs. Two vertical DUs have been established at each SP IAG; the top interval is from 0 to 0.5 foot bgs, and the bottom interval is from 0.5 to 1 foot bgs. ISM sample increments will be collected from both intervals at each of the two SP IAGs.

The two SP IAGs extend beyond the existing silt fence. As described in Section 3.1, a temporary exclusion fence will be constructed around the perimeter of the sampling area and vegetation within the work area and within 4 feet of the exclusion fence (measured from the outside edge) will be removed to discourage mice from entering the work area. The exclusion fence and the existing silt fence will be modified as necessary to create an opening, and pickleweed will be cleared from a small swath (less than 10 feet wide) to create a footpath to the sample area to allow safe access for sampling staff to hand-sampling areas within the stormwater retention pond SP IAGs. Figure 4 of the PSMHRP (Appendix H) shows areas of pickleweed potentially disturbed by the footpaths.

If contaminants of concern are not detected at concentrations exceeding cleanup goals in the surface and 4-foot increment ISM samples in Fill IAGs, no further analysis will be required. If concentrations of lead, total DDT, and total PCBs are detected in excess of cleanup goals in a 4-foot increment ISM soil sample, that 4-foot increment will be subdivided into two 2-foot increments that will be analyzed for the contaminants that exceeded cleanup goals. In addition, ISM soil samples may be analyzed to further refine the areas of contaminated fill if the residual site-wide average concentrations of lead, total DDT, and total PCBs at AOI 14 exceeds the Navy IR Site 25 site-wide average remediation goals.

If contaminants of concern in SP IAGs are not detected at concentrations greater than cleanup goals in the top interval sample (0 to 0.5 feet bgs), no further analysis will be required. If contaminants of concern are detected in excess of cleanup goals, the bottom interval ISM soil samples (0.5 to 1 foot bgs) will be analyzed for the contaminants that exceeded cleanup goals.

The results of the pilot study and full-scale investigation will be communicated to applicable NASA personnel, regulatory agencies, and NASA's contractors. A summary document that identifies the areas and depth intervals containing soil or sediment with concentrations of contaminants exceeding cleanup goals will be prepared. The residual site-wide average concentrations of lead, total DDT, and total PCBs will be calculated and compared with the site-wide average remediation goals for Navy IR Site 25 (as discussed in Section 2.1). If necessary, additional areas to be excavated to achieve the site-wide average remediation goals will be identified.

3.3 PROFILING SOIL FOR WASTE DISPOSAL

Before excavation begins, NASA Ames will coordinate with waste disposal companies to profile or characterize the vegetation, fill material, construction debris, and sediment to be excavated for disposal. Laboratory data from samples previously collected at AOI 14 and data collected during the site characterization discussed in Section 3.2 will be available for the waste-disposal vendors. Additional waste characterization sampling may not be necessary to adequately characterize the fill material or sediment for disposal because of the number of samples collected during the incremental sampling. However, the waste disposal vendors may request particular waste characterization sampling methods, such as the Toxicity Characteristic Leaching Procedure (TCLP), paint filter test for moisture content, and Waste Extraction Test (WET), before disposal. If necessary, a SAP will be prepared for NASA approval and samples will be collected and analyzed for these analyses.

3.4 PRE-CONSTRUCTION PHOTOGRAPHS

Pre-construction photographs of the existing AOI 14 and NASA Ames infrastructure potentially impacted by the removal action will be taken so that impacts from the removal action can be assessed and adequate repairs and restoration can be made at the end of the NTCRA. Areas included in the photographs will include the FSFA, contractor laydown or staging areas, roads around AOI 14 (particularly all roads designated as haul roads), fences, buildings, pavement, and walkways.

3.5 PERMITS AND NOTIFICATIONS

Removal action operations will be coordinated with the NASA Project Manager and NASA contractors. The following permits and notifications to NASA and other agencies are anticipated for the removal action:

- A NASA Planning Clearance Application will be completed and submitted to NASA Ames. The application requires review and approval by the NASA Ames permit planning board. Field construction work will not begin until the required permitting action is approved and a signed work permit is issued by the NASA Ames Chief Building Official.

- A NASA construction permit application will be completed, submitted to NASA Ames, and approved by NASA before excavation begins.

- A NASA Safety Clearance Permit application will be completed and submitted to NASA Ames for review and approval before work begins.

- A NASA hot work permit is required if any hot work (welding or cutting) will be conducted. Acquisition of this permit will be coordinated through the NASA Ames Safety Group.

- A NASA permit will be obtained if the use two-way radios is planned.

- County or local permits may be required to complete the removal action (for example, permits to abandon existing monitoring well 10A01A, which is the only well impacted by the removal action [Section 4.5], or to operate generators at the site).

- An access agreement (if necessary) will be requested from MROSD to conduct removal or restoration activities on the western slope of the FSFA if equipment will enter the stormwater pond on MROSD property.

- Security access to and transportation across property leased by Planetary Ventures, Inc. (a tenant at Moffett Field) will be coordinated with NASA Ames and Planetary Ventures, including gate access, use of roads near the Moffett Federal Airfield, and site security. Additional training and coordination with Moffett airfield operations groups will be required for access to portions of the haul route that cross an aircraft taxiway.

3.6 UTILITY CLEARANCE

Utility plans provided by NASA Ames will be reviewed and utilities in or near the areas of proposed excavation or disturbance will be identified, including staging or laydown areas if necessary. Known NASA utility information is indicated on the removal action drawings (Appendix C). An underground high-pressure gas main runs along portions of North Perimeter Road at the southern end of the FSFA and near the secondary staging area. The approximate location of this gas main is shown on the drawings in Appendix C. This gas main will be located and protected from damage by avoiding any potential contact. In addition, the geophysical survey conducted in October 2016 indicated a possible underground line or other linear feature along the north-south-oriented dirt road that runs along the western portion of the FSFA (Appendix B). It is not known if this linear feature is a utility corridor that may contain active or abandoned utilities. Underground Service Alert of Northern California and Nevada will be notified and a specialty utility survey company will be used to locate and mark underground utilities in areas that will be disturbed at the FSFA or outside of the FSFA where utilities may be present.

3.7 WATER DIVERSION OR DAMMING

Stormwater may accumulate in the stormwater retention pond surrounding the FSFA, particularly in the wet season from December through March. Stormwater runoff from the western portion of NASA Ames flows northward into the settling basin, into the Eastern Diked Marsh, and then under North Perimeter Road to the stormwater retention pond. Typically, portions of the stormwater retention pond are flooded with 1 to 5 feet of standing water during the wet winter and early spring months but are partially dry during summer and fall. Water diversion or temporary dams may be necessary because the removal action will occur during portions of the wet season.

The removal action may include excavation of the slopes of the FSFA or excavation of sediment within the stormwater pond adjacent to the FSFA (see Figure 5). Water diversion efforts or temporary dams may be necessary to prevent stormwater from entering the removal action area.

Temporary dams may consist of plastic partition-type dams (Porta Dam™ or equal) or bladder-type inflatable dams (Aqua Dam™ or equal). Temporary dam installation and layout will be coordinated with NASA Ames personnel and the USFWS-approved biologist, and dams will be placed within barren areas of the stormwater retention pond or as close to the project footprint as feasible to minimize disturbance of pickleweed. Existing stormwater within the removal action area during and immediately after the temporary dams are installed will be collected in small sumps, filtered, and pumped with centrifugal or diaphragm pumps over the dam and into the stormwater pond. Water that accumulates within the removal action boundary after a dam is installed or that accumulates behind the exclusion fence will be filtered and pumped into the stormwater pond (with EPA and Regional Water Board concurrence) or containerized and disposed of properly off-site. The temporary dams will be removed either as soon as possible when they are no longer required or after excavation and regrading are complete.

The settling basin also receives effluent consisting of treated groundwater from the West-side Aquifers Treatment System (WATS), a contaminated-groundwater treatment system operated by NASA. The settling basin outfall discharges effluent into the Eastern Diked Marsh. WATS effluent (approximately 50 gallons per minute) may be diverted away from the stormwater pond before construction begins to reduce standing water within the removal action boundary or for use during construction. This activity will be covered under the existing National Pollutant Discharge Elimination System (NPDES) permit for WATS discharge (Regional Water Board 2014) with Regional Water Board approval. Under the permit the WATS effluent water is routinely sampled for volatile organic compounds (VOC) and other constituents and is devoid of contamination. If NASA intends to divert or reuse the treated water for any purpose other than those specified in the current NPDES permit, NASA will consult with the Regional Water Board before any action is taken. NASA and the Regional Water Board caseworker will identify the necessary parties to be notified (if any).

If necessary, the WATS water will be diverted using the same methods used for the Navy IR Site 25 remedial action (ITSI Gilbane 2012), which entailed installing a lift pump in an existing manhole at the connection to the stormwater settling basin near the Eastern Diked Marsh. The pump will be powered by a diesel generator or existing electrical supply. The pump discharge will be connected to temporary pipes or fire hoses and directed to an existing catch basin east of Zook Road and west of the Moffett Federal Airfield flight line. The catch basin will convey the water by gravity eastward under the flight line to join the NASA storm drainage system, eventually entering the Northern Channel. From the Northern Channel, water is pumped into the Sunnyvale West Flood Control Channel.

Alternatively, if the WATS water is used for construction purposes (for example, dust control and equipment decontamination), the water will be diverted to the removal action area or contractor staging areas. The Contractor will prepare a water diversion plan for approval by NASA Ames before diverting the WATS water to the construction area or the Northern Channel. This activity will also be included in the NASA construction permit application.

3.8 CONSTRUCTION SUBMITTALS

A complete list of construction submittals will be included in the Construction Specifications. The following is a list of major submittals to be prepared and submitted to NASA Ames for review and approval before construction:

- Site Management Plan (SMP)
- Contractor Quality Control Plan
- Sampling and Analysis Plan (for waste characterization and disposal)
- Health and Safety Plan (HSP)
- Pre-construction photographs
- Utility survey
- Traffic Control Plan
- NASA, county, or other local construction permits and notifications
- Water Diversion Plan (if necessary)
- Updated SWPPP (to reflect contractor-specific modifications)
- Spill Control Release Plan (emergencies, drums, liquids, stormwater runoff, etc.)
- Dust Control Plan (including water supply and usage)
- Waste Management Plan (including disposal and recycling facility requirements and equipment/truck decontamination)
- Final Grading Plan
- Final Site Restoration Plan

Descriptions and requirements for these submittals are discussed in subsequent sections of this RAWP or in the construction specifications. As site conditions or construction methods change during removal action activities, these submittals will be revised and updated as necessary.

4.0 CONSTRUCTION ACTIVITIES

This section describes the general methods and materials to be used to complete the removal action activities, including site management, mobilization, site preparation, meetings, excavation, and site restoration.

4.1 SITE MANAGEMENT

Site management is discussed in this section. Health and safety concerns are discussed in Section 6.3 and Appendix E.

The Contractor will provide an SMP that documents the planned approach for excavating and disposing of soil off site and site regrading. It will describe the project management approach, work conducted to prepare the site before work begins, and work performed to manage the site. The project management approach will discuss roles and responsibilities of the Contractor's management team and subcontractors, provide a communications plan to disseminate information to NASA, leaseholders, and all other concerned parties, present a construction schedule that reflects provision of all submittals and licenses and implementation of this RAWP. The schedule will reflect all phases of work. The SMP will also provide drawings showing the planned changes to site work zones (support, contamination-reduction, and exclusion zones) as work proceeds.

4.1.1 Security, Access, and Traffic Control

All persons entering NASA Ames will have security badges issued by NASA Ames. No pets or firearms will be allowed onto NASA Ames or any other portions of Moffett Field. No drones will be allowed because the site is near an active airfield. Once inside the facility, all vehicle traffic will strictly observe NASA traffic control and construction permit requirements. Truck traffic will adhere to restrictions related to the use of specific gates for access to and egress from NASA Ames. The Contractor will coordinate with NASA Ames and Planetary Ventures as necessary for security, access, and traffic control.

Project personnel and vehicles will proceed to work areas and staging areas over established roadways or areas previously cleared for use. During construction, the Contractor will coordinate with NASA Ames to establish truck routes and holding areas. All trucks transporting excavated material from the FSFA will strictly follow the haul route outlined in Appendix C. Trucks will enter NASA Ames through the Ellis Street Gate and proceed around the western side of Moffett Federal Airfield along Zook Road. The Ellis Street Gate is staffed during work hours by NASA security. Additional access requirements are necessary to pass through the gates on either side of the airfield taxiway. All Contractor drivers who will access the airfield taxiway will attend training provided by NASA Ames, must be U.S. citizens or Green Card holders, and will coordinate access times with NASA airfield operations. Contractor personnel will be responsible for ensuring that foreign object debris does not accumulate on the airfield taxiway from Contractor vehicles.

Traffic controls will include signage and flagmen during high-volume transportation and disposal (T&D) operations and measures to ensure that diesel-burning haul trucks are not idling

more than necessary. Traffic controls will be consistent with guidance from the California Manual on Uniform Traffic Control Devices for Streets and Highways (California Department of Transportation 2014). The Contractor will provide a Traffic Control Plan to NASA Ames for review and approval.

Although AOI 14 is within NASA Ames, the NASA Ames boundary fence is along the southern border of the FSFA. Therefore, access to the FSFA is not controlled on the north, east, and west. Access to this area is not restricted, and the public (bicyclists and hikers) can access the site via the San Francisco Bay Trail (see Figure 4). Trespassers could cross the stormwater pond during the dry season. Appropriate flagging and warning signs will be posted so that any trespassers are forewarned that they are entering a construction site with potential hazardous waste. Flagging and signs will be less than 3 feet tall or will include anti-perch devices such as flags or spikes to prevent predator perching.

Local site access will be controlled by temporary barriers including warning tape and signage during active sampling, excavation, grading, and restoration. During off-work hours, any work areas near existing roadways that could affect vehicle traffic will be demarcated with battery-operated reflectors. Gates between NASA Ames and the FSFA (Gate 16C) or other contractor laydown areas (Gate 16A) will be kept closed (and locked during off-work hours) except when project vehicles are crossing.

4.1.2 Equipment and Personnel Decontamination Facilities

Dry decontamination methods will be used to the maximum extent possible to clean excavators, backhoes, trucks, and other associated tools and equipment. Should decontamination fluids be used, equipment decontamination areas will be established near the excavation sites and at any staging areas to avoid tracking of contaminated soil off site. Potential areas for contractor staging/laydown areas and decontamination facilities are indicated on the construction drawings in Appendix C. Equipment decontamination areas will be constructed as specified in the SWPPP (Appendix F).

Personnel decontamination areas may be established at work areas if required by the Contractor's HSP. If feasible, WATS effluent water will be used for equipment decontamination (see Section 3.7).

Decontamination water will be contained, collected in a storage tank, and reused on site or disposed of at a licensed disposal facility, based on characterization. Solids collected in the decontamination area will be stored and characterized for subsequent reuse or disposal.

4.1.3 Temporary Utilities during Construction

The Contractor will provide or use the following utilities during project execution:

- Construction water (for dust control, equipment decontamination, or compaction of backfill, for example) will be imported or obtained from WATS effluent.
- On-site communication will be accomplished via two-way radios and cell phones.
- An electrical power drop is available near both the primary and secondary Contractor trailer areas to power the Contractor's field trailer. Known locations of electrical utility lines are shown on the construction drawings (Appendix C). The Contractor will coordinate with NASA Ames personnel to connect to NASA's electrical service.
- Bottled water or potable water jugs will be provided for site workers.
- Sanitation facilities including portable toilets and refuse containers will be set up near the work sites. Portable toilets will have non-potable water for hand washing.

4.1.4 Work Hours

Work within the FSFA area will be conducted Monday through Friday during daylight hours only (between 7:00 a.m. and 6:00 p.m. depending on the time of year) or as specified by a qualified biologist for the protection of sensitive species, and in accordance with the requirements of the BO. Any work on weekends or on federal holidays will be conducted only with pre-approval from NASA Ames and the on-site USFWS-approved biologist. Work on NASA's roadways will conform to business hours established by NASA or Planetary Ventures for these roadways.

4.1.5 Contingency Plan

The likelihood of unplanned releases of contaminants that could threaten human health or the environment is low because the contaminants tend to sorb strongly to soil and the release of sediment or soil from the site will be controlled through stormwater management practices, including the existing silt fence surrounding the removal action area. Amounts of fuel that will be stored at the site will be minimal, and any fuel storage tanks will have dedicated secondary containment.

In case of emergencies, the Contractor will implement emergency response measures described in its site-specific HSP. Measures to protect water resources during the removal action are described in Section 6.5. A SWPPP was developed to describe the best management practices (BMP) that will be put into place to manage stormwater on site, including protection of adjacent surface water resources from erosion of contaminants in the on-site soil (Appendix F).

4.2 MOBILIZATION AND SITE PREPARATION

After NASA provides a NTP, the Contractor will mobilize personnel and equipment to the project site. The Contractor may use the laydown/staging areas shown on the construction drawings to store equipment or material during the removal action. It is anticipated that the primary staging area (located in the southern [upland] portion of the FSFA) and the secondary staging area (located on the N217A peninsula) will contain the following:

- Sanitary facilities (including personnel decontamination facility, portable toilets, non-potable water, and drinking water)
- Equipment decontamination facility (rumble strips, dry decontamination area, wet decontamination area with liner, and wastewater collection and storage)
- Facilities for refueling construction equipment, including fuel tanks with secondary containment, fueling nozzles, and containment facilities to prevent spills during refueling
- Staging areas for equipment when not in use and for material, including materials necessary to repair or maintain roads damaged during construction, materials used to construct stormwater or biological mitigation measures, and fencing.
- Generator for on-site power (including noise baffling devices).

The Contractor may set up a field trailer at the locations shown on the construction drawings (Appendix C), at the primary location near the intersection of Allen Road and Defrance Avenue (preferred) or on an existing concrete pad at the Outdoor Aerodynamics Research Facility south of the Eastern Diked Marsh. The Contractor may tie in to the existing NASA Ames power supply to provide electricity to the trailer. Other utilities may be available for Contractor use, including potable water. The Contractor will coordinate utility hookups with NASA Ames.

Access to restricted areas will be coordinated with NASA Ames security and Planetary Ventures. The roadway near Gate H (Appendix C) will serve as the truck waiting area, where dump trucks will remain until they are ready to be loaded. The trucks will then proceed to the FSFA to receive their load. Waiting trucks will not idle for longer than 5 minutes, in accordance with California regulations. Truck traffic will conform to NASA and Planetary Ventures business hours for these roadways.

Secured storage containers will be mobilized to the job site as needed to store materials and small tools or equipment.

Anti-perch devices such as spike strips will be installed on top of the existing NASA perimeter fence (detailed in Section 3.1) and will remain in place during and after the NTCRA to prevent predators from perching near the habitat of the SMHM.

4.3 CONSTRUCTION MEETINGS

A pre-construction meeting will be attended by key NASA Ames staff, on-site contractors and tenant stakeholders, and key contractors and subcontractors. The meeting will address health and safety considerations, quality management, site security, scope of work, lines of communication, contract requirements, and relevant text from Section 7 of the ESA requirements, as outlined in the BA.

All parties entering the project footprint will be provided with maps showing the project boundaries and access and staging areas and will be informed that construction activity must be confined to those corridors. Maps will include the locations of listed species and habitats and United States Army Corps of Engineers (USACE) jurisdictional waters.

One or more USFWS-approved biologists will conduct a training session for all project personnel and visitors prior to the beginning of any ground-disturbing or vegetation-clearing activities within the project footprint. All personnel or visitors entering the areas with any ground-disturbing or vegetation-clearing activities must attend. The training will be developed and implemented by the USFWS-approved biologist, and a copy of the training module will be given to each person working on the project, with other copies made available in the project management trailer. The training module will include general provisions of the Endangered Species Act and penalties associated with violating those provisions, conservation measures and reasonable and prudent measures listed in the BO, color photographs, a brief natural history description, and description of habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. Due to the difficulty of field identification to species level, any mouse sighted will trigger the conservation measures for the salt marsh harvest mouse, and those measures will remain in place until a biologist with specific salt marsh harvest mouse permitted handling and identification experience can be brought on site and make an evaluation.

The module will also include descriptions of pickleweed, the protection of which is important to the salt marsh harvest mouse, and the invasive pepperweed (*Lepidium latifolium*) with practices to avoid its spread. Vegetation removal methods will also be addressed and will detail requirements of the BO (and detailed in the PSMHRP [Appendix H and Attachment H-3]) for the protection of the salt marsh harvest mouse. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

For work in non-sensitive habitats, environmental briefings will occur weekly or as needed. A USFWS-approved biologist will keep NASA informed about significant biological resources observed on site, such as nests that require buffers. NASA and contractors will comply with all input from the USFWS-approved biologist throughout the duration of the project.

The Contractor will conduct construction meetings before each new phase of work, every month, or as requested by the NASA Ames Project Manager. Meetings will be among NASA Ames staff and key contractors and subcontractors. Meetings will discuss the results of the incremental sampling, progress of construction activities, and ecological monitoring or restoration measures.

4.4 CLEARING AND GRUBBING

Clearing and grubbing of areas at or near excavation sites and at contractor laydown and storage areas may be required. All activities will be conducted under the supervision of a USFWS-approved biologist. Vegetation removal and habitat protection and mitigation measures are described in the BA (Appendix G), PSMHRP (Appendix H), and BO (Appendix H, Attachment H-3). Clearing may include removal of large bushes and surface debris such as concrete blocks and rebar. Areas that will not be excavated will not be disturbed, if possible, except to remove debris that may pose a health and safety risk (such as exposed rebar).

4.5 MONITORING WELL ABANDONMENT

Only one monitoring well (10A01A) is located at AOI 14; this well will be abandoned as part of the removal action because it is within the removal action area, will be impacted by construction activities, and is not required for ongoing monitoring. The location of monitoring well 10A01A is shown on the construction drawings (Appendix C). Monitoring well 10A01A was installed on the FSFA in 1991 to monitor potential concentrations of VOCs in groundwater as part of NASA's Center-Wide Sampling and Analysis Program.

Monitoring well 10A01A was completed to 20 feet bgs with 2-inch-diameter Schedule 40 polyvinyl chloride casing, screened from 10 to 20 feet bgs, and completed with an above-grade standpipe and bollards for protection (approximately 3 feet above ground surface). The depth to water at well 10A01A was approximately 13 feet bgs when the well was installed and the boring log for the monitoring well shows that native clay was encountered at approximately 10 feet bgs.

Samples were collected from monitoring well 10A01A semi-annually from 1991 to 1995, annually from 1996 to 2000, and once in 2004. Each sample was analyzed for VOCs. No VOCs were detected in any of the samples collected at monitoring well 10A01A except for one detection of trichloroethene (TCE) (0.61 microgram per liter [µg/L]) in the sample collected on July 6, 1995. This concentration is less than the federal and California maximum contaminant level for TCE (5 µg/L). The groundwater sample collected from monitoring well 10A01A in September 2004 was also analyzed for PCBs. No PCBs were detected in the sample.

The well is not located within or near any VOC plume or area of affected groundwater. The monitoring well has not been sampled since 2004 and no VOCs or PCBs have been detected in the well with the exception of the single TCE detection in 1995. In addition, groundwater is not a medium of concern at AOI 14 because fill material is not in contact with groundwater and because groundwater sampling results indicate that contamination is not impacting groundwater. The contaminants detected in soil (metals, PCBs, and pesticides) generally sorb strongly to soil particles and thus, their potential for migration to groundwater is low. Therefore, monitoring well 10A01A will be abandoned and a replacement well will not be installed.

The surface features will be removed and disposed of along with the construction debris. Portions of the monitoring well that extend below the excavation will be drilled out or pressure grouted in accordance with Santa Clara Valley Water District Well Ordinance 90-1.

4.6 REMOVAL OF CONSTRUCTION DEBRIS

Construction debris encountered during excavation or on the surface of the FSFA in work areas will be removed from the excavated fill and sediment, segregated into material types, and transported to an appropriate landfill for disposal or recycling. As indicated by the geophysical investigation (Section 2.2), construction debris consists mainly of reinforced concrete, asphalt, and wood debris at the surface and along the slopes of the FSFA (Figure 8). As required to meet grading requirements, construction debris will be segregated and removed based on visual inspection, and no visible asphalt will be left at the surface of the FSFA. As much as practicable, concrete and metal will be recycled, and brick, glass, plastic, asphalt, and wood will be disposed of in a Class III landfill. Material with visible oil staining will be tested for PCBs. The material will be cleaned as necessary before recycling or disposed of off-site based on the results of the testing.

The apparent extent of artificial fill is approximately 6 acres, and the portion of apparent artificial fill that contains ferrous metal debris is approximately 5.5 acres. The geophysical investigation indicated a greater density and thickness of construction debris fill in the northern portion of the FSFA. Based on the geophysical investigation, it is estimated that 3,000 (bank) cubic yards of construction debris will be transported and disposed of as solid waste at either a California Class II landfill or as construction debris.

4.7 EXCAVATION OF CONTAMINATED MATERIAL

The excavation areas, depths, and volumes will be determined by the results of the site characterization (Section 3.2) and may include FSFA fill material and sediment within the adjacent stormwater pond (Navy IR Site 25). Excavation will occur in each DU as directed by the results of the site characterization ISM samples, after communication with EPA and the Regional Water Board. DUs containing contaminated soil or sediment will be identified; these DUs will be a minimum of 2 feet thick and will encompass the entire IAG. IAGs will range in size from approximately 8,000 square feet to approximately 15,000 square feet. Clean material (containing concentrations of contaminants below the cleanup goals) in DUs located above DUs with contaminated material will be removed and stockpiled for use during regrading after the contaminated material is removed. Quality control (QC) procedures used by the Contractor to measure the depths and areas of contaminated material will be documented in the Contractor's Quality Management Program (QMP), which will be approved by NASA before construction begins.

Figure 8. Location and Type of Surface Construction Debris

Construction debris, fill, and sediment will be excavated and segregated from each IAG at the FSFA based on the ISM sampling results. It is estimated that the total volume of material to be excavated will be 65,000 (bank) cubic yards, which is based on geophysical investigation and the results of the discrete soil samples collected at the FSFA prior to 2016. However, the volume of material to be excavated may vary and will be determined based on the site characterization ISM sampling results. Soil and sediment with contaminant concentrations greater than cleanup goals will be loaded into trucks for off-site T&D. It is assumed that approximately 48,000 (bank) cubic yards will be excavated, sampled, and disposed of at a nonhazardous waste landfill, and approximately 3,000 (bank) cubic yards will require disposal at a hazardous waste landfill. Assuming a bulking factor of 40 percent and the use of trucks with capacities of 20 cubic yards, approximately 3,400 loads will be hauled through NASA Ames to the nearest highway for transport to off-site disposal facilities.

Analytical data from the DUs that have contaminant concentrations less than the cleanup goals (that is, not including data from DUs that will be excavated because the contaminant concentrations exceed the cleanup goals) will be used to calculate the volumetric average concentrations of lead, total DDT, and total PCBs in soil remaining at the site. These volumetric averages will be compared to the Navy IR Site 25 site-wide average remediation goals. If volumetric site-wide average concentrations of lead, total DDT, or total PCBs at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14 as part of this NTCRA. Otherwise, soil within DUs that have contaminant concentrations less than cleanup goals (clean soil) will be left in place, or if necessary, staged and stockpiled for reuse in developing final grades at the site. Based on the results of the discrete soil sampling conducted prior to 2016, it is estimated that 11,000 (bank) cubic yards of FSFA clean soil will be used for grading.

The excavation will not extend significantly below the grade of the surrounding stormwater retention pond and is not expected to encounter groundwater because the fill material was placed on top of native soil to create a peninsula. BMPs such as dust suppression, personal protective equipment, and covering the load during transportation will be implemented to minimize potential risks to on-site species, workers, and the community.

4.8 GRADING AND SITE RESTORATION

Disturbed areas will be graded during and after excavation for stormwater drainage. Bulldozers and road graders will move the temporarily stockpiled clean soil into excavated areas. Final grades will generally be sloped to minimize erosion and maximize the surface area of optimal pickleweed growth (typically from 0.5 to 3 feet above mean sea level [amsl]). Clean soil, rock, and other structures that do not pose a human health safety risk will be left in place. Any exposed rebar or other surface debris that may cause a physical hazard will be removed.

If excavation of sediment from the stormwater pond is necessary, the sediment will be excavated in a manner that promotes drainage, to the extent practicable. Excavated areas within the stormwater pond will not be backfilled, and no material will be placed within jurisdictional wetlands or waters of the state. Slopes between the existing pond bottom and the excavated area may be cut back if necessary (that is, additional sediment will be removed from the area

surrounding the excavation to create a gradual slope) to smooth the transition from the excavated areas to the non-excavated areas within the pond.

The volume of clean material that will remain on site after excavation cannot be accurately calculated without the results of the site characterization; therefore, the final grading plan cannot be specified until the site characterization is complete and the final excavation areas are identified. After the excavation areas and volumes are specified based on site characterization results, the Contractor will prepare and submit a final grading plan to NASA Ames for review and approval. The final grading plan will follow these general guidelines:

- The final deposition of material will not extend beyond the toe of slope of the FSFA or into wetlands.

- Soil for final grades and for the seedbed will be soil from within the removal action boundary containing concentrations of site contaminants below the cleanup goals. If possible, the soil from areas dominated by native wetland species (pickleweed, alkali heath [*Frankenia* sp.], saltgrass [*Distichlis spicata*], etc.) will be salvaged and stockpiled for use in final grading and restoration. Ideally, the upper six inches of soil after final grading will have fine texture and greater organic matter compared to the coarser-textured soils at depth.

- Final grading will create a rough, undulating surface and will avoid creating a smooth planar surface. Natural debris such as wood or other weed-free organic litter will be spread as available, throughout the pickleweed restoration area (1.0 to 3.5 feet amsl). Pickleweed removed during the excavation (and free of contaminants) may also be sparsely transplanted in the lower elevations (0.5 to 2 feet amsl) to create micro-topography, added as mulch to the pickleweed restoration area surface, or incorporated into the upper 12 inches to add organic matter.

- Final sideslopes will not be greater than 25 percent (1 foot vertical:4 feet horizontal) unless approved by NASA Ames. If possible, the Contractor will reduce slopes to minimize erosion and maximize the surface area of optimal pickleweed growth. The slopes will be graded to drain stormwater on the newly constructed peninsula into the existing stormwater pond (minimum 3-percent grade).

- Upland areas will be restored to allow mice and other animals upland refuge during periods of high stormwater elevation in the surrounding stormwater pond. The upland areas will be connected to the existing upland area of the southern portion of FSFA. The upland area will be at least 5 feet amsl.

Stormwater controls (for example, fiber rolls) on the slope and the existing silt fence will remain until vegetation is established.

After regrading is finished, protected species habitat will be restored and general site vegetation will be established as detailed in the PSMHRP (Appendix H). The final site restoration design

will be determined by the extent of the excavation and disturbed areas. To the extent possible, final grades will be consistent with the surrounding stormwater ponds, slopes, and uplands. The Contractor will prepare a final site restoration plan and will submit it to NASA Ames for review and approval.

4.9 DECONTAMINATION OF EQUIPMENT

Before demobilization and to prevent the spread of contamination during the removal action, all excavation equipment and vehicles that come into contact with contaminated soil, sediment, or liquids will be decontaminated in controlled and contained upland areas before leaving the work area. Equipment will be raised on rumble strips and cleaned using brushes and wipes in these areas to eliminate the need for or minimize the volume of rinsate water requiring treatment or disposal. If equipment has oil smears or other coatings that cannot be removed with brushes and wipes, the equipment will be washed and cleaned with a contaminant neutralizing agent, as necessary.

If necessary during rainfall or when significant contamination is present, equipment and vehicles (particularly tires) will be washed with a pressure washer over a bermed lined upland area. WATS water will be used if feasible and in accordance with the NPDES permit (see Section 3.7). Decontamination will proceed until all soil, sediments, or residues are removed. Waste liquids will be contained, sampled, and disposed of properly. With concurrence from EPA and the Regional Water Board, waste liquid may be discharged on site, depending on the results of the sampling.

5.0 POST-CONSTRUCTION ACTIVITIES

This section describes post-construction activities including demobilization, inspections and surveys, and ecological restoration and monitoring.

5.1 COMPLETION INSPECTIONS

Completion inspections will include a Punch-out Inspection, Pre-final Inspection, and Final Acceptance Inspection. The inspections will be performed in accordance with the Contractor's QMP and as described below.

The Punch-out Inspection will be conducted by the Contractor QC Manager (CQCM) near the completion of each phase of the removal action. The CQCM will develop a punch list of items that do not conform to the approved drawings, plans, specifications, or submittals for that phase. A copy of the punch list will be provided to the NASA Ames Project Manager. The CQCM will conduct follow-on inspections to ascertain that all deficiencies have been corrected. When inspections are complete, the CQCM will notify the NASA Ames Project Manager that the completed phase of work is ready for final inspection.

The NASA Ames Project Manager or a designated representative will perform the Pre-final Inspection to verify that the removal action has been constructed satisfactorily. A Pre-final Punch List may be developed as a result of this inspection. The CQCM will ensure that all items on this list are corrected in a timely manner and before notification to NASA Ames that a final inspection can be scheduled.

The Final Acceptance Inspection will be scheduled by the NASA Ames Project Manager based on the results of the Pre-final Inspection. The NASA Ames Project Manager will be notified when the Pre-final Punch List items and any other rework items have been completed, along with all remaining work under the contract.

5.2 FINAL LAND SURVEY

The final grades, elevations, and site features will be land surveyed after all construction activities are complete. The final topographical survey will be conducted by a California-licensed land surveyor to document locations and elevations of key features. The results of the final survey will be used to generate as-constructed Record Drawings. The final survey will be conducted to an accuracy of 0.1 foot horizontally and 0.1 foot vertically. All horizontal coordinates will be based on the California State Plane Zone 3, NAD 83, U.S. Survey Feet surveying control datum, and all vertical elevations will be based on NAVD88 surveying control datum.

5.3 SITE CLEANUP AND DEMOBILIZATION

After field activities are complete, the Contractor will conduct final cleanup of the site and all disturbed areas. The Contractor will replace or repair any existing utilities, site features, or landscaping that was damaged during construction activities. Other restoration activities include repairs and restoration to preconstruction conditions of NASA Ames infrastructure including roads and fencing. If a road or other site improvement was constructed on the FSFA to allow vehicle access to the removal action area, those improvements may remain as constructed with NASA approval to allow maintenance and inspection of the removal action area.

The Contractor will demobilize earthwork equipment and personnel at the completion of site activities and remove the exclusion fence. After all site activities are complete, the Contractor will inspect the equipment storage area and laydown areas to verify that all project-related equipment, trash, and debris have been collected and properly disposed of.

Demobilization will also include the disposition of government-owned property (if any); removal of equipment, tools, and supplies; removal of stormwater pollution prevention or ecological mitigation measures; and removal of temporary fencing, traffic control devices, signs, storage containers, portable toilets, and refuse containers. The existing silt fence around the removal action boundary and the erosion control devices (such as fiber rolls) will remain in place until vegetation is established (according to the specifications listed in the SWPPP). The anti-perch devices along the existing NASA security fence will remain. A final site inspection will be conducted by NASA Ames and other stakeholders as required.

5.4 ECOLOGICAL MONITORING AND MAINTENANCE

Areas where sensitive habitat was disturbed during the removal action will be restored, and monitored and maintained, with maintenance work conducted by hand to the maximum extent possible. Materials and supplies will be transported to the site by truck, offloaded, and moved by hand into the restoration area.

Monitoring and maintenance will be conducted for 5 years or until vegetation performance criteria detailed in the PSMHRP and BO are met, to ensure the effectiveness of the mitigation. Ecological restoration and monitoring requirements are discussed in the PSMHRP (Appendix H).

5.5 POST-REMOVAL ACTION SUBMITTALS

The Contractor will prepare a removal action completion report that describes in detail the site operations performed for the removal action. The report will include site diagrams; results of chemical analysis and other tests; confirmation that the cleanup goals and site-wide average remediation goals were met; amounts and type of materials disposed of; a list of disposal facilities used; copies of waste manifests; copies of weigh tickets; and certificates of disposal, destruction, or recycling. The completion report will also include Record (As-built) Drawings with final grades, elevations, and site features, and a summary of the Contractor's QMP.

NASA Ames will submit the draft completion report to EPA and the Regional Water Board, with copies to site stakeholders, for review and comment. The final version will incorporate resolved regulatory agency comments. All tabular and spatial data and documentation will be included in the report and submitted to NASA in its original form.

Other submittals are listed in the construction specifications.

6.0 PROJECT REQUIREMENTS

This section describes the plans prepared to complete the removal action.

6.1 QUALITY MANAGEMENT PROGRAM

All phases of the removal action will be conducted by the Contractor in accordance with a QMP. The construction specifications outline the requirements for the Contractor to implement the QMP. The QMP focuses on providing confidence that the removal action will meet NASA and all stakeholder requirements for both contractor performance and planned removal action activities.

The QMP will ensure that the removal action is completed and acceptable to NASA and other stakeholders. The QMP consists of the following three phases for each major definable feature of work:

- Preparatory – before the start of each activity, review processes (plans, specifications, construction methods, safety requirements, QC test requirements, and other relevant documents) established to ensure the correctness of the work

- Initial – at the start of each activity, verify that all involved parties understand the processes required to verify that the removal action is completed correctly

- Follow-up – during each activity, monitor the results of the established processes to ensure that the removal action is completed correctly

Site characterization activities will be conducted under the SAP/QAPP in Appendix D. The remaining removal action activities will be conducted under a separate site-specific Quality Control Plan (QCP) prepared by the Contractor. The site-specific QCP will be prepared to comply with the QMP specified in the construction specifications. The QCP will be submitted to NASA Ames for review and approval before construction begins. The plan will include:

- A description of the Contractor's QC organization, including a chart showing lines of authority, and identification of the CQCM.

- The name, qualifications, duties, authorities, and responsibilities of each person assigned a QC function.

- A schedule for managing submittals, testing, inspections, and other QC functions that involve ensuring quality workmanship, verifying compliance with plans and specifications, or any other QC objectives.

- A schedule of inspections required to verify compliance with contract specifications.

- Reporting procedures and reporting format for QC activities, including daily summary reports, schedules of data submittals, inspection data sheets, problem identification and corrective measures reports, evaluation reports, acceptance reports, and final documentation.

- A list of definable features of the work to be performed.

The Contractor will implement all construction activities under the QC measures specified in the Contractor's QCP. QC measures will ensure that design specifications are adhered to and that the construction practices achieve the design objectives. QC documentation—including daily QC inspections, daily photographic logs, product and material submittals (if necessary), preparatory documentation, weekly QC meeting agendas and minutes, and QC testing information—will be submitted to the NASA Ames Project Manager. Daily QC documentation will be submitted with daily contractor production reports and daily health and safety tailgate attendance forms.

6.2 SAMPLING AND ANALYSIS PLAN

The SAP provides guidance to all field and laboratory personnel on the procedural and analytical requirements for collecting samples. Site characterization activities will be conducted in accordance with the SAP/QAPP in Appendix D. As stated in Section 3.3, it is assumed that additional waste characterization sampling will not be necessary to adequately characterize the fill material or sediment for disposal because of the extensive sampling during the site characterization. However, the waste disposal vendors may request particular waste characterization sampling methods, such as TCLP or WET, before disposal. In addition, characterization of wastewater or other removal action-derived waste may be necessary. If warranted, the Contractor will collect these samples and arrange for laboratory analysis. The Contractor will prepare a SAP, in accordance with the construction specifications, for NASA review and approval before collecting the waste characterization samples.

6.3 HEALTH AND SAFETY PLAN

A HSP was prepared for site characterization activities at AOI 14 (Appendix E), and a similar site-specific HSP will be prepared to address all construction activities performed in accordance with the construction specifications. The Contractor will provide a safe and healthful environment for all personnel involved, as well as personnel working near the removal action and other areas disturbed by the removal action.

The Contractor will certify to NASA Ames that the final HSP is reviewed with each Contractor and subcontractor employee prior to mobilization and the start of field work. The HSP will be immediately accessible to all workers at the site at all times during the project, and copies will be located adjacent to the Safety and Health Bulletin on site and in every vehicle on site.

The HSP will be reviewed on a regular basis because it may require updates as site conditions change. Changes to the activity hazard analysis made in the field will be documented and added

to the activity hazard analysis as field change notices. The HSP will be reviewed and approved by NASA Ames prior to the start of any field activities.

6.4 PROTECTION OF BIOLOGICAL RESOURCES

This section describes the plans and assessments to protect biological resources during and after the removal action at AOI 14.

6.4.1 Biological Assessment

NASA Ames prepared the BA to evaluate the anticipated effects of the removal action on threatened and endangered species, as required by the ESA. The BA is included in this RAWP as Appendix G. The USFWS BO is included as an attachment to the PSMHRP in Appendix H. Agency comments on the BA and PSMHRP and NASA's responses are included in Appendix I.

6.4.2 Protected Species Mitigation and Habitat Restoration Plan

The PSMHRP (Appendix H) identifies state-listed threatened and endangered species and presents conservation measures to be implemented prior to and during the removal action for the protection of these species. The removal action will include restoration of wetland, transitional, and upland habitats. The PSMHRP addresses site grading, soil requirements for pickleweed growth, native revegetation (methods and plant palette), methods for monitoring and site maintenance during the habitat restoration period, and vegetation performance criteria, as required by the BO (Appendix H, Attachment H-3).

6.5 ENVIRONMENTAL PROTECTION PLAN

The Environmental Protection Plan (EPP) establishes procedures for executing the project in a manner that protects the environment during the removal action. This EPP includes two main parts: the SWPPP (Appendix F) and dust control plan, as discussed in Sections 6.5.1 and 6.5.2. The protection of biological resources was discussed in Section 6.4.

Environmental protection, as discussed in this section, includes maintaining the environment in its natural state and enhancing or restoring the appearance of disturbed areas after the removal action is complete. Consideration will be given to air, water, and land resources; possible natural, historical, and archeological resources; noise; and solid waste. The EPP will be implemented so that work is performed in a manner that minimizes the pollution of air, water, and land resources and complies with federal, state, and local regulations. Waste minimization practices and recycling will be implemented to the maximum degree practicable. Green and sustainable remediation (GSR) practices, such as using WATS water for dust control or the use of alternative fuels for powering equipment, will be implemented where feasible.

Activities at excavation areas will be conducted in a manner that minimizes impacts to land resources within and outside the project boundaries. Site features including roads and fences will

be restored as appropriate. Before-and-after photographs will be provided for each disturbed location (the FSFA and any laydown or staging areas) to document the restoration.

Archeological remains and artifacts are not anticipated to be encountered during the removal action. However, any structure or artifact of potential historical interest discovered during the removal action will be carefully preserved in an undisturbed state, and the Contractor will report any findings to the NASA Ames Project Manager immediately so that proper authorities may be notified.

6.5.1 Stormwater Pollution Prevention Plan

The SWPPP (Appendix F) describes the site, work to be performed, BMPs to be implemented during construction activities, BMPs to be implemented for erosion control, waste management and disposal practices for spill responses, post-construction controls, site inspection and monitoring programs, responsible personnel, training requirements, and certifications and compliance requirements. This SWPPP will be updated as necessary with site-specific equipment and methods in response to changing site conditions.

Stormwater BMPs described in the SWPPP focus on the following pollutant sources:

- Contaminated soil from excavation suspended in stormwater runoff
- Trackout of soil and sediment from trucks leaving the site
- Hazardous materials from removal activities, including spills of removal action equipment fuel, oil, or lubricant
- Wind erosion of stockpiles of contaminated soil built during construction
- Solid waste from construction
- Sanitary waste from portable toilets

Updates to the stormwater BMPs will be consistent with BMPs and actions identified in the BA, BO, and PSMHRP. A general NPDES stormwater construction permit is not required because removal action activities are being conducted under Section 121(e) of CERCLA.

6.5.2 Dust Control Plan

Project activities will be conducted in a manner that minimizes the release of airborne particulates within or outside the removal action boundary. The principal concern for site excavation involves controlling dust containing lead and other site contaminants. Air monitoring for dust will be conducted in accordance with the Contractor's approved HSP (Section 6.3). Dust control will be

implemented within and downwind of the removal action boundary. All practical precautions will be taken to ensure that dust is not created and that applicable dust criteria (specified in the Contractor's HSP) are not exceeded.

During all earth-moving activities, dust control will be achieved in accordance with the HSP. As a GSR measure, treated effluent from WATS will be used for dust control, if feasible and in accordance with the NPDES permit. Dust control measures will be in place at all times while soil is being excavated, stockpiled, stored, or transported. Truck tires will be decontaminated to prevent trackout of dirt and dust. A street sweeper will be available on the roadways near the truck access points to reduce dust emissions. WATS water effluent used for dust suppression will be monitored to ensure that it meets standards for worker inhalation safety at the point of discharge. The effluent will be included in the Contactor's HSP as a potential source of VOCs and managed accordingly.

Any temporary stockpiles will be covered to prevent releases or will be dampened as needed to control dust. Stockpiles of contaminated soil will be covered with high-density polyethylene sheeting and secured with hold-down weights (for example, sandbags) when not exposed for receiving or removing soil. At the end of each work day, active work areas will be swept or washed as appropriate to minimize the potential for fugitive dust during non-working hours. Care will be taken to control overspraying and to minimize discharge of spray water.

6.6 WASTE MANAGEMENT PLAN

Waste materials generated during this project may include: vegetative matter from clearing and grubbing, construction debris removed from the FSFA, contaminated soil, contaminated wastewater, and other construction-related debris generated during the removal action. Wastes will be characterized and disposed of in accordance with appropriate regulations under RCRA and California Code of Regulations (CCR) Title 22. This section outlines waste profiling, transport, and disposal procedures, which will comply with the CERCLA off-site rule. This Waste Management Plan will be similar to the plan developed for Navy IR Site 25 because of the similarities of this removal action to the remedial action at Navy IR Site 25 (ITSI Gilbane 2012).

6.6.1 Waste Profiling

As previously discussed, contaminated soil and sediment will be characterized for disposal in accordance with applicable regulatory and disposal facility criteria. The Contractor will consult with the disposal facilities on appropriate methods for characterizing the soil and sediment for off-site disposal. As previously described, a sampling effort will be conducted to fully characterize the contaminated soil and sediment on the FSFA prior to excavation; these results and other analyses required by the waste disposal facility (if necessary) will be used to profile the contaminated soil and sediment and assess the hazardous-waste status of the material.

6.6.2 Transportation and Disposal Coordinator

The Contractor will identify a T&D Coordinator who will manage soil T&D activities, including contacting and scheduling the trucking companies and coordinating profiles and manifests with NASA Ames. No shipments of waste will leave the site without a NASA representative's signature under NASA's Site identification number.

The T&D Coordinator will direct and track all shipments and will provide a report to the QCM detailing the specifics of management of the waste, including tonnage and date of shipment on each day that materials are shipped. The T&D Coordinator will ensure that the NASA Project Manager receives the copies of signed manifests (after the generator and transporter have signed) for hazardous waste, as well as all waste acceptance letters and certificates of disposal. The T&D Coordinator will receive the waste acceptance letters from the disposal facilities for inclusion in the completion report and will receive bills of lading for Class II and Class III waste, any concrete and rubble, and any metal or other materials provided to recycling facilities. All manifests and bills of lading will be included in the removal action completion report.

6.6.3 Transport and Disposal of Contaminated Soil

Soil, sediment, and other waste identified for off-site disposal will be transported from NASA Ames using California-licensed waste haulers. All shipments will be traced using waste manifests signed by NASA Ames and bills of lading. No regulated waste or material shipment will leave NASA Ames without a NASA-signed manifest. All shipments will be disposed of at waste facilities licensed to accept the waste and in compliance with the CERCLA off-site rule.

6.6.4 Vegetative Matter

Vegetative matter from clearing and grubbing operations will be stockpiled temporarily, pending transport to a local licensed facility that accepts vegetative debris. This material will be stockpiled at appropriate locations (that are not in native or sensitive habitat) within the project area based on conditions at the time of clearing, and at the direction of the NASA biologist. Soil will be removed from the roots of plants at the locations the plants are removed and before stockpiling. Stockpiled material will be disposed of in a timely manner. Materials to be disposed of off site will be inspected to ensure that contaminated soil is not included in the waste stream. Vegetative matter will be disposed of at an appropriate off-site facility. Pickleweed removed during the excavation (and free of contaminants) may also be sparsely transplanted in the lower elevations (0.5 to 2 feet amsl) to create micro-topography, added as mulch to the pickleweed restoration area surface, or incorporated into the upper 12 inches to add organic matter.

6.6.5 Debris Generated During Removal Action

General debris and trash will be collected and disposed of throughout the project duration. Trash will be disposed of properly, and work sites will be kept trash free to reduce animal attraction. Trash cans must have secure lids that close tightly. Disposal of the debris will be coordinated with NASA Ames to minimize disruption to NASA Ames activities during transport.

Construction debris encountered during excavation will be segregated for recycling or disposal at an appropriate off-site facility, or used as backfill. NASA will determine the deposition of the construction debris based on the results of the site characterization, visual inspection of the debris for signs of staining, and results of any wipe test or other test to detect contamination on the debris.

6.6.6 Wastewater Disposal

Liquid wastes generated during the removal action will be collected and stored on site using roll-off tanks or other transportable tanks. The water will be tested for potential site contaminants including metals, pesticides, PCBs, and fuel constituents, and compared to numerical standards for Effluent Limitations and Trigger Pollutants and other water quality criteria in the NPDES permit (NPDES No. CAG91202, Order No. R2-2012-0012). If concentrations are below the numerical standards and criteria, the liquid will be discharged on site. Water not suitable for on-site discharge will be disposed of off site at a licensed disposal facility. Analytical methods and related method detection limits for the sampling of liquid waste will be consistent with those identified in the SAP for site characterization (Appendix D).

6.7.7 Asbestos-containing Material

It is anticipated that no asbestos-containing material (ACM) will be encountered during this removal action. If ACM is encountered, the Contractor will contact the NASA Ames Project Manager to coordinate material handling and sampling using a specialty subcontractor or personnel licensed for such activities.

7.0 REFERENCES

Alderete, Chris. 2013a. Biological Survey for NASA Ames Research Center AOI-14 Silt Fence Installation on 11/7/3 [unpublished]. Prepared by Chris Alderete, Wildlife Biologist, Leidos, NASA Ames Research Center, Moffett Field, California.

Alderete, Chris. 2013b. Email from Chris Alderete (Leidos) to Hugo Hoffman (NASA Ames). "AOI 14 BUOW Evening Survey." December 4.

Alderete, Chris. 2013c. Email from Chris Alderete (Leidos) to Hugo Hoffman (NASA Ames). "AOI 14 Silt Fence Installation Snowy Plover." December 18.

California Department of Transportation. 2014. California Manual on Uniform Traffic Control Devices. Revision 1.

California Regional Water Quality Control Board, San Francisco Bay Region. 2014. Notice of General Permit Coverage for Discharge from the West-side Aquifer Treatment System (WATS) Facility located at SES-TECH Trailer North of Building 45, Cummins Avenue, Moffett Field, Santa Clara County, California 94305, under the Requirements of Order No. R2-2012-0012, NPDES Permit No. CAG912003 (VOC General Permit). August 25.

Earth Resource Technology, Inc. 2014. "Area of Investigation 14, Former Soil Fill Area, Final Interim Corrective Action Measures Completion Report, NASA Ames Research Center, Moffett Field, California." June.

Engineering/Remediation Resources Group, Inc. 2010. Remedial Action Work Plan for Installation Restoration Sites 07 and 18 at Parcel B; Soil Hotspot Locations at Parcels B, D-1, and G; and Soil Stockpiles at Parcels D-1 and G, Hunters Point Shipyard, San Francisco, California. July.

Innovative Technical Solutions, Inc. (ITSI) Gilbane Company. 2012. Final Remedial Design and Remedial Action Work Plan, Remedial Action at IR Site 25, Former NAS Moffett Field, Moffett Field, California. March.

ITSI Gilbane Company. 2013. Final Remedial Action Completion Report, Remedial Action at IR Site 25, Former Naval Air Station Moffett Field, Moffett Field, California. July.

SulTech. 2007. Addendum to the Revised Final Station-wide Feasibility Study, Site 25, Former Naval Air Station Moffett Field, California. June 29.

Tetra Tech, Inc. 2015. Area of Investigation 14 Engineering Evaluation/Cost Analysis, NASA Ames Research Center, Moffett Field, CA. September.

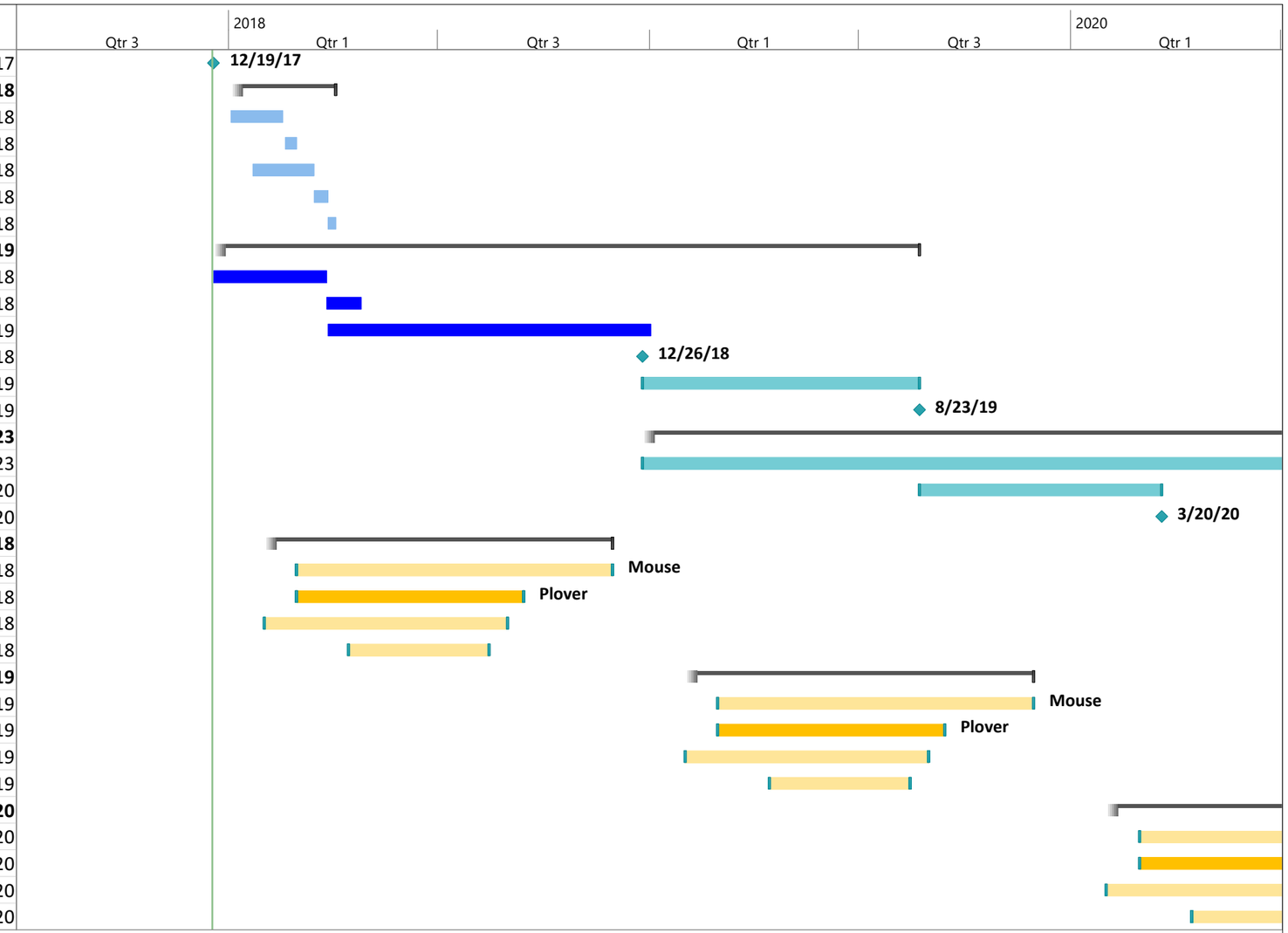
Tetra Tech, Inc. 2017. Final Area of Investigation 14 Action Memorandum, NASA Ames Research Center, Moffett Field, CA. March.

U.S. Environmental Protection Agency (EPA). 2013. USEPA Region IX, Unilateral Administrative Order, U.S. EPA Docket No. RCRA-7003-09-2013-0002, Former Soil Fill Area, NASA Ames Research Center, Moffett Field, California.

USFWS. 2017. Formal Consultation on the NASA Ames Research Center Area of Investigation 14 Non-Time-Critical Removal Action, Moffett Field, Santa Clara County, California (NASA Reference #: JQ: 204-15). October 30.

APPENDIX A
PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	Final RAWP	0 days	12/19/17	12/19/17
2	**Site Characterization**	**65 days**	**1/3/18**	**4/3/18**
3	Pilot-Scale Sampling/Analysis/95UCL Calculations	33 days	1/3/18	2/16/18
4	Agency/NASA Meeting (RSD Calculations)	8 days	2/19/18	2/28/18
5	Full-Scale Sampling/Analysis/Volume Calculations	39 days	1/22/18	3/15/18
6	Agency/NASA Meeting (Volume Calculations)	8 days	3/16/18	3/27/18
7	Final Data Report/ Grading Plan	5 days	3/28/18	4/3/18
8	**Removal Action**	**438 days**	**12/19/17**	**8/23/19**
9	Mobilization	70 days	12/19/17	3/26/18
10	Submittals/Moblization	30 edays	3/26/18	4/25/18
11	Excavation, Off-Site Disposal, Regrading, Vegetatic	10 mons	3/28/18	1/1/19
12	End	0 days	12/26/18	12/26/18
13	RACR (Removal Action Completion Report)	240 edays	12/26/18	8/23/19
14	RACR Complete	0 days	8/23/19	8/23/19
15	**Restoration Monitoring**	**1305 days**	**12/26/18**	**12/26/23**
16	Restoration Monitoring	1305 days	12/26/18	12/26/23
17	Long-term Management Plan (LTMP)	210 edays	8/22/19	3/19/20
18	LTMP Complete	0 days	3/20/20	3/20/20
19	**Breeding Season 2018**	**216 days**	**2/1/18**	**11/30/18**
20	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/18	11/30/18
21	Western Snowy Plover Breeding Season	197 edays	3/1/18	9/14/18
22	California Clapper Rail	211 edays	2/1/18	8/31/18
23	California Least Tern	122 edays	4/15/18	8/15/18
24	**Breeding Season 2019**	**216 days**	**2/1/19**	**11/30/19**
25	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/19	11/30/19
26	Western Snowy Plover Breeding Season	197 edays	3/1/19	9/14/19
27	California Clapper Rail	211 edays	2/1/19	8/31/19
28	California Least Tern	122 edays	4/15/19	8/15/19
29	**Breeding Season 2020**	**215 days**	**2/1/20**	**11/30/20**
30	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/20	11/30/20
31	Western Snowy Plover Breeding Season	197 edays	3/1/20	9/14/20
32	California Clapper Rail	152 days	2/1/20	8/31/20
33	California Least Tern	122 edays	4/15/20	8/15/20



Project:AOI 14 RAWP Appendix A
Date: 12/19/17

Task		Project Summary		Manual Task		Start-only		Deadline	
Split		Inactive Task		Duration-only		Finish-only		Progress	
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			

APPENDIX B
GEOPHYSICAL INVESTIGATION REPORT

Area of Investigation 14 Former Soil Fill Area Geophysical Investigation Report

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

December 2016

www.nasa.gov

Area of Investigation 14 Former Soil Fill Area Geophysical Investigation Report

Prepared for:

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

December 2016

Prepared by:

Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, CA 94612

Jeffrey D. Eddo, PGp, PG
Professional Geophysicist

Signature

Date 12/1/16

TABLE OF CONTENTS

EXECUTIVE SUMMARY ES-1
1.0 INTRODUCTION 1
2.0 SITE DESCRIPTION 1
3.0 GEOPHYSICAL INVESTIGATION METHODS 2
3.1 Geophysical Data Collection 3
3.2 Geophysical Data Processing and Interpretation 4
4.0 RESULTS 5
5.0 CONCLUSIONS 7
6.0 LIMITATIONS 7
7.0 REFERENCES 7

FIGURES

Figure 1 AOI 14 Former Soil Fill Area Site Features

Figure 2 AOI 14 Former Soil Fill Area Magnetometer Survey Results

Figure 3 AOI 14 Former Soil Fill Area EM31 Quadrature Survey Results (Leveled)

Figure 4 AOI 14 Former Soil Fill Area EM31 Quadrature Survey Results (Unleveled) and Electrical Resistivity Sections

Figure 5 AOI 14 Former Soil Fill Area Geophysical Survey Results and 1977 Aerial Photo

APPENDIX

Appendix A Photo Log

ACRONYMS AND ABBREVIATIONS

AGI	Advanced Geosciences, Inc.
AOI	Area of Investigation
bgs	Below ground surface
BRAC	Base Realignment and Closure
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
DDT	Dichlorodiphenyltrichloroethane
DGM	Digital geophysical mapping
DGPS	Differential global positioning system
EM	Electromagnetic
FSFA	Former Soil Fill Area
IR	Installation Restoration
MOU	Memorandum of Understanding
MROSD	Midpeninsula Regional Open Space District
mS/m	Millisiemens per meter
NAD	North American Datum
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASA Ames	NASA Ames Research Center
NMEA	National Marine Electronics Association
NPL	National Priorities List
nT	NanoTesla
NTCRA	Non-time-critical removal action
Ohm-m	Ohm-meters
PCB	Polychlorinated biphenyl
ppt	Parts per thousand
RMS	Root mean square

GEOPHYSICAL INVESTIGATION REPORT

NASA Ames Research Center
Moffett Field, California

December 2016

SUBJECT: **Geophysical Investigation Report for Non-Time-Critical Removal Action at Area of Investigation 14 Former Soil Fill Area, NASA Ames Research Center, Moffett Field, California**

Site Status:	Non-NPL
Category of Removal:	Non-Time-Critical Removal Action
CERCLIS ID:	CA1800005034
Site ID:	Area of Investigation 14

EXECUTIVE SUMMARY

Tetra Tech, Inc. performed a geophysical investigation to support the non-time-critical removal action (NTCRA) at the Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA), National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames), Moffett Field, California. Historical aerial photographs indicate the FSFA was constructed by depositing artificial fill on the existing surface of a stormwater retention pond. The artificial fill, which varies in thickness across the FSFA, is a heterogeneous mixture of gravel, sand, silt, clay, and miscellaneous construction debris. Construction debris consisting of reinforced concrete, asphalt, and metal (rebar, beams, and metal debris) is exposed at the surface along and adjacent to the slopes of the FSFA. The original FSFA assumed removal action boundary consisted of the toe and bottom of FSFA slope (Figure 1). The native soil underneath the fill material is primarily clay. Metals, polychlorinated biphenyls (PCBs), and pesticides (expressed as total dichlorodiphenyltrichloroethane [DDT]) detected within the FSFA are distributed non-uniformly throughout the artificial fill, both vertically and horizontally. Knowledge of the site history and contaminant distribution suggests that the source of the contaminants is not on site, but is rather a source from the original location of the artificial fill brought to the site (Tetra Tech 2015).

The objectives of the geophysical investigation were to:

- Detect and delineate the apparent lateral (horizontal) extent of artificial fill and debris fill and help estimate the apparent vertical extent of artificial fill at the AOI 14 FSFA
- Provide information to constrain approximate volume estimates of detectable apparent artificial fill and debris fill at the AOI 14 FSFA to support the NTCRA remedial action work plan design

Digital geophysical mapping (DGM) surveys consisted of magnetic and electromagnetic (EM) surveys to delineate the apparent lateral extent of artificial fill and debris fill and included the use of a Geometrics, Inc. G-858 cesium vapor magnetometer and Geonics, Ltd. EM31. An Advanced

Geosciences, Inc. (AGI) SuperSting R8 was used for the electrical resistivity surveys, which were used to help estimate the apparent vertical extent of artificial fill. Magnetometer and EM31 data were collected at 0.5-second intervals along transects nominally spaced 5 feet apart over accessible portions of the AOI 14 FSFA. Step-out magnetometer and EM31 DGM surveying was also conducted at accessible areas to ensure adequate delineation of apparent debris and artificial fill areas. Electrical resistivity profiles were conducted at the site to assess the apparent vertical limits of artificial fill associated with contrasts in electrical resistivity between the artificial fill and native material at depth. Electrical resistivity data were collected as profiles using a dipole-dipole configuration along seven 140-foot-long resistivity lines with electrodes spaced 2.5 feet apart.

The results of the geophysical investigation are:

- The magnetometer survey detected a greater density of magnetic anomalies within the northern portion of the FSFA (Figure 2). An interpretation of lateral extent of apparent artificial fill at the site has been made based on a combination of the extent of magnetic anomalies and the bottom or toe of the FSFA slopes. The apparent artificial fill extent is depicted by a dashed black line boundary on Figures 2 through 5, and encompasses approximately 6 acres. The portion of apparent artificial fill that contains ferrous metal debris is interpreted to be approximately 5.5 acres, and a solid red line boundary is used to show the mapped extent of ferrous metal on Figures 2 and 5. Magnetic anomalies within the flat areas adjacent to the base of the FSFA slopes indicate that apparent artificial fill extends beyond the toe or base of the slopes at several locations.

- The unleveled EM31 quadrature phase detected anomalous areas of relatively low conductivity (high resistivity) at the northern portion of the FSFA, where a greater density and thickness of construction debris fill are known based on previous borings and site observations. Interpretation of the possible vertical extent from ground surface of apparent artificial fill is shown with a dashed black line symbol on the resistivity sections on Figure 4. Electrical resistivity sections show a thicker and more electrically resistive apparent artificial fill layer where construction debris is known to have been buried at greater depths and quantities at the northern portion of the FSFA. Based on the electrical resistivity sections, the artificial fill may extend to depths as great as 18 feet below ground surface (bgs) (at the northern portion of the site) and may be as shallow as 4 feet bgs (at the southern portion of the site). High resistivity areas and areas where high resistivity layers have a greater thickness in the Sting electrical resistivity sections correlate very well with low conductivity (high resistivity) areas detected by the EM31 at the northern portion of the FSFA (Figure 4).

- The apparent lateral extent of artificial fill interpreted from the geophysical survey results shows a good correlation with the apparent extent of graded and disturbed fill material and soil piles shown in a 1977 aerial photo (Figure 5).

1.0 INTRODUCTION

Tetra Tech, Inc. performed a geophysical investigation to support the non-time-critical removal action (NTCRA) at the Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA), National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames), Moffett Field, California. The objectives of the geophysical investigation were to:

- Detect and delineate the apparent lateral extent of artificial fill and debris fill and help estimate the apparent vertical extent of artificial fill at the AOI 14 FSFA

- Provide information to constrain approximate volume estimates of detectable apparent artificial fill and debris fill at the AOI 14 FSFA to support the NTCRA remedial action work plan design.

The purpose of the NTCRA is to prevent erosion of contaminated soil and release of contaminants from AOI 14 to adjacent Navy Installation Restoration (IR) Site 25. The selected removal action for the NTCRA consists of excavation and off-site disposal of soil containing concentrations of contaminants exceeding cleanup goals and restoration of the excavated area to appropriate ecological habitat. After excavation and ecological restoration, the site will be available for unrestricted use.

The field activities described in this geophysical report were conducted on October 17 through October 27, 2016. Geophysical data were collected at the AOI 14 FSFA in accordance with the approved final geophysical investigation work plan (Tetra Tech 2016). The methods, data, results, findings, and conclusions of the geophysical investigation are presented in this report.

2.0 SITE DESCRIPTION

NASA Ames is one of several centers within NASA, a federal agency. It is an active facility with no plans for closure or transfer. NASA Ames consists of the NASA Ames Research Center campus and the majority portion of former Naval Air Station (NAS) Moffett Field, transferred to NASA on July 1, 1994. The former NAS Moffett Field is a Superfund site listed on the National Priorities List (NPL) from 1987.

NASA Ames is located in Santa Clara County, California, approximately 1 mile south of San Francisco Bay, 35 miles southeast of San Francisco, and 10 miles northwest of San Jose (Figure 1). NASA Ames is separated from San Francisco Bay by former salt evaporation ponds. The City of Mountain View is adjacent to the western and southern boundaries of NASA Ames, and the City of Sunnyvale is adjacent to the southern and eastern boundaries.

AOI 14 is located at the northern end of NASA Ames and consists of three peninsulas (the FSFA, N217 area, and N217A area) that extend into a stormwater retention pond (Figure 1). The western boundary of AOI 14 borders the portion of the stormwater retention pond located within the Midpeninsula Regional Open Space District (MROSD). Navy IR Site 25 comprises the entire stormwater retention pond surrounding AOI 14 and the Eastern Diked Marsh south of the stormwater pond. The Navy conducted a remedial action at IR Site 25 in 2012 that included

excavation and off-site disposal of contaminated sediment, focused restoration of wetland excavation areas, and ecological monitoring.

The Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics was established in 1939 on land adjacent to NAS Moffett Field and consisted of wind tunnels, hangars, aircraft operations, and other research facilities. In 1958, NASA was established under the Space Act, and Ames Aeronautical Laboratory became NASA Ames Research Center.

In 1991, the Navy Base Realignment and Closure (BRAC) Commission identified NAS Moffett Field for closure. In 1994, a majority portion of NAS Moffett Field was transferred from the Navy to NASA, excluding the military housing at Orion Park and Wescoat Housing, which was transferred initially to the U.S. Air Force, and then to the U.S. Army. The Navy and NASA entered into a Memorandum of Understanding (MOU) that established roles and responsibilities for environmental restoration and ongoing environmental compliance at former NAS Moffett Field.

Historical aerial photographs indicate the N217 peninsula consists of native soil and the FSFA and N217A peninsulas were constructed by depositing artificial fill on the existing surface of the stormwater retention pond. The peninsulas provide mainly terrestrial habitat and are adjacent to the wetland habitat of the stormwater retention pond. Ground cover varies across AOI 14 and includes tall grasses and low-lying brush. A silt fence borders the AOI 14 Former Soil Fill Area along its western, northern, and eastern sides (Figure 1).

The FSFA is not actively used, and access to this area is restricted by the NASA Ames security fence to the south and by NASA's stormwater retention pond on all other sides. There are two buildings on the N217 and N217A areas that are currently used for periodic research, development, and testing of magnetic field equipment.

The area of AOI 14 subject to the NTCRA is contaminated fill that was deposited in the northern portion of the FSFA peninsula. The N217 and N217A areas do not require remediation and are not included in the NTCRA based on the depths and limited extent of contaminants in these areas.

The artificial fill, which varies in thickness across the FSFA, extends over an area of approximately 6 acres and is a heterogeneous mixture of gravel, sand, silt, clay, and miscellaneous construction debris. Construction debris consisting of reinforced concrete, asphalt, and metal (rebar, I-beams, and metal debris) is exposed at the surface along and adjacent to the slopes of the FSFA (Figure 1 and Appendix A). The original FSFA assumed removal action boundary consisted of the toe and bottom of FSFA slope (Figure 1). The native soil underneath the fill material is primarily clay. Metals, polychlorinated biphenyls (PCBs), and pesticides (expressed as total dichlorodiphenyltrichloroethane [DDT]) detected within the FSFA are distributed non-uniformly throughout the artificial fill, both vertically and horizontally. Knowledge of the site history and contaminant distribution suggests that the source of the contaminants is not on site, but is rather a source from the original location of the artificial fill brought to the site (Tetra Tech 2015).

3.0 GEOPHYSICAL INVESTIGATION METHODS

Geophysical surveys were conducted to detect and map the apparent extent of debris fill (believed to be likely sources of chemicals of potential concern) at the AOI 14 FSFA Site. Digital

geophysical mapping (DGM) surveys consisted of magnetic and electromagnetic (EM) surveys and included the use of a Geometrics, Inc. G-858 cesium vapor magnetometer and Geonics, Ltd. EM31. An Advanced Geosciences, Inc. (AGI) SuperSting R8 was used for electrical resistivity surveys.

The magnetometer survey was used to evaluate ferrous metals (metal debris) in artificial fill. The magnetometer was used to detect magnetic anomalies by measuring the strength of the total magnetic field along transects. The magnitude and orientation of a magnetic anomaly depends on the material, size, shape, depth, and orientation of nearby ferrous metal objects. The G-858 uses an optically pumped cesium vapor sensor and generally has a measurement sensitivity of 0.1 nanoTesla (nT) or 0.1 gamma.

The EM31 survey was used to evaluate terrain electrical conductivity, and detect EM anomalies associated with debris such as concrete, asphalt, wood, and large buried metal objects. The EM31 is capable of detecting both ferrous and non-ferrous metallic debris. The EM31 consists of a transmitter coil mounted at one end and a receiver coil at the other end of a 12.14-foot (3.7-meter)-long fiberglass boom. The EM31 measures ground electrical conductivity (quadrature phase component) in millisiemens per meter (mS/m) and the ratio of the induced secondary magnetic field to the primary magnetic field (in-phase component) in parts per thousand (ppt). The effective depth of exploration for the EM31 in vertical dipole mode can be up to approximately 15 feet, depending on the target size and material, soil, and site conditions.

Electrical resistivity profiles were conducted at the site to assess the apparent vertical limits of artificial fill associated with contrasts in electrical resistivity between the artificial fill and native material at depth. A total of seven electrical resistivity lines were used to assess the apparent vertical extent of the artificial fill at the site. In general, the maximum depth of detection is typically 1/3 to 1/5 the length of the resistivity line.

3.1 GEOPHYSICAL DATA COLLECTION

Single sensor magnetometer and vertical dipole mode EM31 data were collected at 0.5-second intervals along transects nominally spaced 5 feet apart over accessible portions of the AOI 14 FSFA Site. Inaccessible portions of the site included areas inundated with water. Step-out magnetometer and EM31 DGM surveying was also conducted at accessible areas to ensure adequate delineation of apparent debris and artificial fill areas. The magnetometer and EM31 were each configured with a sub-meter real-time accuracy Trimble ProXRS differential global positioning system (DGPS), and positioning data were streamed to the data logger through a National Marine Electronics Association (NMEA) stream in real time.

Magnetometer data can be susceptible to drift in background readings associated with diurnal variations of the total magnetic field and magnetic storms. Therefore, a base station location at the site was established away from metallic interferences where stationary readings were recorded with the magnetometer several times throughout the survey to evaluate diurnal variations in the magnetic field or magnetic storm activity. Solar geomagnetic activity was also checked at the National Oceanic and Atmospheric Administration (NOAA) webpage (http://www.sec.noaa.gov/ftpdir/forecasts) to provide additional assessment of diurnal variations in the Earth's magnetic field. If affected data could not be precisely corrected, then portions of

magnetometer data affected by large diurnal magnetic field variances were to be recollected. However, no significant diurnal variances in the magnetic field were measured or noted from the NOAA webpage search, and diurnal corrections to magnetometer data or recollection of magnetometer data were not required.

The EM31 quadrature phase and in-phase components were calibrated in the field at the FSFA before data were collected. The quadrature phase was adequately calibrated and functioned as intended. The in-phase could not be adequately calibrated because the very high electrical conductivity of the soil at the site resulted in out of range in-phase readings. These readings were confirmed by several attempts at calibrating the EM31 in-phase component at various locations at the site, calibrating the instrument at the hotel where the geophysical team was staying, and communications with the instrument manufacturer (Geonics). After the EM31 was calibrated at the hotel, the in-phase component appeared to be functioning properly and reading within range around the hotel, which confirmed the in-phase component was unusable at the FSFA because of the associated soil conditions. Therefore, the EM31 in-phase component was not used for the geophysical investigation.

Electrical resistivity data were collected using a dipole-dipole configuration along seven resistivity lines. The locations and orientations of the resistivity lines were based on the EM31 and magnetometer DGM survey results, site conditions, and access. Each resistivity spread/line consisted of 56 electrodes. The electrode spacing (2.5 feet) and lengths of the resistivity lines (140 feet) were designed to optimize detection of electrical resistivity contrasts associated with the apparent depth of artificial fill and debris fill. The electrodes were driven roughly 6 inches into the ground and the area around the electrodes were moistened with salt water to improve electrical connectivity with the soil. Small holes were also dug around each electrode (up to approximately 6 inches bgs and up to approximately 12 inches in diameter) to improve contact of the salt water with the electrodes. The holes were backfilled after data had been collected for each resistivity line. During electrical resistivity data collection, electrical current was injected into the ground through the stainless steel electrodes, and the electric potential difference between multiple electrodes was measured simultaneously. The spacing between the current and potential electrodes was changed between readings to preprogrammed values.

3.2 GEOPHYSICAL DATA PROCESSING AND INTERPRETATION

Magnetometer and EM31 DGM data were processed and gridded with Geosoft Oasis montaj software. Preprocessing of the magnetometer data included loading raw data files into MagMap2000 software and exporting the files to geodetic files. Preprocessing of the EM31 data included loading raw data files into DAT31W software and exporting the files to geodetic files. Corpscon software was used to convert geodetic coordinates to state plane coordinates (North American Datum [NAD] 1983, Zone 3, U.S. survey feet). Data files were loaded into Geosoft Oasis montaj software and entered in a dynamically linked database used to plot and review data files for background drift, GPS dropouts, and data quality. Magnetometer data corrections included removal of data spikes and dropouts and applying a 2-foot sensor offset correction for the spacing between the cesium vapor magnetometer sensor and the GPS antenna. A rolling statistics median filter was applied to the magnetometer and EM31 data to estimate the background drift curves for each data set. Background leveling or dedrifting of the data was performed by

subtracting the drift curves from each data set. The magnetometer and EM31 quadrature phase data were both gridded with a 0.25-foot grid cell size and 7-foot blanking distance.

Electrical resistivity data processing, modeling, and analysis was performed using EarthImager Version 2.1.7, two-dimensional resistivity inversion software. Noisy data points were removed and a strong gradient array was used for the inversions to minimize the root mean square (RMS) error. The calculated root RMS error provided a measure of the differences between the calculated apparent resistivity values predicted by the inverse model and the measured apparent resistivity values. RMS errors of the electrical resistivity sections ranged from 8.25 to 22.60 percent. Interpretations of the apparent depth of artificial fill using the post-processed electrical resistivity sections were also compared with borehole data from adjacent borings.

ArcMap 10.2 software was used create final geophysical data maps and to overlay gridded magnetometer and EM31 DGM data on a current aerial photo, current topographic elevation contours, and historical aerial photos to aid in interpretation of the approximate extent of apparent artificial fill. ArcMap software was also be used to spatially compare the extent of apparent artificial fill and debris fill interpreted from magnetometer and EM31 DGM data with electrical resistivity sections.

4.0 RESULTS

The leveled magnetometer survey results are presented in Figure 2 and show variation in the total magnetic field readings. The color scale on the magnetometer data map indicates the amplitude of the total magnetic field measurements in nT. Light blue to blue represents lower magnetic field amplitudes, green represents background, and yellow to pink represents higher magnetic field amplitudes. Magnetic anomalies consist of variations from background readings. Numerous magnetic anomalies were detected that indicate the presence of ferrous metal debris within the artificial fill at the site. In general, a greater density of magnetic anomalies was detected within the northern portion of the FSFA. The leveled magnetometer survey results and the locations of the bottom or toe of the FSFA slope were used to delineate the apparent lateral extent of artificial fill. The apparent extent of artificial fill is approximately 6 acres, and the portion of apparent artificial fill that contains ferrous metal debris is approximately 5.5 acres. The apparent artificial fill extent is depicted by a dashed black line boundary on Figures 2 through 5, and encompasses approximately 6 acres. The portion of apparent artificial fill that contains ferrous metal debris is interpreted to be approximately 5.5 acres, and a solid red line boundary is used to show the mapped extent of ferrous metal on Figures 2 and 5. Magnetic anomalies within the flat areas adjacent to the base or toe of the FSFA slopes indicate that apparent artificial fill extends beyond the toe of the slopes at several locations (Figure 2).

The leveled EM31 quadrature phase results are shown in mS/m in Figure 3. Blue represents lower electrical conductivity (higher electrical resistivity), green represents background (also representing fill), and yellow to pink represents higher electrical conductivity (lower electrical resistivity) values. The leveled EM31 quadrature phase results show measured terrain conductivity and some of the presence of metal debris within the artificial fill, and a possible underground line or other linear feature along the north-south oriented dirt road that runs along the western portion of the FSFA. The leveled EM31 quadrature phase emphasizes the shallower anomalies at the central and southern portions of the site, where there is a lower density of debris fill and higher

conductivity background readings than at the northern portion of the site, where there is a greater thickness and density of debris fill and background conductivity readings are significantly lower. The leveled EM31 quadrature phase data along the slopes of the FSFA and within the salt flats surrounding the FSFA show high variability in conductivity readings within high background conductivity (indicated by large variations in warm and cold colors on Figure 3). Therefore, the leveled EM31 quadrature phase data were not used to delineate the limits of the lateral extent of the artificial fill at the FSFA.

The unleveled EM31 quadrature phase results and Sting electrical resistivity sections are both shown in Figure 4. Purple to dark blue EM31 quadrature readings represents high conductivity (low resistivity) values that represent background, and light blue to red represents lower conductivity (higher resistivity) values. The unleveled EM31 quadrature phase data show anomalous areas of relatively low conductivity (high resistivity) at the northern portion of the FSFA, where a greater density and thickness of construction debris fill are known based on previous borings and site observations.

The electrical resistivity sections for the seven Sting resistivity lines (RL-1 through RL-7) show resistivity contrasts of subsurface materials in Ohm-meters (Ohm-m) on Figure 4. Warm colors represent higher resistivity (lower conductivity), and cool colors represent lower resistivity (higher conductivity) values. The uppermost section of high resistivity (approximately 2.7 to 7,000 Ohm-m) in the resistivity sections was interpreted as the apparent layer of artificial fill underlain by low resistivity (high conductivity) native clay material (approximately 0.1 to 2.7 Ohm-m). Interpretation of the possible vertical extent from ground surface of apparent artificial fill is shown with a dashed black line symbol on the resistivity sections on Figure 4. The resistivity sections show a thicker and more electrically resistive apparent artificial fill layer where construction debris is known to have been buried at greater depths and quantities at the northern portion of the FSFA based on previous borings and site observations.

The range of thicknesses of apparent artificial fill interpreted from the electrical resistivity sections are:

- RL-1: 4 to 14.5 feet bgs
- RL-2: 7 to 15 feet bgs
- RL-3: 6.5 to 17.5 feet bgs
- RL-4: 4.5 to 18 feet bgs
- RL-5: 4 to 12 feet bgs
- RL-6: 4 to 9.3 feet bgs
- RL-7: 4.3 to 11.5 feet bgs

The depths of apparent artificial fill interpreted from the electrical resistivity sections correlate with the apparent depths of artificial fill observed in several nearby borings.

5.0 CONCLUSIONS

The magnetometer survey detected a greater density of magnetic anomalies within the northern portion of the FSFA (Figure 2). The interpreted apparent extent of artificial fill at the site based on a combination of the extent of magnetic anomalies and the bottom FSFA slope, and measures approximately 6 acres in areal extent. The portion of apparent artificial fill that contains ferrous metal debris is approximately 5.5 acres. Magnetic anomalies within the flat areas adjacent to the base of the FSFA slopes indicate apparent artificial fill extends beyond the toe or base of the slopes at several locations.

The unleveled EM31 quadrature phase data detected anomalous areas of low conductivity (high resistivity) at the northern portion of the FSFA, where a greater density and thickness of construction debris fill are known based on previous borings and site observations. Electrical resistivity sections also show a thicker and more electrically resistive apparent artificial fill layer where construction debris is known to have been buried at greater depths and quantities in the northern portion of the FSFA. Based on the electrical resistivity sections, the artificial fill may extend to depths as great as 18 feet bgs (at the northern portion of the site) and may be as shallow as 4 feet bgs (at the southern portion of the site). High resistivity areas and areas where high resistivity layers have a greater thickness in the Sting electrical resistivity sections correlate very well with low conductivity (high resistivity) areas detected by the EM31 in the northern portion of the FSFA (Figure 4). The apparent lateral extent of artificial fill interpreted from the geophysical survey results also shows a good correlation with the apparent extent of graded and disturbed fill material and soil piles shown in a 1977 aerial photo (Figure 5).

6.0 LIMITATIONS

The geophysical field investigation and analysis in this report have been conducted in general accordance with the current practice and the standard of care exercised by consultants performing similar tasks in the project area. No evaluation is detailed enough to reveal every subsurface feature or condition. No warranty (expressed or implied) is made regarding the conclusions and opinions in this report. Variations and conditions not observed or described in this report may be present.

Please note that even though care was taken during resistivity surveys, the resistivity results have been computer-modeled, and computer-modeling by nature does not yield a unique solution for a given dataset. Therefore, resistivity results should be considered interpretive and approximate, and only provide information at the locations of the resistivity survey lines. Therefore, it is recommended that adjacent borehole information be considered in for approximate volume estimates of apparent artificial fill and debris fill at the AOI 14 FSFA.

7.0 REFERENCES

Tetra Tech, Inc. 2015. Area of Investigation 14 Engineering Evaluation/Cost Analysis, NASA Ames Research Center, Moffett Field, CA. September.

Tetra Tech, Inc. 2016. Final Area of Investigation 14 Former Soil Fill Area Geophysical Investigation Work Plan, NASA Ames Research Center, Moffett Field, CA. October.

FIGURES

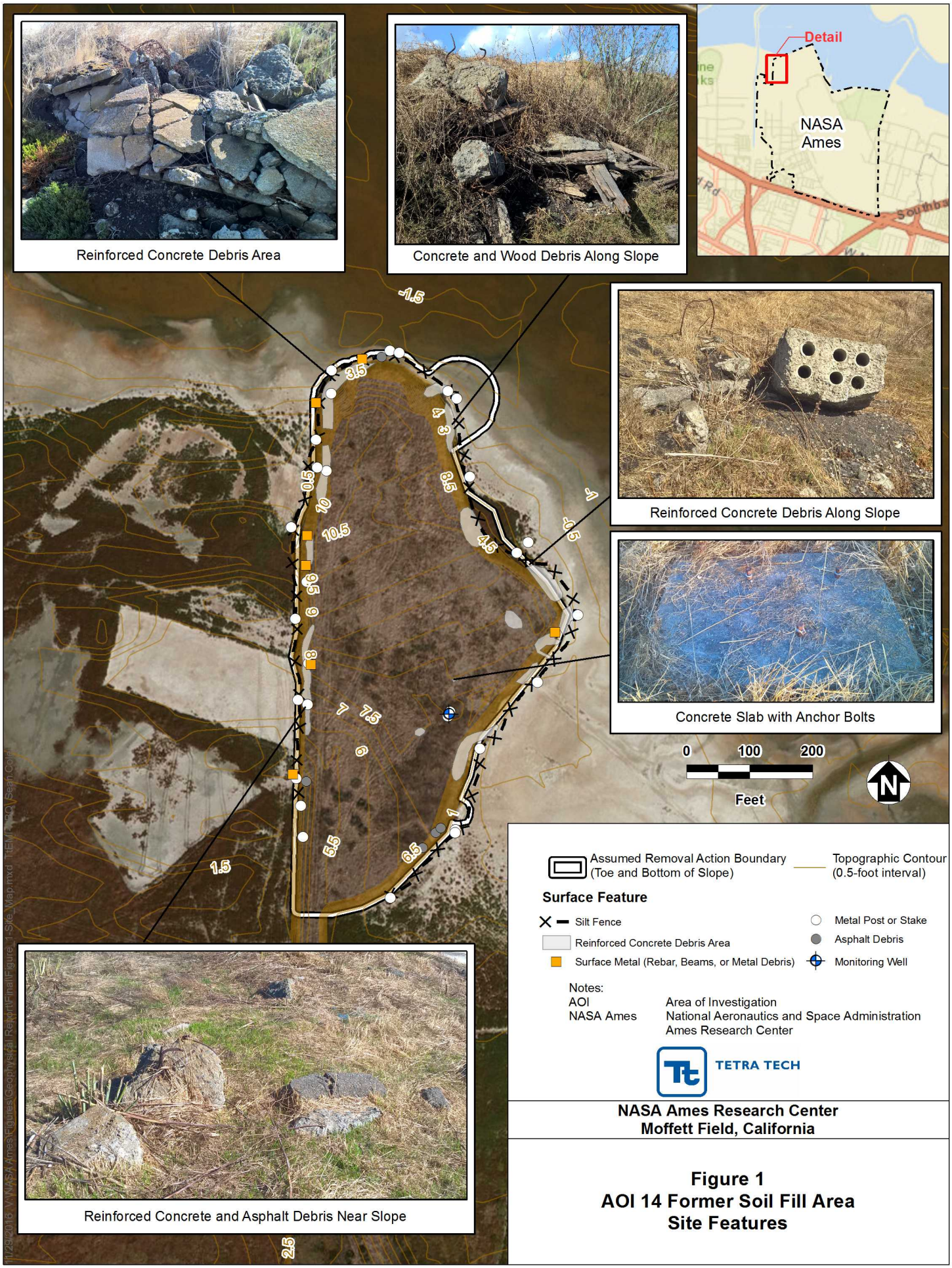


Figure 1
AOI 14 Former Soil Fill Area
Site Features

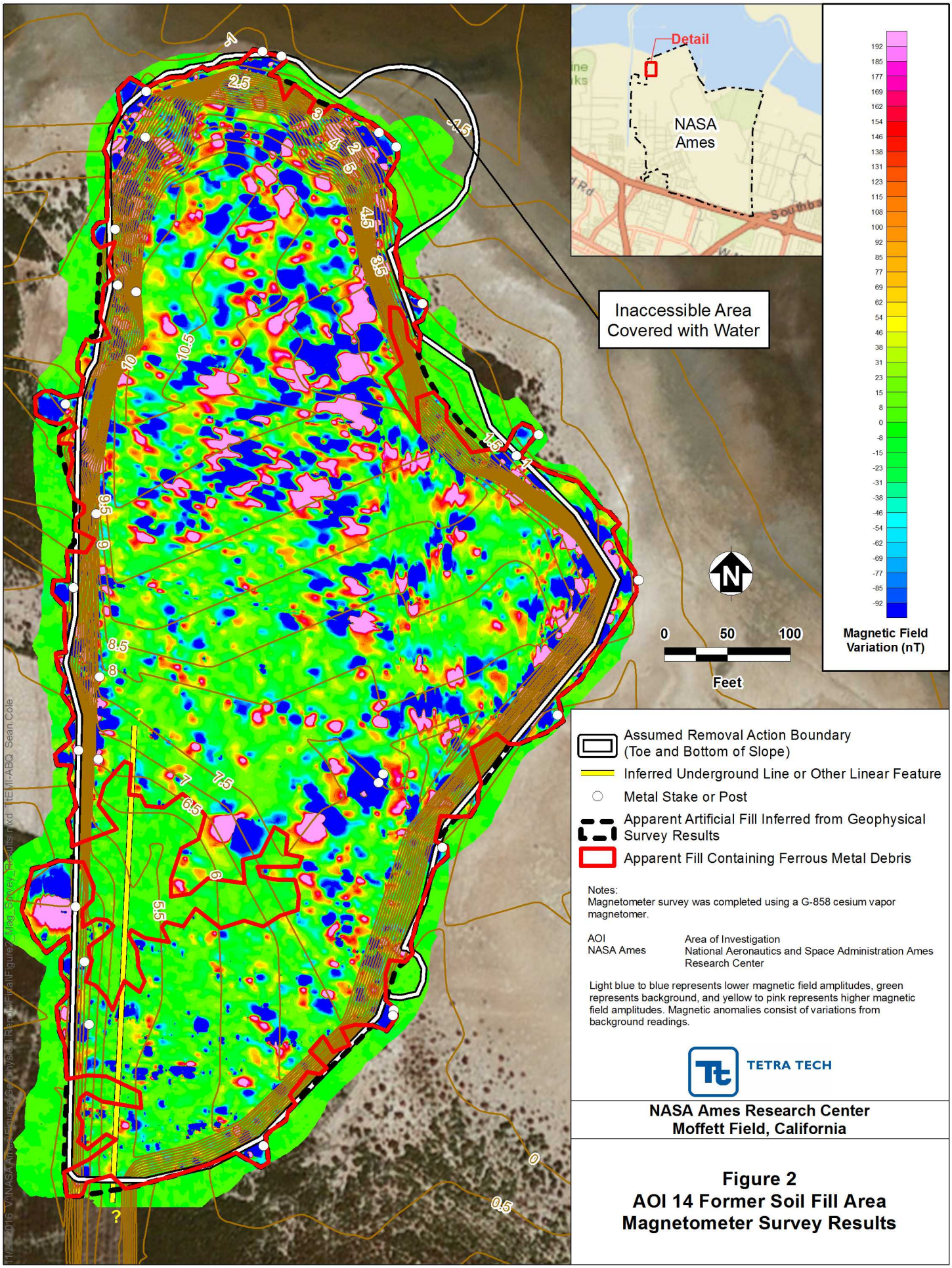


Figure 2
AOI 14 Former Soil Fill Area
Magnetometer Survey Results

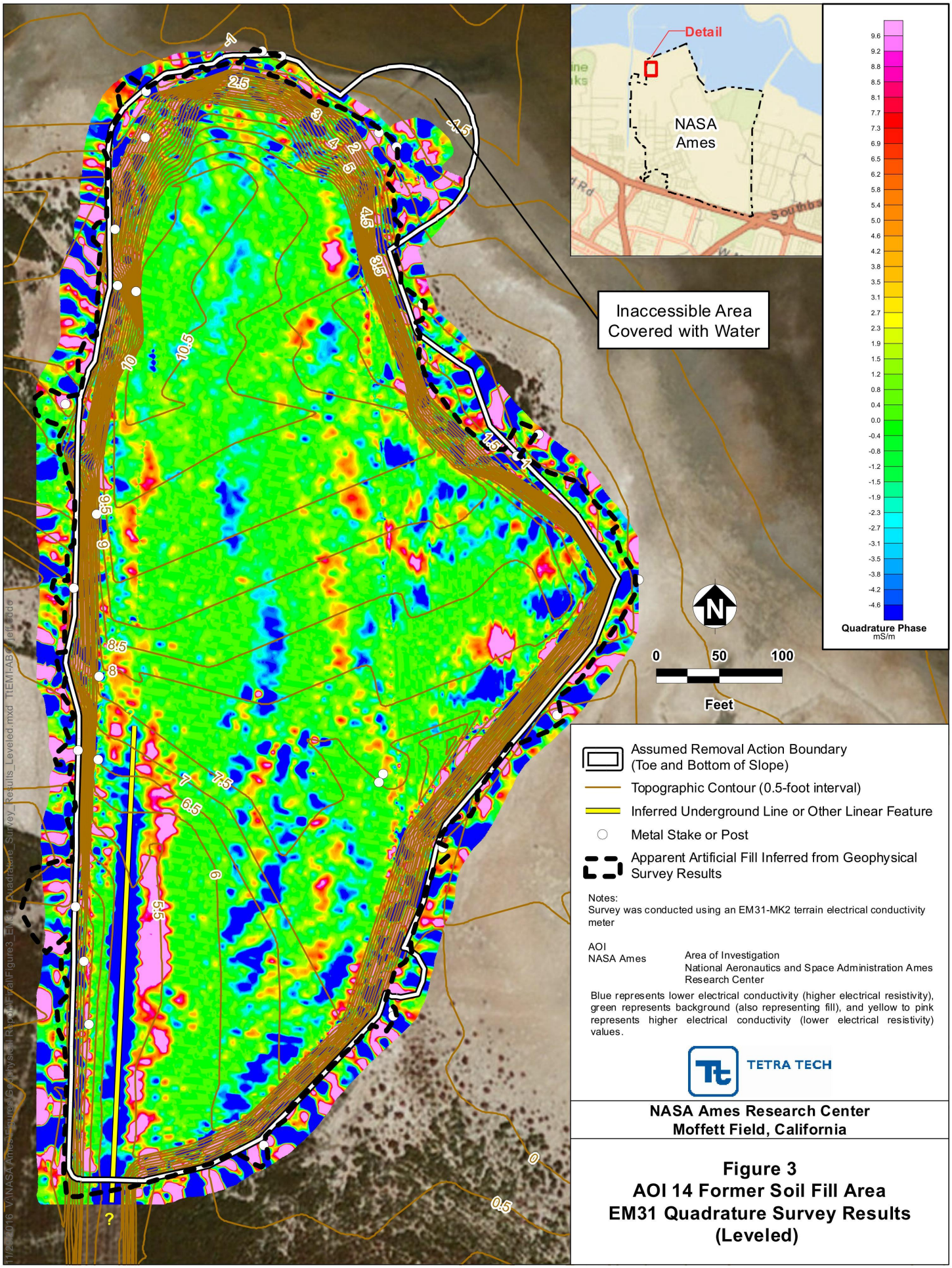
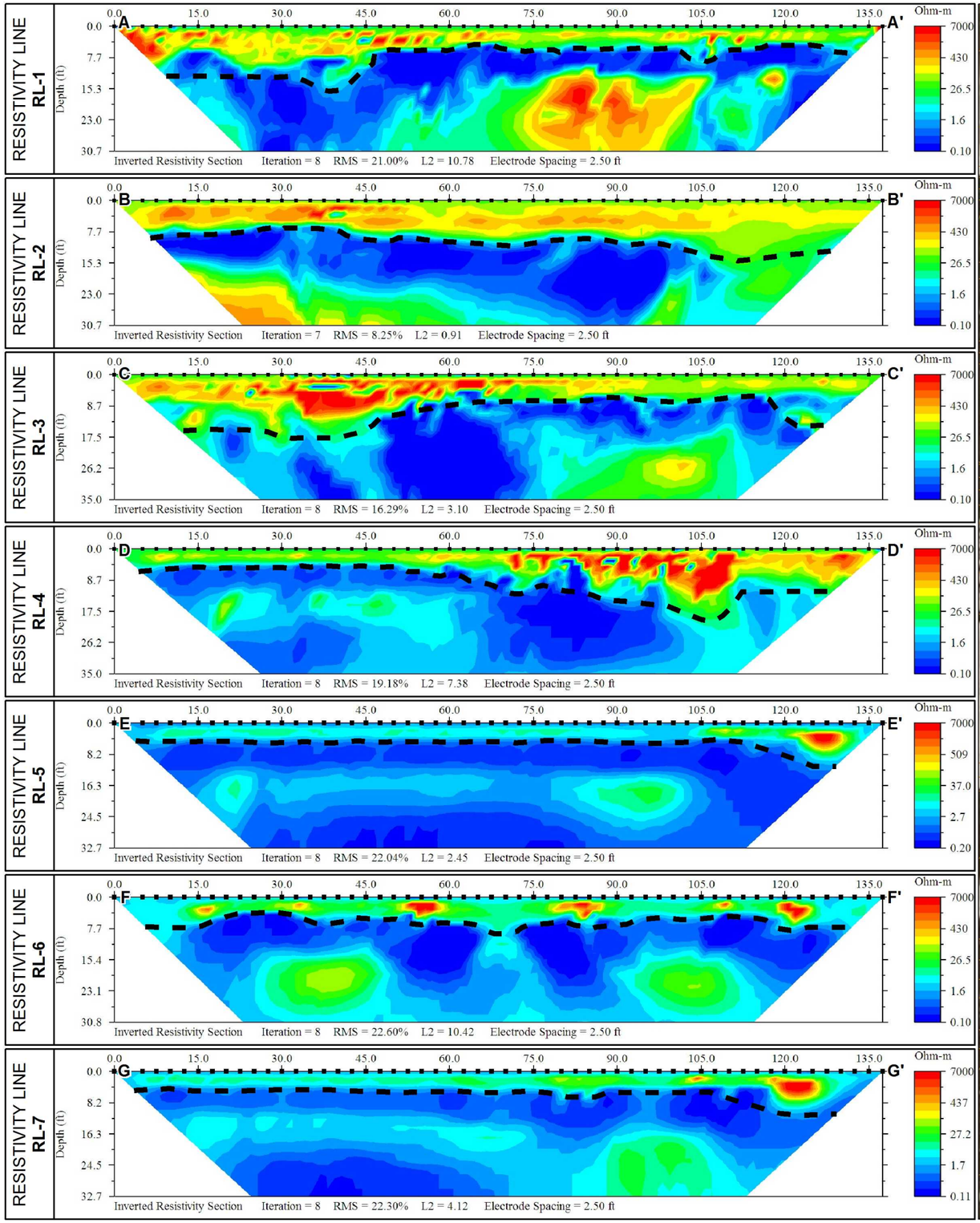
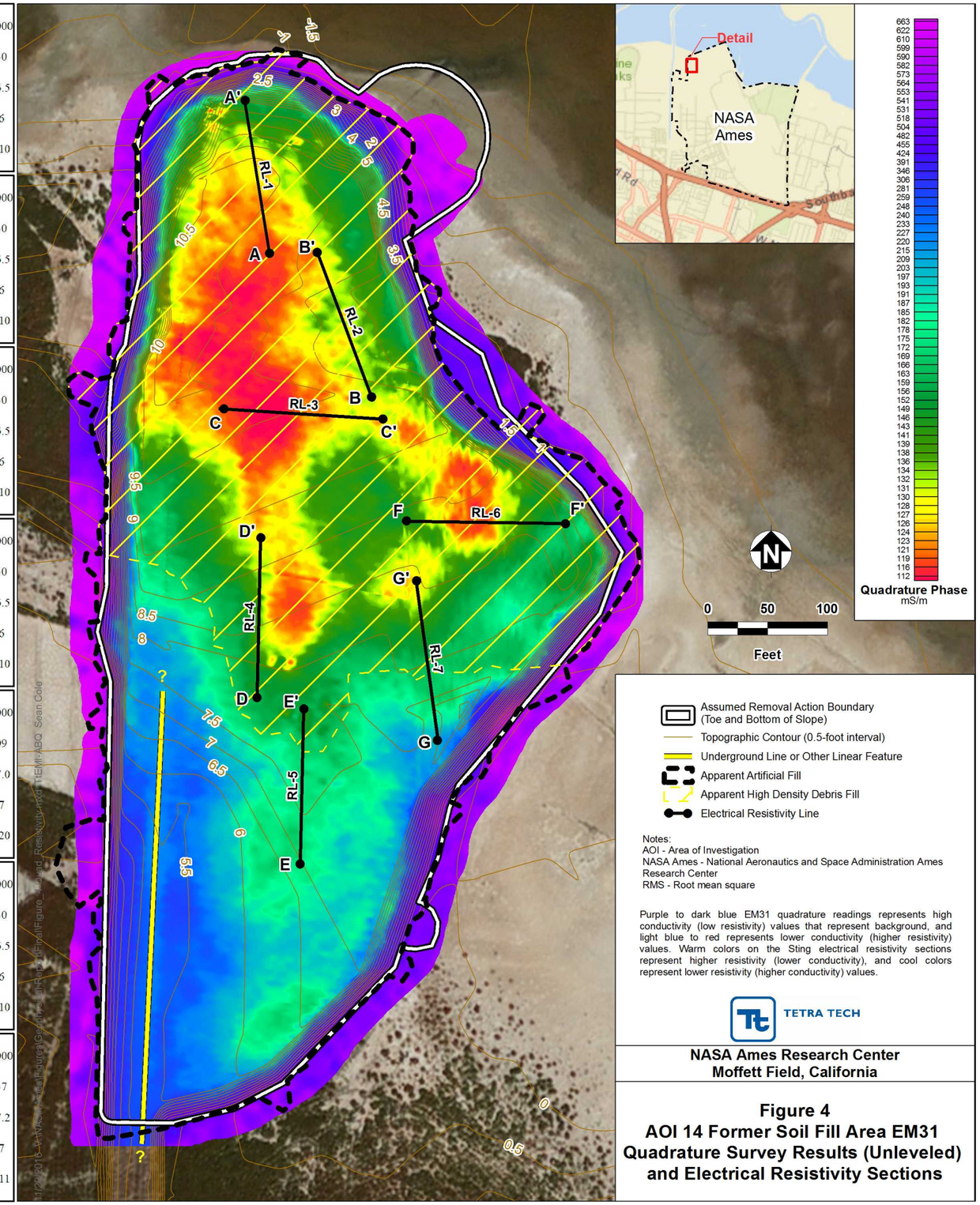


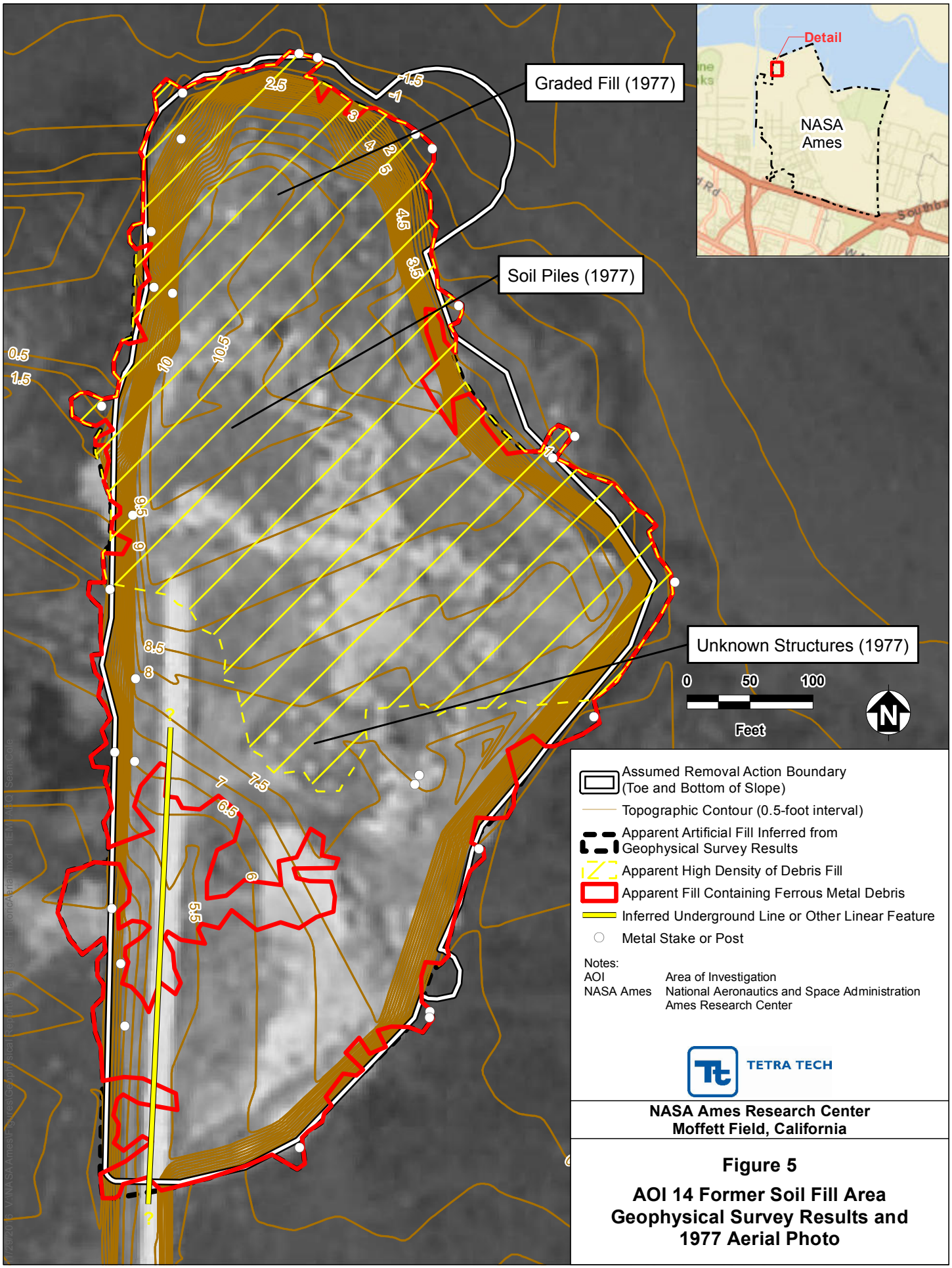
Figure 3
AOI 14 Former Soil Fill Area
EM31 Quadrature Survey Results
(Leveled)





NASA Ames Research Center
Moffett Field, California

Figure 4
AOI 14 Former Soil Fill Area EM31 Quadrature Survey Results (Unleveled) and Electrical Resistivity Sections



NASA Ames Research Center
Moffett Field, California

Figure 5

AOI 14 Former Soil Fill Area Geophysical Survey Results and 1977 Aerial Photo

APPENDIX A
PHOTO LOG

Photo 1: View looking southwest down the slope of the Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA) toward pickleweed and the silt fence. The silt fence borders the FSFA along its western, northern, and eastern sides.

Photo 2: View looking west at reinforced concrete representative of similar construction debris found along the western slope of the FSFA.

Photo 3: View looking south along western edge of the AOI 14 FSFA slope.

Photo 4: Debris consisting of wooden post with wiring conduit near eastern slope of the AOI 14 FSFA.

Photo 5: View looking north at a large area of reinforced concrete debris along the eastern slope of the AOI 14 FSFA.

Photo 6: View looking south at construction debris consisting of asphalt, reinforced concrete, and wood frame along the northern slope of the AOI 14 FSFA.

Photo 7: View looking south at large precast concrete debris along northern slope of the AOI 14 FSFA.

Photo 8: View looking southeast at large construction debris piles containing asphalt, reinforced concrete, chain link fence, and metal beams on the northwestern slope of the AOI 14 FSFA.

Photo 9: View looking at concrete slab with anchor bolts at the southeast center of the AOI 14 FSFA. Three large anchor bolts extend from the slab.

Photo 10: View looking west at a large asphalt pile along northern slope of the AOI 14 FSFA.

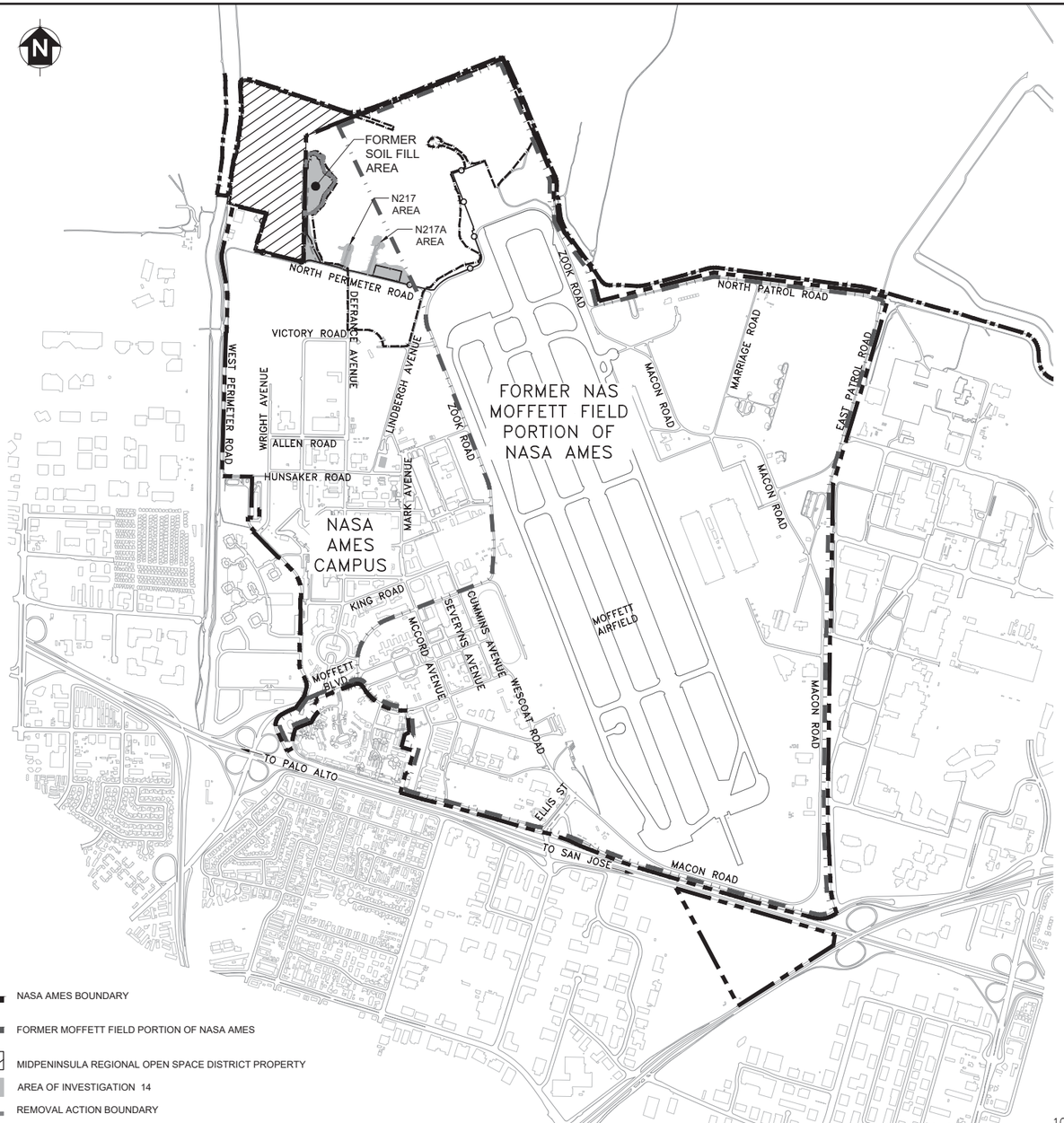
Photo 11: View looking west over the stormwater basin bordering the northern and eastern portions of the AOI 14 FSFA.

Photo 12: View looking north at EM31 data collection over the AOI 14 FSFA.

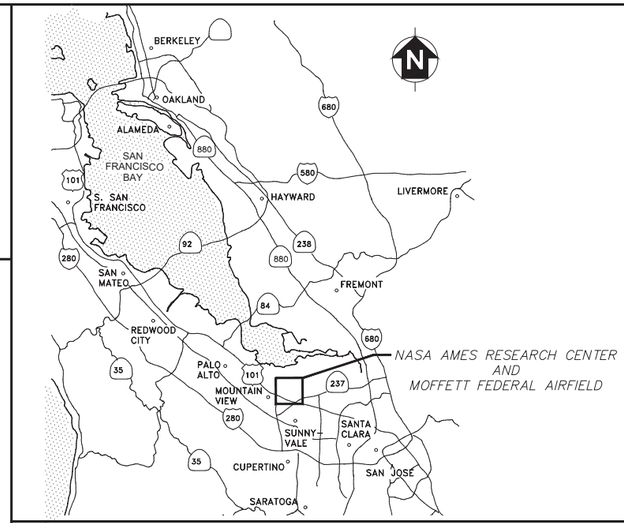
Photo 13: View looking southeast at Sting Resistivity Line 7 data collection on the southeastern portion of the AOI 14 FSFA.

APPENDIX C
CONSTRUCTION DRAWINGS

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14 NASA AMES RESEARCH CENTER MOFFETT FIELD, CALIFORNIA



FACILITY MAP
SCALE: 1" = 1000'



VICINITY MAP
SCALE: 1" = 7.5 MILES

7.5 0 7.5 15
SCALE: 1" = 7.5 MILES

SHEET INDEX

DRAWING NUMBER	DRAWING TITLE	NASA DRAWING NUMBER
T1	VICINITY MAP, FACILITY MAP AND SHEET INDEX	XXX---XXXX-T1
C1	EXISTING CONDITIONS	XXX---XXXX-C1
C2	EXISTING UTILITIES	XXX---XXXX-C2
C3	SITE PREPARATION/TRAFFIC HAUL ROUTE	XXX---XXXX-C3
C4	STORMWATER/HABITAT CONSERVATION MEASURES 1	XXX---XXXX-C4
C5	STORMWATER/HABITAT CONSERVATION MEASURES 2	XXX---XXXX-C5
C6	STORMWATER/HABITAT CONSERVATION MEASURES DETAIL	XXX---XXXX-C6
C7	SAMPLING/EXCAVATION PLAN VIEW	XXX---XXXX-C7
C8	SAMPLING/EXCAVATION CROSS-SECTION	XXX---XXXX-C8
C9	CONCEPTUAL GRADING AND SITE RESTORATION PLAN VIEW	XXX---XXXX-C9
C10	CONCEPTUAL GRADING AND SITE RESTORATION CROSS-SECTION	XXX---XXXX-C10
C11	FINAL STORMWATER/HABITAT CONSERVATION MEASURES	XXX---XXXX-C11

NASA DWG. NO.
XXX---0000-T1

REVISIONS

SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED
REV. 1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE
SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE
D.M. | F.P.
BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

VICINITY MAP, FACILITY MAP AND SHEET INDEX

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

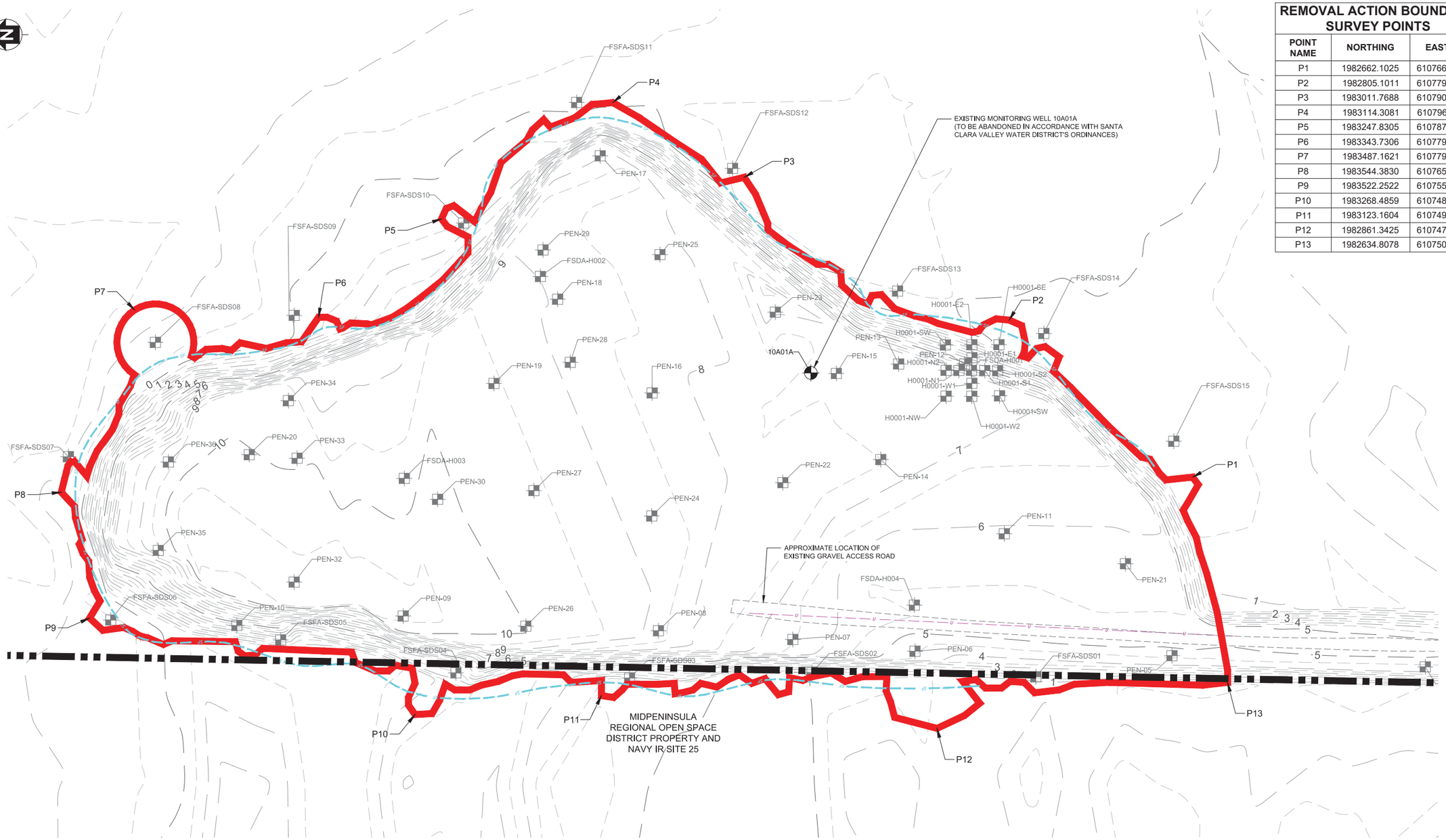
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
T1

SHEET 01 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ T1-NASA.dwg 12/14/2017 steve.szmyd DN



PLAN: EXISTING CONDITIONS

SCALE: 1" = 40'

REMOVAL ACTION BOUNDARY SURVEY POINTS

POINT NAME	NORTHING	EASTING
P1	1982662.1025	6107668.6638
P2	1982805.1011	6107791.1304
P3	1983011.7688	6107902.5124
P4	1983114.3081	6107960.7901
P5	1983247.8305	6107870.0539
P6	1983343.7306	6107793.3338
P7	1983487.1621	6107799.0078
P8	1983544.3830	6107656.8607
P9	1983522.2522	6107558.7475
P10	1983268.4859	6107483.5029
P11	1983123.1604	6107498.2567
P12	1982861.3425	6107472.7007
P13	1982634.8078	6107508.5844

LEGEND:

- NASA AMES BOUNDARY
- 7 EXISTING 1-FT CONTOUR
- EXISTING 0.5-FT CONTOUR
- HISTORIC SOIL SAMPLING LOCATION
- MONITORING WELL
- REMOVAL ACTION BOUNDARY
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE

NOTES:

1. UPDATED TOPOGRAPHIC SURVEY WILL BE PROVIDED BY OTHERS.
2. ALL NORTHINGS AND EASTINGS SHOWN ARE BASED ON CALIFORNIA STATE PLANE ZONE 3, NAD 83, AND ELEVATIONS ARE BASED ON NAVD88.
3. BOUNDARIES ARE AVAILABLE TO THE CONTRACTOR IN AUTOCAD.

SURVEY CONTROL POINT

POINT NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION	LOCATION
ARC21	1981822.33	6108024.28	3.77	3-IN BRASS DISK	SET FLUSH WITH GRADE, 15 FT SOUTH OF CENTERLINE OF NORTH PERIMETER ROAD, WEST OF GATE 16B

40' 0 40' 80'

SCALE: 1" = 40'

NASA DWG. NO.
XXX---0000-C1

SYMBOL	DESCRIPTION	PREP. BY	DATE
REV. 1	AGENCY COMMENTS	EJP	11/22/17
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17

REVISIONS

TETRA TECH

DSGN. DSM	CHK. KB	DRN. EJP	SATISFACTORY TO	DATE
SUBMITTED BY		DATE 12/14/2017	APPROVED	DATE
D.M.		F.P.		
BR.HD.		DIR.		

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION
FOR AREA OF INVESTIGATION 14

EXISTING CONDITIONS

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

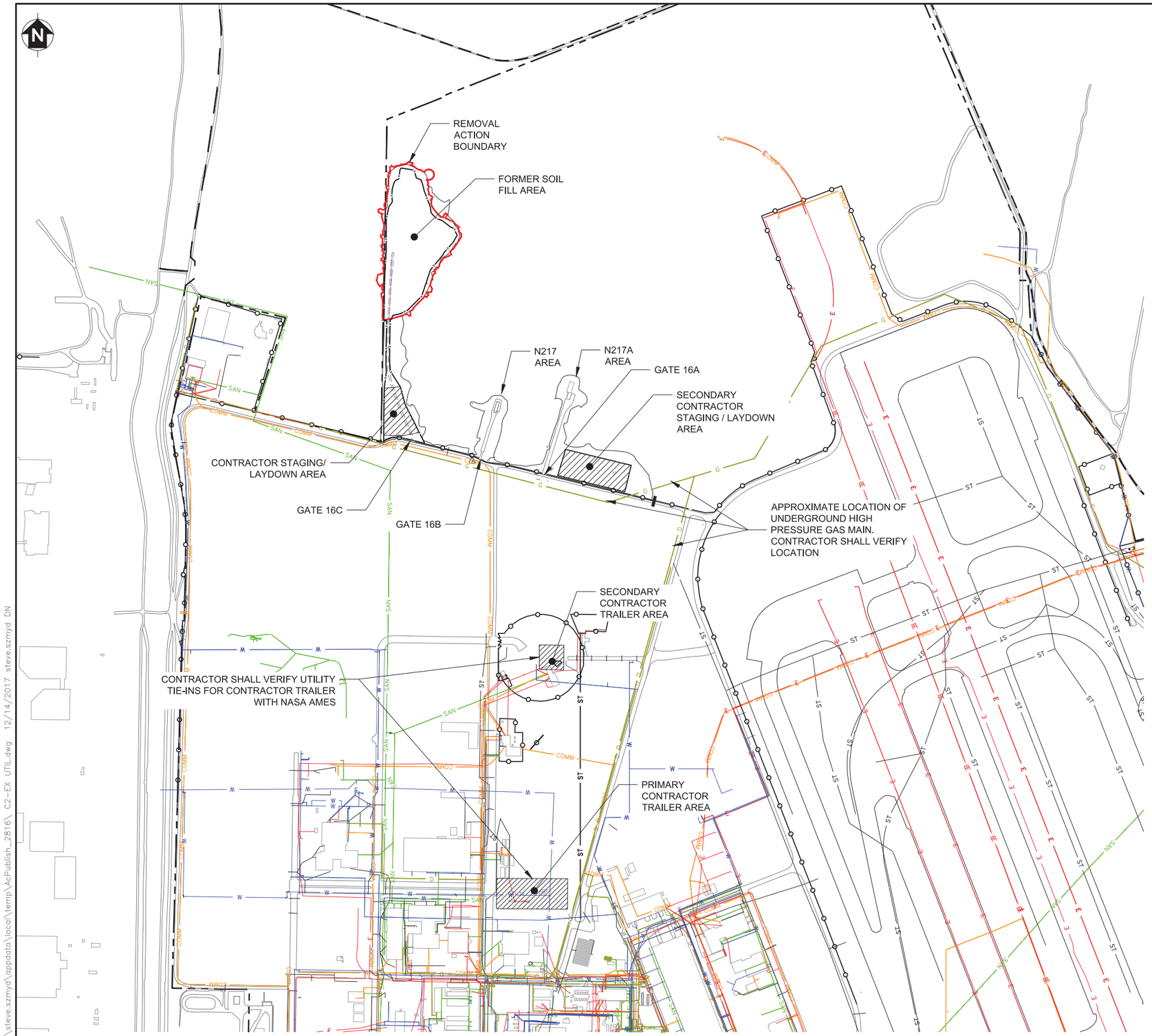
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C1

SHEET 02 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C1-EXISTING.dwg 12/14/2017 steve.szmyd DN



PLAN: EXISTING UTILITIES
SCALE: 1" = 300'

NOTES:

1. LOCATIONS OF UTILITIES SHOWN ARE APPROXIMATE ONLY. CONTRACTOR SHALL FIELD VERIFY BEFORE CONSTRUCTION. CONTACT ALL UTILITY AGENCY REPRESENTATIVES SO THAT THOSE AGENCY REPRESENTATIVES MAY MARK THE LOCATIONS OF THEIR LINES. NOTIFY UNDERGROUND SERVICE ALERT OF NORTHERN/CENTRAL CALIFORNIA AND NEVADA BY DIALING 811 OR CALLING (800) 227-2600 PRIOR TO CONSTRUCTION. PROTECT EXISTING UTILITES, WHETHER SHOWN OR NOT SHOWN ON DRAWINGS.
2. PROTECT NASA AMES PERIMETER SECURITY FENCE.
3. ALL NORTHING AND EASTINGS SHOWN ARE BASED ON CALIFORNIA STATE PLANE ZONE 3, NAD83, AND ELEVATIONS AREA BASED ON NADV88.

SURVEY CONTROL POINT

POINT NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION	LOCATION
ARC21	1981822.33	6108024.28	3.77	3-IN BRASS DISK	SET FLUSH WITH GRADE, 15 FT SOUTH OF CENTERLINE OF NORTH PERIMETER ROAD, WEST OF GATE 16B

LEGEND:

- NASA AMES BOUNDARY
- REMOVAL ACTION BOUNDARY
- BAY TRAIL
- UNKNOWN UNDERGROUND UTILITY
- EXISTING ELECTRIC
- EXISTING HIGH PRESSURE GAS MAIN
- EXISTING WATERLINE
- EXISTING COMMUNICATIONS
- EXISTING SANITARY SEWER
- EXISTING STORM SEWER
- EXISTING NASA PERIMETER FENCE

300' 0 300' 600'
SCALE: 1" = 300'

NASA DWG. NO.
XXX---0000-C2

REVISIONS

REV.	DESCRIPTION	PREP. BY	DATE	APPROVED
1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE
SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE
D.M. | F.P. | BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

EXISTING UTILITIES

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

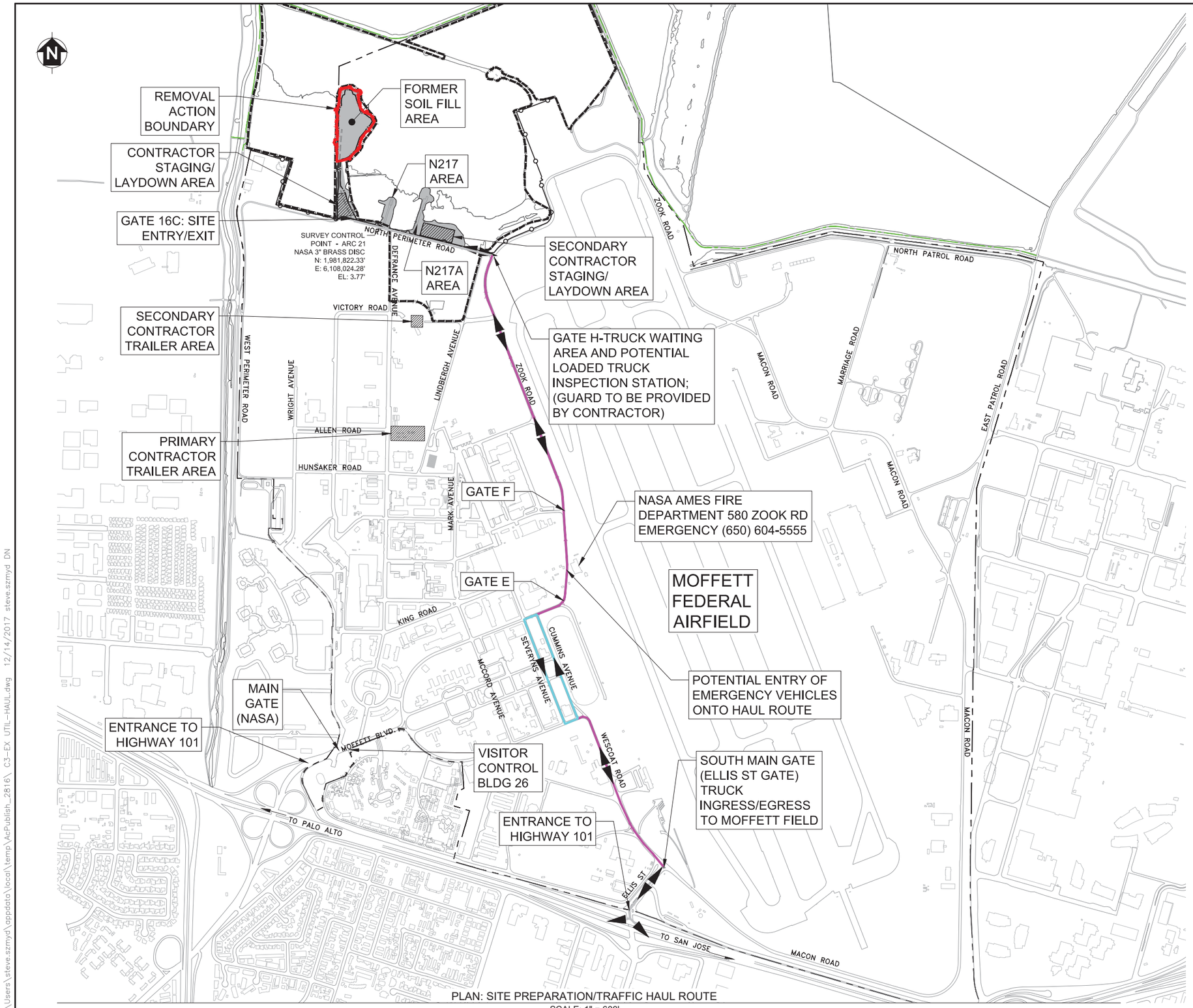
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C2

SHEET 03 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C2-EX UTIL.dwg 12/14/2017 steve.szmyd DN



PLAN: SITE PREPARATION/TRAFFIC HAUL ROUTE

SCALE: 1" = 600'

NOTES:

1. BOUNDARIES OF LAYDOWN / STAGING AREAS TO BE DETERMINED BY NASA AMES.
2. REPAIR DAMAGE TO EXISTING ROADWAYS AND INFRASTRUCTURE. REPAIRS SHALL BE MADE TO MATCH EXISTING AT NO COST TO THE GOVERNMENT AND TO THE SATISFACTION OF NASA AMES.
3. CONTRACTOR SHALL MAINTAIN HAUL ROUTE DURING CONSTRUCTION IN GOOD WORKING ORDER TO PREVENT ADDITIONAL EROSION OR STORMWATER RUNOFF. PROVIDE TRAFFIC ACCESS THROUGH OR AROUND THE CONSTRUCTION ACTIVITY AT ALL TIMES.
4. NO MATERIAL SHALL BE STOCKPILED OR LEFT ON THE ROADS AT ANY TIME DURING CONSTRUCTION.
5. MAINTAIN VEHICLE ACCESS TO ALL PROPERTIES ADJACENT TO THE WORK DURING CONSTRUCTION.
6. PROTECT NASA SECURITY FENCE(S) AND GATES DURING CONSTRUCTION. GATES SHALL BE KEPT CLOSED (AND LOCKED DURING OFF-WORK HOURS) EXCEPT WHEN PROJECT VEHICLES ARE CROSSING.
7. CONTRACTOR SHALL PLACE WARNING AND NO TRESPASSING SIGNS ALONG PERIMETER SECURITY FENCE AND ALONG BAY TRAIL NOTIFYING THE PUBLIC OF THE CONSTRUCTION AREA. THE LOCATION OF THE SIGNS SHALL BE IDENTIFIED IN THE CONTRACTOR'S TRAFFIC CONTROL PLAN.
8. CONTRACTOR SHALL PLACE CONTRACTOR TRAILER AT PRIMARY CONTRACTOR TRAILER AREA UNLESS DIRECTED BY NASA AMES TO USE SECONDARY CONTRACTOR TRAILER AREA.
9. HAUL ROUTE CROSSES AIRFIELD TAXIWAY BETWEEN GATES E AND F. ALL CONTRACTOR PERSONNEL DRIVING VEHICLES ACROSS AIRFIELD TAXIWAY SHALL ATTEND AIRFIELD ACCESS TRAINING (PROVIDED BY NASA AMES). CONTRACTOR PERSONNEL SHALL PRESENT EVIDENCE OF U.S. CITIZENSHIP OR GREEN CARD BEFORE TAKING THE TRAINING.
10. CONTRACTOR SHALL COORDINATE ACCESS TO AIRFIELD TAXIWAY WITH AIRFIELD OPERATIONS GROUPS TO ENSURE THERE ARE NO CONFLICTS WITH MOVEMENT OF AIRCRAFT.
11. CONTRACTOR SHALL ENSURE DUMP TRUCKS AND OTHER VEHICLES CROSSING AIRFIELD TAXIWAY ARE CLEAN AND DO NOT LEAVE FOREIGN OBJECT DEBRIS ON TAXIWAY. CONTRACTOR SHALL CONDUCT TAXIWAY DEBRIS INSPECTIONS DAILY OR AT THE FREQUENCY REQUIRED BY NASA AMES DURING TRANSPORTATION OF CONTAMINATED SOIL AND SEDIMENT.
12. VEHICLES AND EQUIPMENT SHALL NOT LEAVE DESIGNATED ROADWAYS. CONTRACTOR SHALL ONLY PARK IN AREAS DESIGNATED BY NASA AMES.

LEGEND:

- NASA AMES BOUNDARY
- NAVY IR SITE 25 BOUNDARY
- BAY TRAIL
- REMOVAL AREA BOUNDARY
- AOI 14
- ONE-WAY DIRECTION TRUCK TRAFFIC
- TWO-WAY DIRECTION TRUCK TRAFFIC
- CONTRACTOR STAGING/LAYDOWN OR TRAILER AREA

600' 0 600' 1200'

SCALE: 1" = 600'

NASA DWG. NO.

XXX---0000-C3

REV.	DESCRIPTION	PREP.BY	DATE	APPROVED
1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

REVISIONS

TETRA TECH

DSGN. DSM	CHK. KB	DRN. EJP	SATISFACTORY TO DATE
SUBMITTED BY		DATE 12/14/2017	APPROVED DATE
D.M.		F.P.	
BR.HD.		DIR.	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AMES RESEARCH CENTER

AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

SITE PREPARATION/TRAFFIC HAUL ROUTE

SIZE D

IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT

SCALE REDUCED ACCORDINGLY

PROJECT LOCATION MOFFETT FIELD

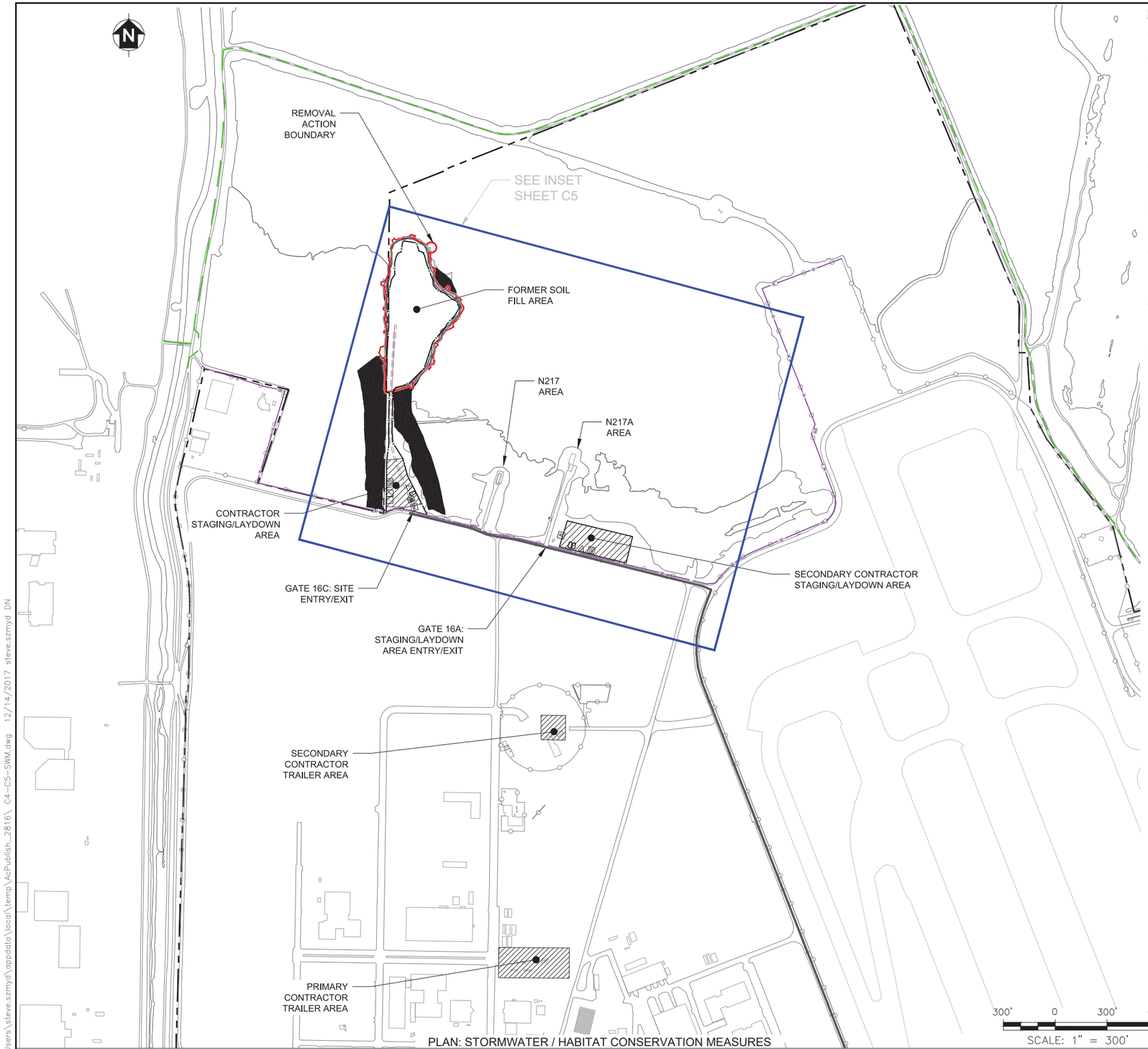
CONSTR. CONTR. NO. 000-00-X-0000

DWG. NO.

C3

SHEET 03 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C3-EX UTIL-HAUL.dwg 12/14/2017 steve.szmyd DN



PLAN: STORMWATER / HABITAT CONSERVATION MEASURES

SCALE: 1" = 300'

NOTES:

1. BOUNDARIES OF STAGING/LAYDOWN AREAS TO BE DETERMINED BY NASA AMES.
2. USFWS-APPROVED BIOLOGIST IN COORDINATION WITH THE ENGINEER SHALL MARK PROJECT FOOTPRINT BEFORE CONSTRUCTION BEGINS. CONSTRUCTION ACTIVITY SHALL BE CONFINED TO THE PROJECT FOOTPRINT. ALL MARKERS SHALL BE LESS THAN 3 FT TALL.
3. USFWS-APPROVED BIOLOGIST SHALL CONDUCT TRAINING OF ALL PROJECT PERSONNEL AND VISITORS BEFORE ANY GROUND-DISTURBING ACTIVITIES. TRAINING SHALL INCLUDE DESCRIPTION OF SPECIAL STATUS SPECIES AND SENSITIVE HABITAT.
4. CONSTRUCTION PERSONNEL WHO INJURE OR KILL SPECIAL STATUS SPECIES SHALL IMMEDIATELY INFORM ON-SITE USFWS-APPROVED BIOLOGIST, WHO WILL IMMEDIATELY NOTIFY NASA AMES.
5. CONTRACTOR SHALL CONSTRUCT AND EMPLOY NOISE REDUCTION DEVICES ON STATIONARY SOURCES OF NOISE AND, TO THE EXTENT PRACTICABLE, ALL MOBILE EQUIPMENT.
6. COMPLETE LISTING AND DESCRIPTIONS OF BEST MANAGEMENT PRACTICES ARE INCLUDED IN THE SWPPP, AND CONSERVATION MEASURES ARE IN THE BIOLOGICAL ASSESSMENT, BIOLOGICAL OPINION, AND PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN.
7. MINIMIZE DISRUPTION OF ONGOING FACILITY OPERATIONS AT BUILDINGS ON N217 AND N217A AREAS. ACCESS TO SECONDARY CONTRACTOR STAGING/LAYDOWN AREA SHALL BE COORDINATED WITH TENANTS OF BUILDING N217A.
8. CONTRACTOR SHALL INSTALL ANTI-PERCH DEVICES ALONG TOP OF EXISTING NASA PERIMETER FENCE WHERE INDICATED.

LEGEND:

- NASA AMES BOUNDARY
- REMOVAL ACTION BOUNDARY
- BAY TRAIL
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE
- LAYDOWN AREA
- PICKLEWEED TO REMAIN UNDISTURBED
- PICKLEWEED TO BE DISTURBED
- HAUL ROUTE
- EXISTING NASA PERIMETER FENCE
- EXISTING FENCE WITH ANTI-PERCH DEVICES

NASA DWG. NO.
XXX---0000-C4

SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED
REV. 1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

REVISIONS

TETRA TECH

DSGN. DSM	CHK. XXX	DRN. EJP	SATISFACTORY TO DATE
SUBMITTED BY		DATE 12/14/2017	APPROVED DATE
D.M.		F.P.	
BR.HD.		DIR.	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

STORMWATER/HABITAT CONSERVATION MEASURES 1

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

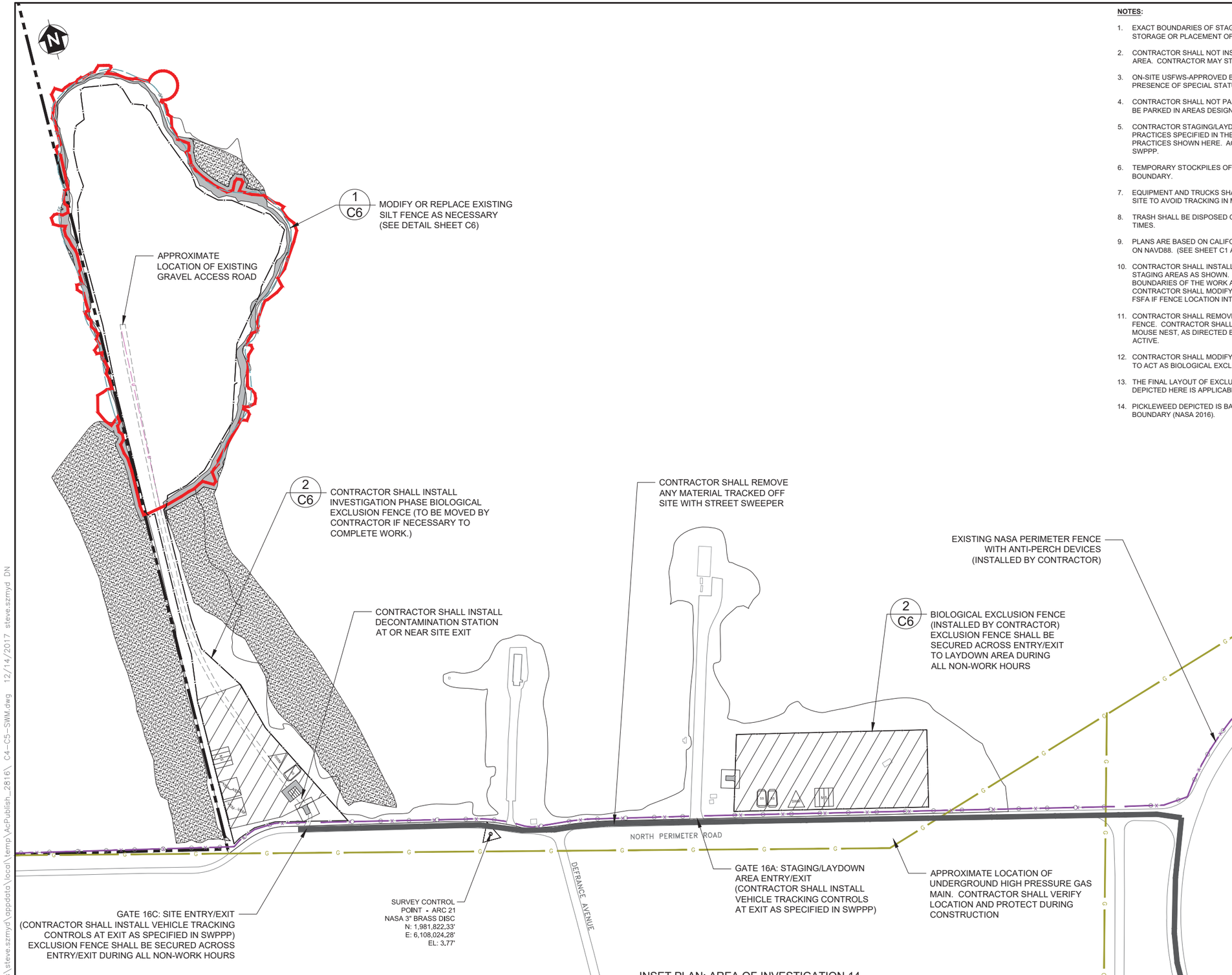
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C4

SHEET 04 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C4-C5-SWM.dwg 12/14/2017 steve.szmyd DN



INSET PLAN: AREA OF INVESTIGATION 14

SCALE: 1" = 100'

NOTES:

1. EXACT BOUNDARIES OF STAGING/LAYDOWN AREAS SHALL BE DETERMINED BY NASA AMES. STORAGE OR PLACEMENT OF MATERIAL OR EQUIPMENT OUTSIDE THIS AREA IS PROHIBITED.
2. CONTRACTOR SHALL NOT INSTALL TEMPORARY SECURITY FENCE AROUND STAGING/LAYDOWN AREA. CONTRACTOR MAY STORE EQUIPMENT IN PORTABLE LOCKED ENCLOSURES.
3. ON-SITE USFWS-APPROVED BIOLOGIST SHALL INSPECT CONSTRUCTION EQUIPMENT FOR PRESENCE OF SPECIAL STATUS SPECIES BEFORE EACH WORK DAY.
4. CONTRACTOR SHALL NOT PARK PERSONAL VEHICLES ON AOI 14. PERSONAL VEHICLES SHALL BE PARKED IN AREAS DESIGNATED BY NASA AMES.
5. CONTRACTOR STAGING/LAYDOWN AREA SHALL INCLUDE THE STORMWATER BEST MANAGEMENT PRACTICES SPECIFIED IN THE SWPPP. CONCEPTUAL LAYOUT OF BEST MANAGEMENT PRACTICES SHOWN HERE. ACTUAL LAYOUT OF STAGING/LAYDOWN AREA TO BE SPECIFIED IN SWPPP.
6. TEMPORARY STOCKPILES OF EXCAVATED MATERIAL SHALL REMAIN WITHIN REMOVAL ACTION BOUNDARY.
7. EQUIPMENT AND TRUCKS SHALL BE CLEANED AT AN OFF-SITE LOCATION BEFORE ENTERING THE SITE TO AVOID TRACKING IN MATERIAL OR NOXIOUS WEEDS FROM OTHER SITES.
8. TRASH SHALL BE DISPOSED OF PROPERLY, AND CONTAINER LIDS SHALL BE SECURED AT ALL TIMES.
9. PLANS ARE BASED ON CALIFORNIA STATE PLANE ZONE 3, NAD83, AND ELEVATIONS ARE BASED ON NAVD88. (SEE SHEET C1 AND C2 FOR SURVEY CONTROL POINT INFORMATION.)
10. CONTRACTOR SHALL INSTALL BIOLOGICAL EXCLUSION FENCE AROUND THE WORK SITE AND STAGING AREAS AS SHOWN. THE EXCLUSION FENCE SHALL BE PLACED AS CLOSE TO THE BOUNDARIES OF THE WORK AREA AS POSSIBLE TO MINIMIZE PICKLEWEED DISTURBANCE. CONTRACTOR SHALL MODIFY LOCATION OF EXCLUSION FENCE WITH NASA APPROVAL AROUND FSFA IF FENCE LOCATION INTERFERES WITH WORK ACTIVITIES.
11. CONTRACTOR SHALL REMOVE PICKLEWEED BY HAND TO A DISTANCE OF 4 FEET OF EXCLUSION FENCE. CONTRACTOR SHALL STOP ALL WORK WITHIN 10 FEET OF A SALT MARSH HARVEST MOUSE NEST, AS DIRECTED BY USFWS-APPROVED BIOLOGIST, UNTIL THE NEST IS NO LONGER ACTIVE.
12. CONTRACTOR SHALL MODIFY OR REPLACE EXISTING SILT FENCE IF NECESSARY FOR WORK OR TO ACT AS BIOLOGICAL EXCLUSION FENCE.
13. THE FINAL LAYOUT OF EXCLUSION FENCE FOR THE REMOVAL IS TO BE DETERMINED. LAYOUT DEPICTED HERE IS APPLICABLE TO THE SITE CHARACTERIZATION SAMPLING.
14. PICKLEWEED DEPICTED IS BASED ON MAPPED EXTENT IN JULY 2016, 100 FEET OUT FROM FSFA BOUNDARY (NASA 2016).

LEGEND:

- NASA AMES BOUNDARY
- REMOVAL ACTION BOUNDARY
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE
- LAYDOWN AREA
- PICKLEWEED TO REMAIN UNDISTURBED
- PICKLEWEED TO BE DISTURBED
- HAUL ROUTE
- EXISTING HIGH PRESSURE GAS MAIN
- EXISTING FENCE WITH ANTI-PERCH DEVICES

CONSTRUCTION SITE BEST MANAGEMENT PRACTICES:
(SOURCE: "STORM WATER QUALITY HANDBOOKS, CONSTRUCTION SITE BEST MANAGEMENT PRACTICES MANUAL" STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION, MARCH 2003.)

- MATERIAL DELIVERY AND STORAGE (WM-1)
- VEHICLE EQUIPMENT FUELING (NS-9)
- CONSTRUCTION ENTRANCE/EXIT (TC-1)
- SOLID WASTE MANAGEMENT (WM-5)
- PORTABLE TOILETS (WM-9)
- VEHICLE EQUIPMENT AND MAINTENANCE (NS-10)
- TIRE WASH (TC-3)

100' 0 100' 200'

SCALE: 1" = 100'

REV.	AGENCY COMMENTS	EJP	11/22/17	DSM
1	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM
SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED

REVISIONS

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE

SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE

D.M. | F.P. | BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

STORMWATER/HABITAT CONSERVATION MEASURES 2

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C5

NASA DWG. NO.
XXX---0000-C5

SHEET 05 OF 12

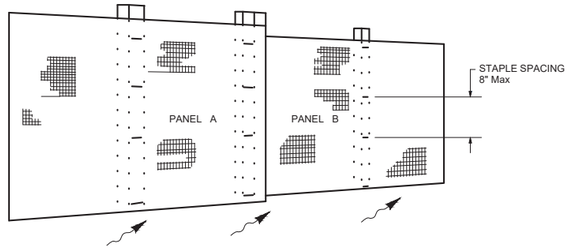
C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C4-C5-SWM.dwg 12/14/2017 steve.szmyd DN

NOTES:

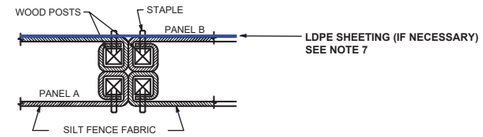
1. THE DOWNSTREAM END OF THE TEMPORARY SILT FENCE SHALL HAVE THE LAST 8' ANGLED UP SLOPE.
2. SETBACK DIMENSIONS MAY VARY TO FIT FIELD CONDITIONS.
3. POSTS TO OVERLAP AND FENCE FABRIC TO FOLD AROUND EACH POST ONE FULL TURN. SECURE FABRIC WITH 4 STAPLES FOR EACH POST.
4. POSTS SHALL BE DRIVEN TIGHTLY TOGETHER TO PREVENT POTENTIAL FLOW-THROUGH OF SEDIMENT AT THE JOINT. THE TOPS OF THE POSTS SHALL BE SECURED TO EACH OTHER WITH WIRE.
5. FOR EACH END POST, FENCE FABRIC SHALL BE FOLDED AROUND TWO POSTS ONE FULL TURN AND SECURED WITH 4 STAPLES.
6. MINIMUM OF 4 STAPLES SHALL BE INSTALLED PER POST. DIMENSIONS SHOWN ARE TYPICAL.
7. LDPE SHEETING SHALL BE ADDED TO EXISTING SILT FENCE IF FENCE IS ACTING AS BIOLOGICAL EXCLUSION FENCE. LDPE SHEETING SHALL BE SECURED TO EXISTING FENCE WITH STAPLES.
8. ADDITIONAL SUPPORT POSTS MAY BE NECESSARY TO SUPPORT HORIZONTAL FORCE FROM WATER IN STORMWATER POND IF LDPE SHEETING IS ADDED TO EXISTING SILT FENCE.

LEGEND:

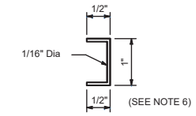
- TAMPED BACKFILL
- SLOPE DIRECTION
- DIRECTION OF FLOW



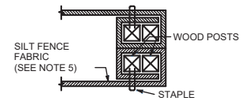
PERSPECTIVE
SILT FENCE PANELS AT JOINTS



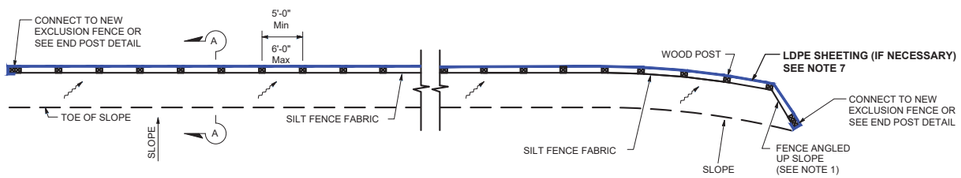
PLAN
POST AT JOINTS



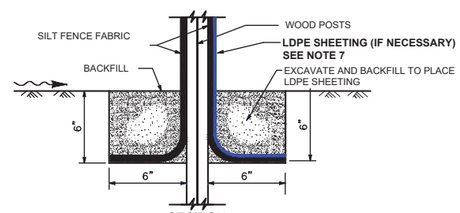
STAPLE DETAIL



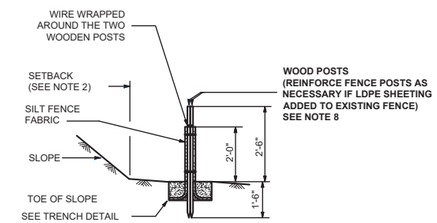
PLAN
END POST DETAIL
(IF NOT USED AS AN EXCLUSION FENCE)



PLAN
TEMPORARY SILT FENCE



SECTION
TRENCH DETAIL



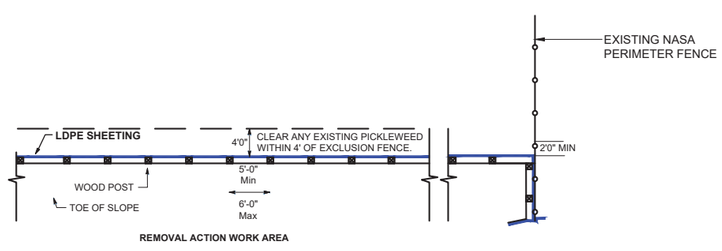
SECTION A-A
SILT FENCE

1 C6 MODIFICATIONS TO OR REPLACEMENT OF EXISTING SILT FENCE (IF NECESSARY)
SCALE: NOT TO SCALE

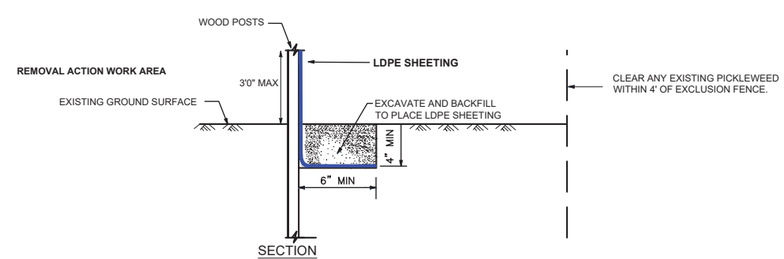
SOURCE: NASA AREA OF INVESTIGATION 14 FORMER SOIL FILL AREA
FINAL INTERIM CORRECTIVE ACTION MEASURES REPORT, JUNE 2014.

NOTES:

1. LDPE SHEETING SHALL BE ATTACHED TO THE WOODEN POSTS WITH 1" STAPLES OR OTHER METHODS TO SECURE LDPE SHEETING TAUNT ALONG LENGTH OF EXCLUSION FENCE.
2. SECURE EXCLUSION FENCE ACROSS ENTRY/EXIT DURING ALL NON-WORK HOURS. TO ALLOW ENTRY/EXIT, LDPE SHEETING MAY BE PLACED ON GROUND SURFACE INSTEAD OF BURIED AND HELD IN PLACE WITH SANDBAGS OR SECURED BY OTHER TEMPORARY METHODS.
3. STAKE DIMENSION ARE NOMINAL AND MAY VARY TO FIT FIELD CONDITION.
4. TO CREATE OPENINGS AS DIRECTED BY USFWS-APPROVED BIOLOGIST, LDPE SHEETING SHALL BE CUT AT FENCE POST, REMOVED FROM GROUND AND SECURED. TO REPLACE, SHEETING WILL BE REATTACHED TO POST OR NEW SECTION OF SHEETING SHALL BE STRETCHED BETWEEN POSTS AND SECURED. BOTTOM OF SHEETING WILL BE REPLACED 4"(MIN) BELOW GROUND SURFACE AS SHOWN IN SECTION.



PLAN
EXCLUSION FENCE



SECTION
EXCLUSION FENCE

2 C6 EXCLUSION FENCE
SCALE: NOT TO SCALE

NASA DWG. NO.
XXX---0000-C6

SYMBOL	DESCRIPTION	PREP. BY	DATE	APPROVED
REV. 1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

REVISIONS

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE
SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE
D.M. | F.P. | BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION
FOR AREA OF INVESTIGATION 14

STORMWATER/HABITAT CONSERVATION MEASURES DETAILS

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

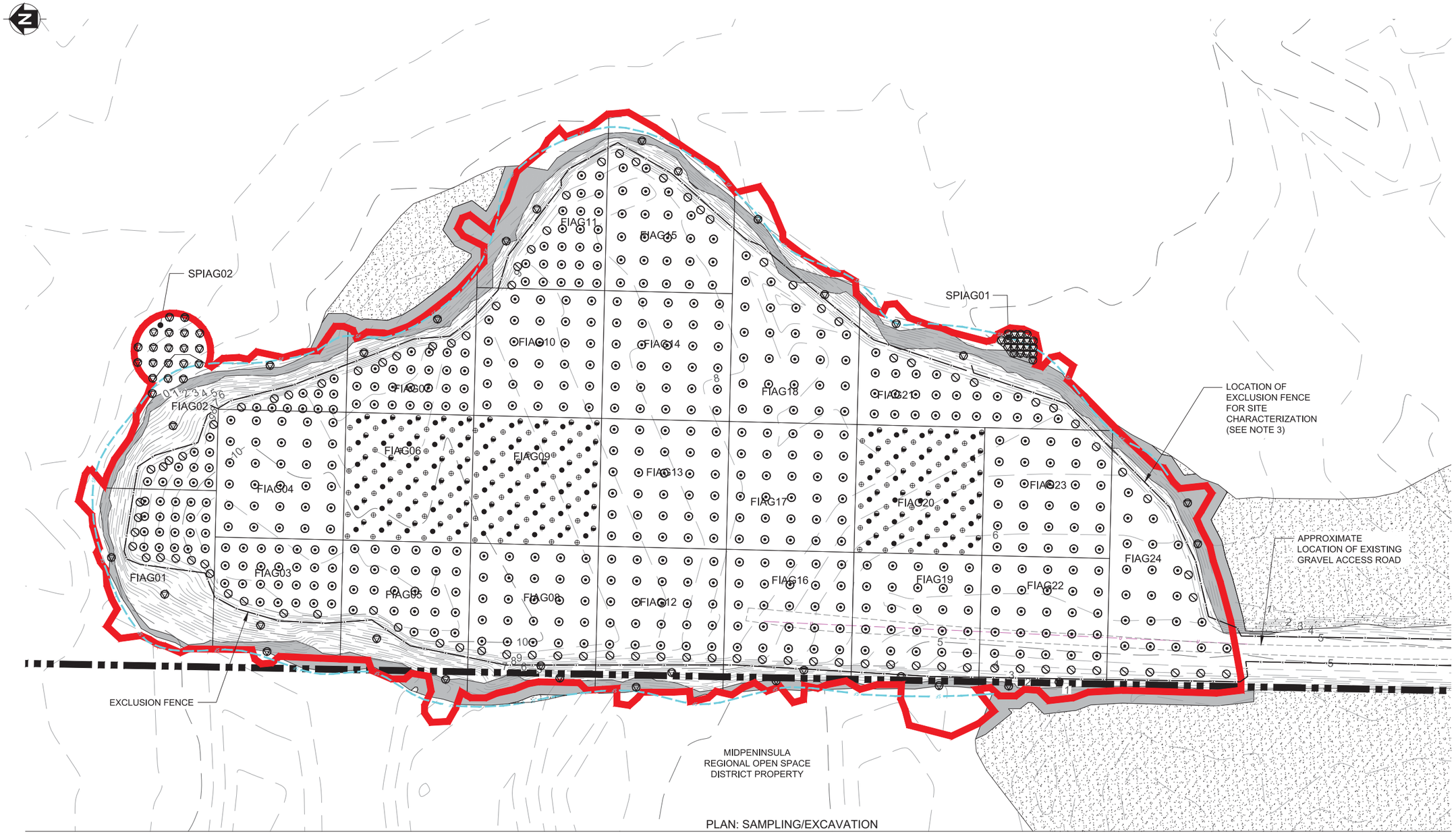
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C6

SHEET 7 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C6-SWM.dwg 12/14/2017 steve.szmyd DN



PLAN: SAMPLING/EXCAVATION

SCALE: 1" = 40'

LEGEND:

- NASA AMES BOUNDARY
- EXISTING 1-FT CONTOUR
- EXISTING 0.5-FT CONTOUR
- INVESTIGATION AREA GRID LIMITS
- REMOVAL ACTION BOUNDARY
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE
- PICKLEWEED TO REMAIN UNDISTURBED
- PICKLEWEED ASSUMED TO BE DISTURBED BY CONTRACTOR FOR REMOVAL ACTION

SAMPLING POINTS

- DPT VERTICAL BORINGS
- DPT ANGLE-HOLE BORINGS
- HAND AUGER BORINGS

PILOT STUDY INCREMENTS

- REPLICATE 1
- REPLICATE 2
- REPLICATE 3

NOTES:

1. SAMPLING TO BE COMPLETED BY OTHERS PRIOR TO CONSTRUCTION. PROPOSED SAMPLING LOCATIONS SHOWN FOR INFORMATIONAL PURPOSES ONLY.
2. CONTRACTOR WILL BE PROVIDED WITH UPDATED SURFACE TOPOGRAPHY AND SURVEY POINTS FOR EACH SAMPLING POINT AND FILL INVESTIGATION AREA GRID (FIAG) AND STORMWATER POND INVESTIGATION AREA GRID (SPIAG) BOUNDARY BEFORE CONSTRUCTION.
3. INSTALL INVESTIGATION EXCLUSION FENCE AND REMOVE PICKLEWEED BEFORE THE SITE CHARACTERIZATION. CONTRACTOR SHALL MOVE OR REPLACE EXCLUSION FENCE OR REMOVE ADDITIONAL PICKLEWEED AS NECESSARY TO CONDUCT WORK.
4. PICKLEWEED DEPICTED IS BASED ON MAPPED EXTENT IN JULY 2016, WITHIN 100 FEET OF FORMER SOIL FILL AREA (FSFA) BOUNDARY. ACTUAL PICKLEWEED DISTURBED WILL BE BASED ON THE RESULTS OF THE SITE CHARACTERIZATION.

40' 0 40' 80'

SCALE: 1" = 40'

NASA DWG. NO.

XXX---0000-C7

REVISIONS				
SYMBOL	DESCRIPTION	PREP. BY	DATE	APPROVED
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM
REV. 1	AGENCY COMMENTS	EJP	11/22/17	DSM

TETRA TECH

DSGN. DSM	CHK. KB	DRN. EJP	SATISFACTORY TO	DATE
SUBMITTED BY		DATE 12/14/2017	APPROVED	DATE
D.M.		F.P.		
BR.HD.		DIR.		

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AMES RESEARCH CENTER

AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

SAMPLING/EXCAVATION PLAN VIEW

SIZE D

IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT

SCALE REDUCED ACCORDINGLY

PROJECT LOCATION MOFFETT FIELD

CONSTR. CONTR. NO. 000-00-X-0000

DWG. NO.

C7

SHEET 08 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C7-SAMPLE.dwg 12/14/2017 steve.szmyd DN

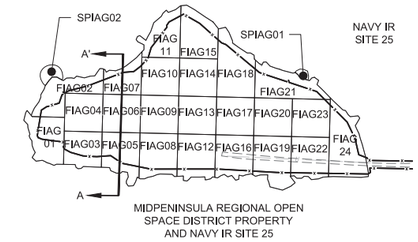
EXAMPLE SUMMARY TABLE OF SAMPLE RESULTS

(TO BE PROVIDED TO THE CONTRACTOR BEFORE EXCAVATION BEGINS)

VERTICAL DECISION UNIT	CONCENTRATION OF LEAD (mg/kg)	CONCENTRATION OF TOTAL DDT (mg/kg)	CONCENTRATION OF TOTAL PCBs (mg/kg)	FSFA MATERIAL CLASSIFICATION
FIAG-05-01	X	X	X	C3
FIAG-05-02	X	X	X	C2
FIAG-05-03	X	X	X	C3
FIAG-05-04	X	X	X	C3
FIAG-05-05	X	X	X	C2
FIAG-05-06	X	X	X	C4
FIAG-06-01	X	X	X	C1
FIAG-06-02	X	X	X	C2
FIAG-06-03	X	X	X	C3
FIAG-06-04	X	X	X	C2
FIAG-06-05	X	X	X	C4
FIAG-06-06	X	X	X	C4
FIAG-07-01	X	X	X	C3
FIAG-07-02	X	X	X	C3
FIAG-07-03	X	X	X	C2
FIAG-07-04	X	X	X	C4
FIAG-07-05	X	X	X	C4

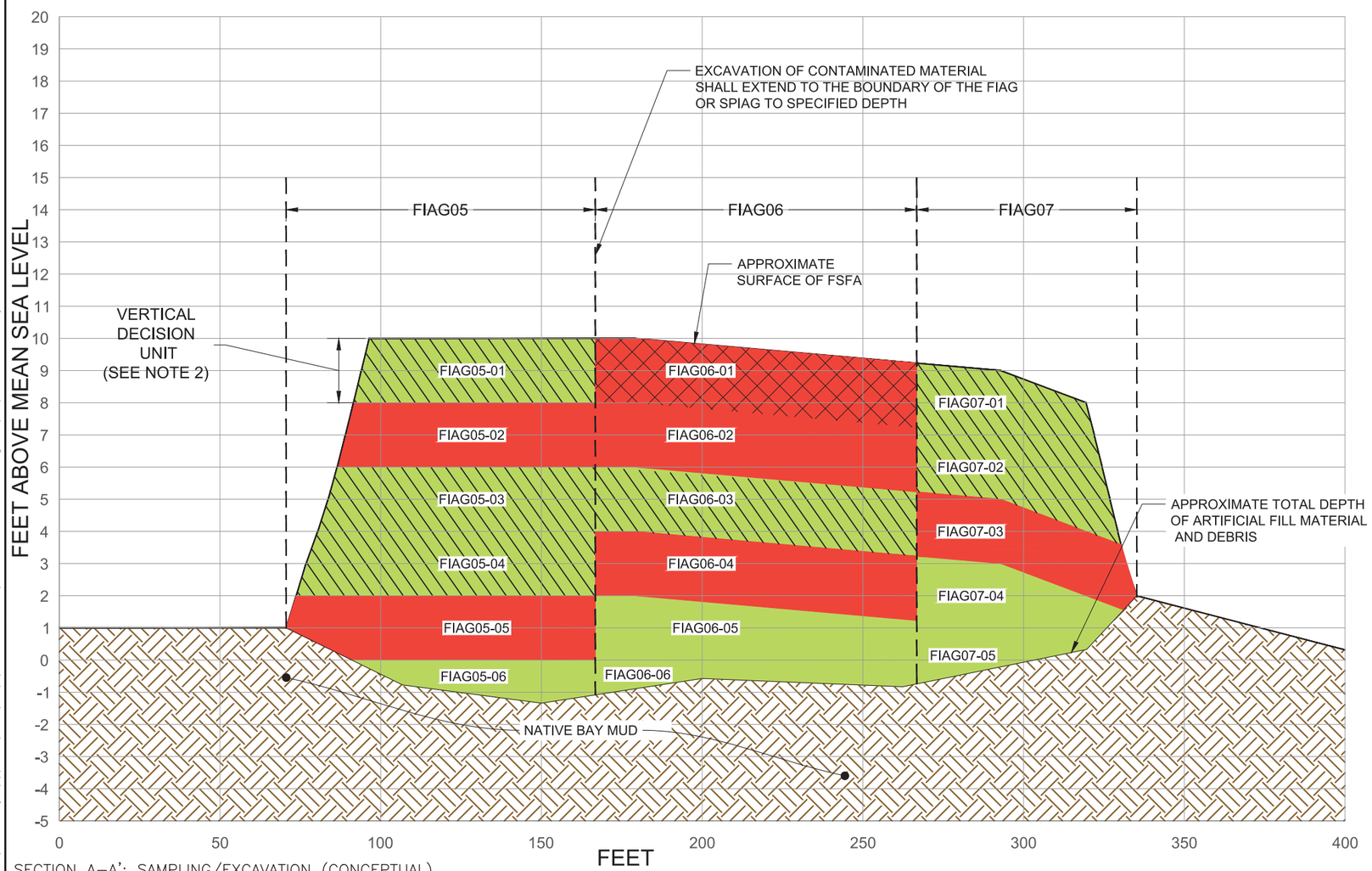
TABLE NOTES:

1. HYPOTHETICAL CLASSIFICATIONS SHOWN FOR ILLUSTRATION PURPOSES.
2. DETECTED CONCENTRATIONS OF COCs AND MATERIAL CLASSIFICATIONS WILL BE PROVIDED TO CONTRACTOR PRIOR TO CONSTRUCTION.
3. CONTRACTOR WILL BE PROVIDED WITH CLASSIFICATION OF FSFA MATERIAL IN EACH FIAG OR SPIAG AFTER SITE CHARACTERIZATION IS COMPLETE.



SAMPLING SECTION LOCATION MAP

SCALE: 1"=200'



SECTION A–A': SAMPLING/EXCAVATION (CONCEPTUAL)

SCALE: HORIZONTAL: 1"=20'; VERTICAL: 1"=2'

LEGEND:

FSFA MATERIAL CLASSIFICATION

C1	FILL MATERIAL POTENTIALLY MEETING CRITERIA FOR DISPOSAL AS A HAZARDOUS WASTE TO BE EXCAVATED AND DISPOSED OF OFF SITE (HYPOTHETICAL)
C2	VERTICAL DECISION UNIT WITH CONCENTRATION OF ONE OR MORE COCs ABOVE CLEAN UP GOALS TO BE EXCAVATED AND DISPOSED OF OFF SITE (HYPOTHETICAL)
C3	CLEAN FILL MATERIAL TO BE EXCAVATED IF NECESSARY TO REMOVE UNDERLYING CONTAMINATED MATERIAL; STOCKPILE AND USE FOR FINAL GRADING OF SITE (HYPOTHETICAL)
C4	VERTICAL DECISION UNIT WITH CONCENTRATIONS OF COCs BELOW CLEAN UP GOALS TO REMAIN IN PLACE OR USED FOR FINAL GRADING OF SITE (HYPOTHETICAL)
FSFA	FORMER SOIL FILL AREA
FIAG	FILL INVESTIGATION AREA GRID
SPIAG	STORMWATER POND INVESTIGATION AREA GRID
COC	CHEMICAL OF CONCERN (LEAD, TOTAL DDT, TOTAL PCBs)

NOTES:

1. CONTRACTOR WILL BE PROVIDED WITH CLASSIFICATION OF FSFA MATERIAL IN EACH FIAG OR SPIAG AFTER SITE CHARACTERIZATION IS COMPLETE.
2. VERTICAL DECISION UNITS ARE MEASURED FROM THE EXISTING GROUND SURFACE. VERTICAL DECISION UNITS ARE MINIMUM 2 FEET IN THICKNESS FOR EACH FIAG AND 6 INCHES THICK IN EACH SPIAG.
3. BOTTOM VERTICAL DECISION UNITS MAY BE THINNER THAN 2 FEET IN FIAGS AND WILL EXTEND TO THE NATIVE BAY MUD.

20' 0 20' 40'

SCALE: 1" = 20'

NASA DWG. NO.

XXX---0000-C8

REV.	SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED
1	N/A	AGENCY COMMENTS	EJP	11/22/17	DSM
		FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

REVISIONS

TETRA TECH

DSGN. DSM CHK. KB DRN. EJP

SUBMITTED BY DATE 12/14/2017 SATISFACTORY TO DATE

D.M. F.P. APPROVED DATE

BR.HD. DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AMES RESEARCH CENTER

AOI 14

NON–TIME–CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

SAMPLING/EXCAVATION CROSS–SECTION

SIZE D

IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT

SCALE REDUCED ACCORDINGLY

PROJECT LOCATION MOFFETT FIELD

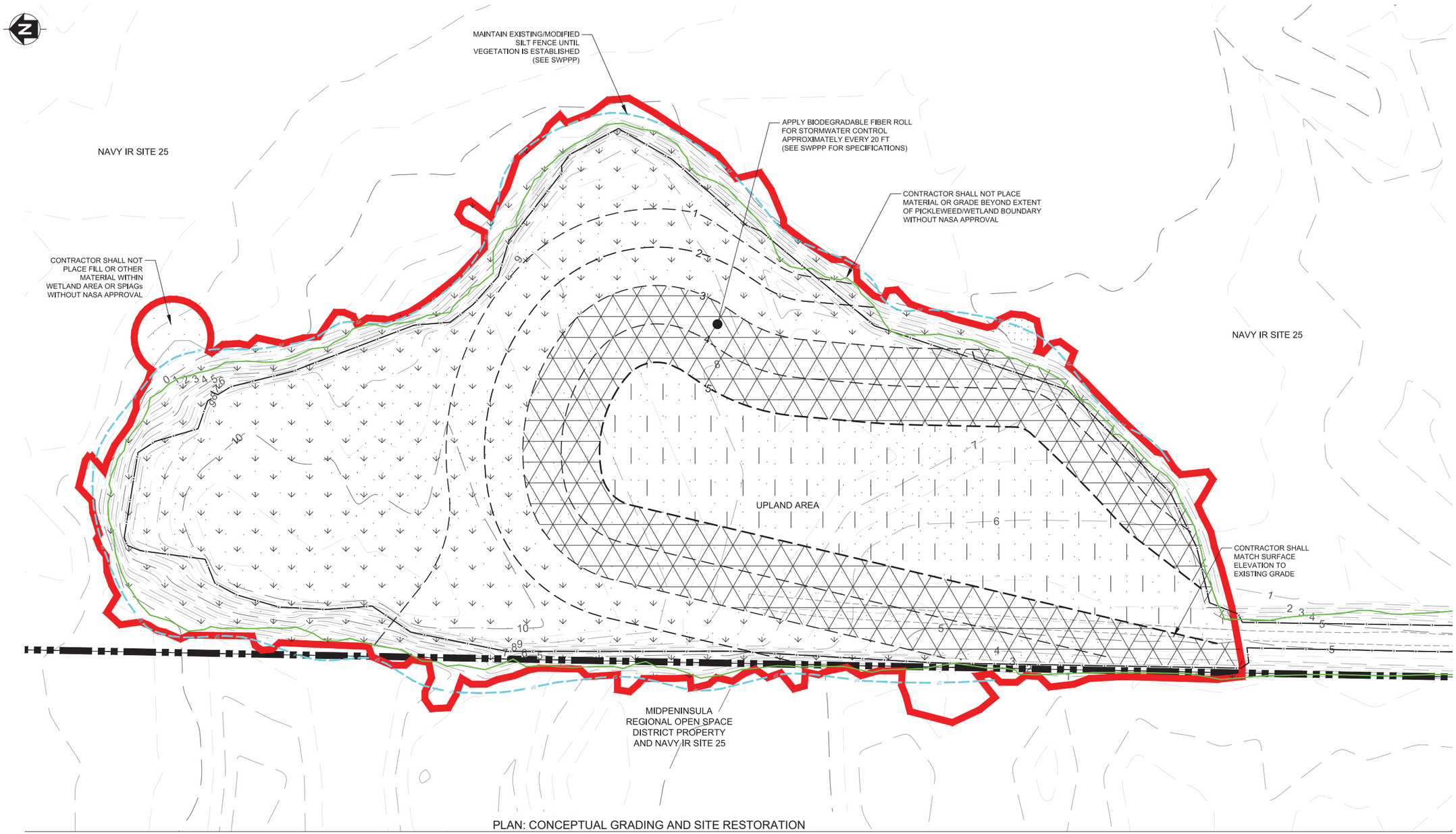
CONSTR. CONTR. NO. 000–00–X–0000

DWG. NO.

C8

SHEET 09 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C8-SAMPLE-SECTION.dwg 12/14/2017 steve.szmyd DN



PLAN: CONCEPTUAL GRADING AND SITE RESTORATION

SCALE: 1" = 40'

LEGEND:

- NASA AMES BOUNDARY
- EXISTING 1-FT CONTOUR
- EXISTING 0.5-FT CONTOUR
- REMOVAL ACTION BOUNDARY
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE
- PROPOSED 1-FT CONTOUR
- PROPOSED 0.5-FT CONTOUR
- EXISTING PICKLEWEED / WETLAND BOUNDARY

FOR REMOVAL ACTION

- PICKLEWEED RESTORATION AREA (FROM 0.5-FT TO 3.0-FT AMSL)
- TRANSITIONAL VEGETATION RESTORATION AREA (3.0-FT TO 5.0-FT AMSL)
- UPLAND VEGETATION RESTORATION AREA (GREATER THAN 5.0-FT AMSL)

AMSL - ABOVE MEAN SEA LEVEL
SWPPP - STORMWATER POLLUTION PREVENTION PLAN

NOTES:

1. THE FINAL GRADING PLAN AND SITE RESTORATION PLAN SHALL BE PREPARED BY THE CONTRACTOR AFTER SITE CHARACTERIZATION BY OTHERS IS COMPLETE. PLANT PALETTES FOR RESTORATION AREAS SHALL BE SPECIFIED IN THE SITE RESTORATION PLAN.
2. CONTRACTOR SHALL DISTRIBUTE AVAILABLE UNCONTAMINATED FILL TO CREATE FINAL GRADE WITHIN REMOVAL ACTION BOUNDARY AND EXTENT OF EXISTING PICKLEWEED/WETLAND BOUNDARY. NO OFFSITE FILL SHALL BE BROUGHT TO THE SITE.
3. FINAL GRADES SHALL BE MINIMUM 3% SLOPES WITH NO INFLECTION POINTS.
4. GRADING SHALL MAXIMIZE SHEET FLOW OFF OF AOI 14 AND INTO EXISTING STORMWATER POND.
5. FINAL GRADES SHALL BE MAXIMUM 25% (1V:4H). GREATER SLOPES MAY BE ACCEPTABLE ONLY WITH NASA APPROVAL.
6. UPLAND AREA SHALL BE A MINIMUM OF 5 FEET ABOVE MEAN SEA LEVEL.
7. PLANS ARE BASED ON CALIFORNIA STATE PLANE ZONE 3, NAD83, AND ELEVATIONS ARE BASED ON NAVD88. (SEE SHEET C1 AND C2 FOR SURVEY CONTROL POINT INFORMATION.)

40' 0 40' 80'

SCALE: 1" = 40'

NASA DWG. NO.
XXX---0000-C9

REV.	DESCRIPTION	PREP. BY	DATE	APPROVED
1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM

REVISIONS

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE
SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE
D.M. | F.P.
BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

CONCEPTUAL GRADING AND SITE RESTORATION PLAN VIEW

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

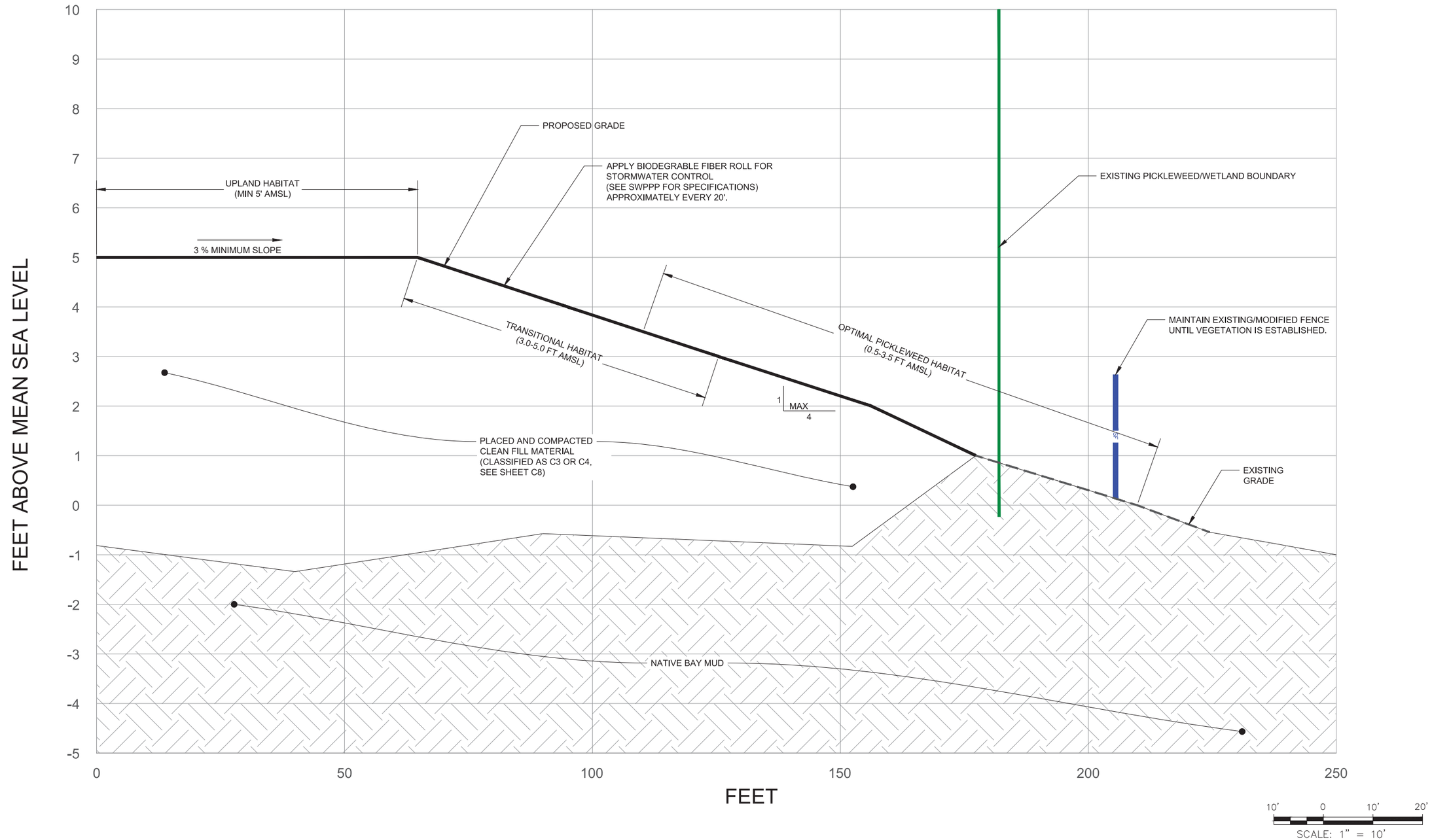
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C9

SHEET 10 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C09-GRADING.dwg 12/14/2017 steve.szmyd DN



SECTION: CONCEPTUAL GRADING AND SITE RESTORATION
SCALE: HORIZONTAL: 1"=10'; VERTICAL: 1"=1'

NOTE:

1. THE FINAL GRADING PLAN AND SITE RESTORATION PLAN SHALL BE PREPARED BY THE CONTRACTOR. PLANT PALETTES FOR RESTORATION AREAS SHALL BE SPECIFIED IN THE SITE RESTORATION PLAN.

AMSL - ABOVE MEAN SEA LEVEL

SWPPP - STORMWATER POLLUTION PREVENTION PLAN

LEGEND:

- EXISTING GRADE
- PROPOSED GRADE
- NATIVE BAY MUD
- EXISTING PICKLEWEED/WETLAND BOUNDARY
- SF — EXISTING SILT FENCE

NASA DWG. NO.
XXX---0000-C10

REV.	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM
SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED

REVISIONS

TETRA TECH

DSGN. DSM | CHK. KB | DRN. EJP | SATISFACTORY TO | DATE
SUBMITTED BY | DATE 12/14/2017 | APPROVED | DATE
D.M. | F.P.
BR.HD. | DIR.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION
FOR AREA OF INVESTIGATION 14

CONCEPTUAL GRADING AND SITE RESTORATION CROSS-SECTION

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

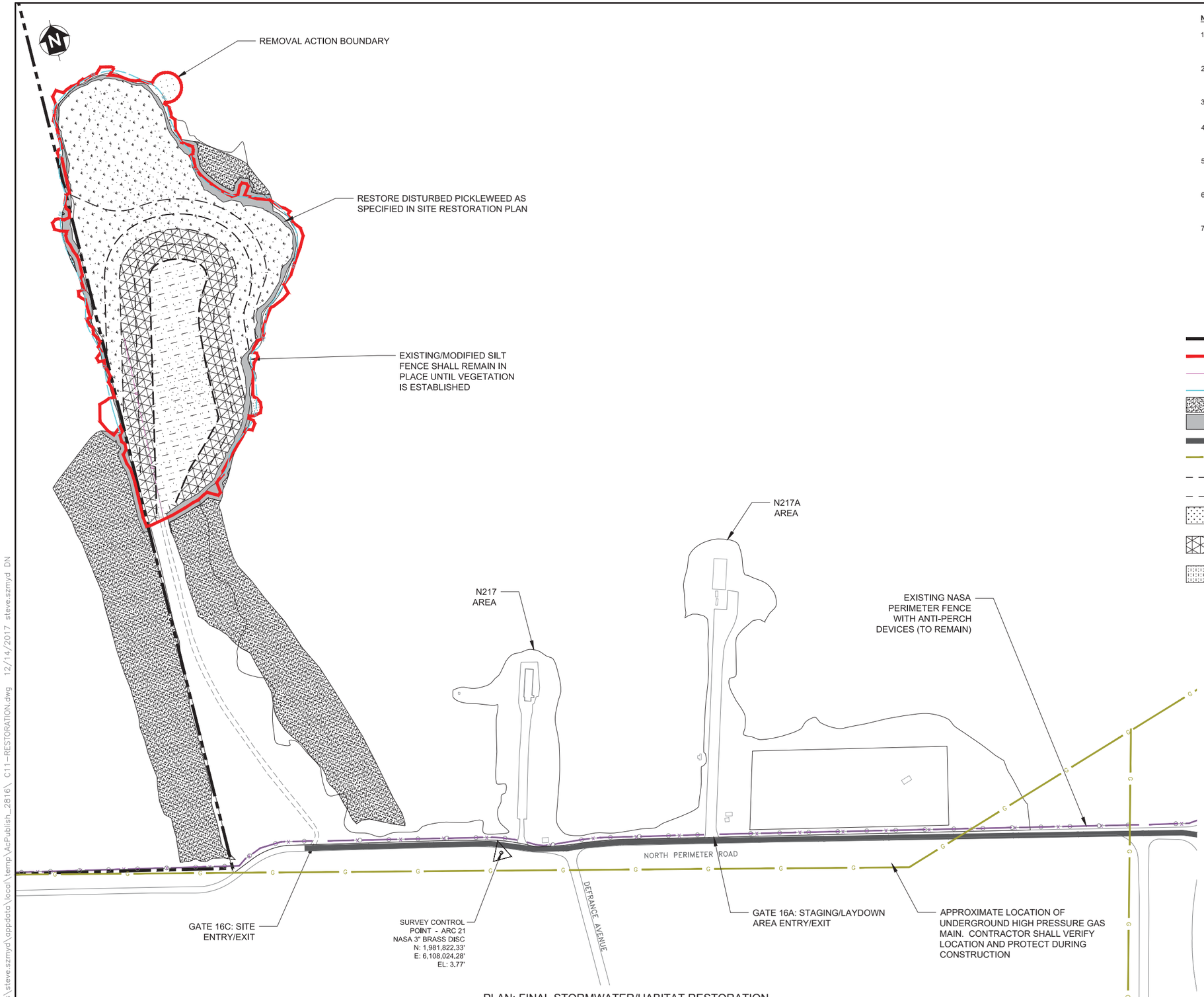
PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C10

SHEET 11 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C10-GRADING-SECTION.dwg 12/14/2017 steve.szmyd DN



PLAN: FINAL STORMWATER/HABITAT RESTORATION

SCALE: 1" = 100'

NOTES:

1. CONTRACTOR SHALL REMOVE ALL EQUIPMENT AND MATERIALS BROUGHT TO NASA AMES THAT ARE NOT PART OF THE REMOVAL ACTION, UNLESS SPECIFIED BY NASA AMES.
2. CONTRACTOR SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES, SITE FEATURES, ROADS, OR LANDSCAPING TO MATCH PRIOR CONDITIONS OR AS SPECIFIED BY NASA AMES.
3. SITE IMPROVEMENTS CONSTRUCTED ON THE FSFA TO ALLOW VEHICLE ACCESS TO THE WORK AREA MAY REMAIN WITH APPROVAL BY NASA AMES.
4. CONTRACTOR SHALL PREPARE FINAL SITE RESTORATION PLAN THAT SPECIFIES RESTORATION, MAINTENANCE, AND MONITORING REQUIREMENTS.
5. PLANS ARE BASED ON CALIFORNIA STATE PLANE ZONE 3, NAD83, AND ELEVATIONS ARE BASED ON NAVD88. (SEE SHEET C1 AND C2 FOR SURVEY CONTROL POINT INFORMATION.)
6. CONTRACTOR SHALL REMOVE EXCLUSION FENCES AFTER CONSTRUCTION IS COMPLETE. IF THE EXISTING SILT FENCE WAS MODIFIED WITH LDPE SHEETING, THE SHEETING SHALL BE REMOVED BY THE CONTRACTOR.
7. CONCEPTUAL GRADING PLAN SHOWN. ACTUAL GRADE AND ELEVATIONS SHALL BE SPECIFIED IN FINAL GRADING PLAN, AFTER SITE CHARACTERIZATION BY OTHERS IS COMPLETE.

LEGEND:

- NASA AMES BOUNDARY
- REMOVAL ACTION BOUNDARY
- UNKNOWN UNDERGROUND UTILITY
- EXISTING SILT FENCE
- PICKLEWEED REMAINING UNDISTURBED
- RESTORATION OF PICKLEWEED DISTURBED BY CONTRACTOR
- HAUL ROUTE
- EXISTING HIGH PRESSURE GAS MAIN
- PROPOSED 5-FT COUNTOUR
- PROPOSED 1-FT CONTOUR
- PICKLEWEED RESTORATION AREA (FROM 0.5-FT TO 3.0-FT AMSL)
- TRANSITIONAL VEGETATION RESTORATION AREA (3.0-FT TO 5.0-FT AMSL)
- UPLAND VEGETATION RESTORATION AREA (GREATER THAN 5.0-FT AMSL)

AMSL - ABOVE MEAN SEA LEVEL

100' 0 100' 200'

SCALE: 1" = 100'

NASA DWG. NO.
XXX---0000-C11

REVISIONS				
REV. 1	AGENCY COMMENTS	EJP	11/22/17	DSM
N/A	FINAL FOR CONSTRUCTION	EJP	12/14/17	DSM
SYMBOL	DESCRIPTION	PREP.BY	DATE	APPROVED

TETRA TECH

DSGN. DSM	CHK. KB	DRN. EJP	SATISFACTORY TO DATE
SUBMITTED BY		DATE 12/14/2017	APPROVED DATE
D.M.		F.P.	
BR.HD.		DIR.	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AMES RESEARCH CENTER
AOI 14

NON-TIME-CRITICAL REMOVAL ACTION FOR AREA OF INVESTIGATION 14

FINAL STORMWATER/HABITAT RESTORATION

SIZE D
IF SHEET IS LESS THAN 22" X 34" IT IS A REDUCED PRINT
SCALE REDUCED ACCORDINGLY

PROJECT LOCATION
MOFFETT FIELD

CONSTR. CONTR. NO.
000-00-X-0000

DWG. NO.
C11

SHEET 12 OF 12

C:\Users\steve.szmyd\appdata\local\temp\AcPublish_2816\ C11-RESTORATION.dwg 12/14/2017 steve.szmyd DN

APPENDIX D
SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN)

Ames RESEARCH CENTER

National Aeronautics and Space Administration

Final

SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN)

DESIGN SITE CHARACTERIZATION

AREA OF INVESTIGATION 14

December 2017

Prepared for:

National Aeronautics and Space Administration
Ames Research Center,
Moffett Field, California

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

SAP WORKSHEETS

ACRONYMS AND ABBREVIATIONS 4

SAP WORKSHEET #1 — TITLE AND APPROVAL PAGE 7

INTRODUCTION 8

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION 17

SAP WORKSHEET #3 — DISTRIBUTION LIST 19

SAP WORKSHEET #4 — PROJECT PERSONNEL SIGN-OFF SHEET 21

SAP WORKSHEET #5 — PROJECT ORGANIZATIONAL CHART 22

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS 23

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE 25

SAP WORKSHEET #8 — SPECIAL PERSONNEL TRAINING REQUIREMENTS 27

SAP WORKSHEET #9 — PROJECT SCOPING SESSIONS 28

SAP WORKSHEET #10 — PROBLEM DEFINITION 31

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY 33

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION 39

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA 46

SAP WORKSHEET #13 — SECONDARY DATA CRITERIA AND LIMITATIONS TABLE 49

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS 50

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE 54

SAP WORKSHEET #16 — PROJECT SCHEDULE/TIMELINE TABLE 58

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE 60

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE 64

SAP WORKSHEET #19 — ANALYTICAL SOP REQUIREMENTS TABLE 81

SAP WORKSHEET #20 — FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE 82

SAP WORKSHEETS (CONTINUED)

SAP WORKSHEET #21 — PROJECT SAMPLING SOP REFERENCES TABLE 84

SAP WORKSHEET #22 — FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE 85

SAP WORKSHEET #23 — ANALYTICAL SOP REFERENCES TABLE 86

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE 87

SAP WORKSHEET #25 — ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE 90

SAP WORKSHEET #26 — SAMPLE HANDLING SYSTEM 92

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE 93

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE 99

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE 104

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE 109

SAP WORKSHEET #31 — PLANNED PROJECT ASSESSMENTS TABLE 113

SAP WORKSHEET #32 — ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES 114

SAP WORKSHEET #33 — QA MANAGEMENT REPORTS TABLE 115

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE 116

SAP WORKSHEET #35 — VALIDATION (STEPS IIa AND IIb) PROCESS TABLE 118

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIa AND IIb) SUMMARY TABLE 120

SAP WORKSHEET #37 — USABILITY ASSESSMENT 123

REFERENCES 127

FIGURES

1 AOI 14 Site Location

2 AOI 14 Site Features

3 Proposed Investigation Area Grid and Previous Sampling Locations

4 Proposed Sampling Locations and Geophysical Survey Results

5 Core Wedge and Collection of Core Wedge

6 Example Scenario for Full-Scale Investigation

7 Decision Logic for Evaluation of DU Results

TABLE

1 AOI 14 Pilot Study Triplicate Soil Sampling Data and Percent Relative Standard Deviation, Template

APPENDIX

A Responses to Comments from the U.S. Environmental Protection Agency and California Department of Fish and Game – Office of Spill Prevention and Response

ATTACHMENTS

1 Standard Operating Procedures

2 Field Forms

3 Laboratory Certifications

ACRONYMS AND ABBREVIATIONS

%R	Percent recovery
95UCL	95th percentile upper confidence limit on the mean
Ames	Ames Research Center
amsl	Above mean sea level
AOI	Area of investigation
bgs	Below ground surface
CAS	Chemical Abstracts Service
CD	Compact disk
CDFW-OSPR	California Department of Fish and Wildlife – Office of Spill Prevention and Response
CLP	Contract Laboratory Program
COC	Contaminant of concern
DCC	Daily continuing calibration
DDD	Dichlorodiphenyldichloroethane
DDE	Dchlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DL	Detection limit
DoD	Department of Defense
DOH	Department of Health
DPT	Direct-push technology
DQA	Data quality assessment
DQI	Data quality indicator
DTSC	Department of Toxic Substances Control
DU	Decision unit
DVG	Data Validation Group
Eco-SSL	Ecological Soil Screening Level
EDD	Electronic data deliverable
EE/CA	Engineering Evaluation / Cost Analysis
EKI	Erler and Kalinowski Inc.
EPA	U.S. Environmental Protection Agency
ERT	Earth Resources Technology, Inc.
FSFA	Former Soil Fill Area
FTL	Field team lead

ACRONYMS AND ABBREVIATIONS (CONTINUED)

GC	Gas chromatograph
GC/ED	Gas chromatograph/electron capture detector
GPC	Gel permeation chromatography
GPS	Global positioning system
HASP	Health and safety plan
HC	Hard copy
IAG	Investigation area grid
ICAL	Initial calibration
ICAM	Interim corrective action measures
ICP	Inductively coupled plasma
ICS	Interference check sample
ICV	Initial calibration verification
ID	Identification
IDW	Investigation-derived waste
IR	Installation Restoration
ISM	Incremental sampling methodology
ISSi	Integrated Science Solutions, Inc.
ITRC	Interstate Technology Regulatory Council
ITSI	Innovative Technical Solutions, Inc.
LCS	Laboratory control sample
LOD	Limit of detection
LOQ	Limit of quantitation
mg/kg	Milligrams per kilogram
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not applicable
NASA	National Aeronautics and Space Administration
Navy	Department of the Navy
NTCRA	Non-time-critical removal action
ORNL	Oak Ridge National Laboratory
PAI	PAI Corporation
PAL	Project action limit
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl

ACRONYMS AND ABBREVIATIONS (CONTINUED)

PM	Project manager
PQL	Project quantitation limits
PQO	Project quality objective
QA	Quality assurance
QAC	Quality assurance coordinator
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality assurance project plan
QC	Quality control
QL	Quantitation limit
QSM	Quality Systems Manual
RACR	Removal action completion report
RAWP	Removal action work plan
Regional Water Board	San Francisco Bay Regional Water Quality Control Board
RPD	Relative percent difference
RSD	Relative standard deviation as a percentage
RSL	Regional Screening Level
SAP	Sampling and analysis plan
SD	Standard deviation
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Statement of work
SP	Stormwater retention pond
SSC	Site Safety Coordinator
TAT	Turnaround time
TBD	To be determined
Tetra Tech	Tetra Tech, Inc.
UFP	Uniform Federal Policy
USFWS	U.S. Fish and Wildlife Service

SAP WORKSHEET #1 — TITLE AND APPROVAL PAGE

Final

Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)

Design Site Characterization
Area of Investigation 14

Prepared for:
National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

October 2017

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

Kevin Bricknell Project Manager	Signature	October 24, 2017
Deborah Kutsal QA Manager	Signature	October 24, 2017

INTRODUCTION

This document presents the Sampling and Analysis Plan (SAP) (Field Sampling Plan/Quality Assurance Project Plan [QAPP]) for the design site characterization investigation of Area of Investigation (AOI) 14, in preparation for the non-time-critical removal action (NTCRA) recommended in the Action Memorandum (Tetra Tech, Inc. [Tetra Tech] 2017a). AOI 14 is located at the northern end of the National Aeronautics and Space Administration (NASA) Ames Research Center (Ames) at Moffett Field, California (see Figures 1 and 2). This Design Site Characterization SAP was prepared in accordance with the requirements of the "Uniform Federal Policy for Implementing Environmental Quality Systems, Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs" (UFP-QAPP) (U.S. Environmental Protection Agency [EPA] 2005, 2012) and "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5" (EPA 2001).

Further investigation of AOI 14 is desired to generate a more detailed understanding of the extent of lead, total dichlorodiphenyltrichloroethane (DDT), and total polychlorinated biphenyls (PCB) contamination in the AOI 14 Former Soil Fill Area (FSFA) to better inform the removal action design and plan the removal action construction activities. Specific excavation units will be identified and characterized as either meeting cleanup goals or exceeding cleanup goals. Those excavation units that meet cleanup goals may be left in place or excavated and stockpiled to be used as on-site backfill for final grading of the site. Those excavation units that exceed cleanup goals require off-site disposal. The design site characterization sampling will also provide information to determine off-site disposal requirements and excavation confirmation sampling.

The design site characterization will be performed using incremental sampling methodology (ISM). ISM is a structured, composite, sampling, and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling (Interstate Technology Regulatory Council 2012). ISM improves precision, accuracy, and representativeness for soil sampling. ISM will be used to characterize soil in AOI 14 excavation units, which are referred to as investigation area grids (IAG) in this SAP (see Figure 3). Subsurface decision units (DU) within IAGs have been established both in areas within the FSFA known to contain fill and debris, referred to as Fill IAGs, and within the bottom of the stormwater retention pond (SP) at the toe of the slope of the FSFA. The FSFA will be divided into 24 Fill IAGs, each representing the approximate area (100 feet by 100 feet, or about 10,000 square feet) required to operate the heavy-construction equipment to be used during the removal action. Two SP IAGs will be established in two areas of the stormwater retention pond adjacent to the FSFA where concentrations of site contaminants of concern (COC) in discrete samples collected outside the interim corrective action measure (ICAM) silt fence exceeded the cleanup goals (see Figure 3).

The design site characterization and removal action will be implemented as follows:

INTRODUCTION (CONTINUED)

- Pilot Study (duration of 2 weeks): Determine the appropriate confidence interval to apply to each of the DU results through evaluation of relative standard deviation as a percentage (RSD) of triplicate (set of three field replicates) results in three predetermined FSFA IAGs.

- Full-Scale Investigation (duration of 6 weeks): Characterize concentrations of COCs in the remaining FSFA DUs and SP DUs to identify those DUs where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in soil or sediment.

- Removal Action (duration of approximately 10 months): Excavate and dispose of soil and sediment in DUs with concentrations of lead, total DDTs, or total PCBs that exceed cleanup goals. As necessary, excavate and stage for on-site reuse soil and sediment in DUs with concentrations of lead, total DDTs, and total PCBs less than cleanup goals. The removal action will include site restoration, to be detailed in the Site Habitat Restoration and Mitigation Plan, which will be included as an appendix to the forthcoming Removal Action Work Plan that supports the overall project objectives.

The following sections describes the site background, conceptual site model, and fate and transport characteristics of site contaminants. A brief summary of the design site characterization sampling plan follows.

SITE BACKGROUND AND PREVIOUS INVESTIGATIONS

AOI 14 is located at the northern end of the NASA Ames at Moffett Field, California (see Figure 1). AOI 14 consists of three peninsulas (FSFA, N217, and N217A), that extend into the SP (see Figure 2). The FSFA and N217A peninsulas were constructed by depositing fill material on the existing surface of the stormwater retention pond. Visual observations of the surface of the peninsulas show that the fill material consists of soil and construction debris, including concrete, rebar, and metal piping. Historical aerial photographs indicate that the N217 peninsula consists of native soil. Based on the results of the streamlined risk evaluation, soil at the N217 and N217A peninsulas does not pose unacceptable risk (Tetra Tech 2015) and therefore the N217 and N217A peninsulas are not included in this design site characterization effort.

The FSFA is approximately 8 acres, and ground surface varies from approximately 4 feet above mean sea level (amsl) and the surface of the surrounding SP at the southern end of the peninsula to 11 feet amsl and the pond surface at the northern end. Groundcover varies across the site and includes tall grasses and low-lying brush. The FSFA is not currently used, and access to the peninsula is restricted by the NASA Ames security fence to the south and the SP on all other sides. There are public trails on the northern and western sides of Department of the Navy's (Navy) Installation Restoration (IR) Site 25 and the Midpeninsula Regional Open Space District property (see Figure 2).

INTRODUCTION (CONTINUED)

The exact dates of construction of the fill areas are unknown, and no records of the sources of the fill material have been located. An approximate chronology was established through review of historical photographs that show deposition of fill materials at the FSFA occurred between 1968 and 1987. Most of the soil is likely from construction projects at NASA Ames. Some of the soil may have originated from construction for the National Full-scale Aerodynamic Complex 80- by 120-foot wind tunnel test section (Building N221B), located approximately 1 mile south of AOI 14 in the center of the NASA Ames campus. An electrical substation was removed to construct the test section; soil from this substation site may have contained PCBs from leaks in electrical equipment, and that soil may have been deposited at the FSFA. In addition, soil from other sources was added to the FSFA over time.

Various investigations have been conducted at AOI 14, most with the intent of determining the extent of the PCB contamination at the FSFA. The following previous investigations have been conducted at AOI 14.

Investigation	Reference Document
1992 Listing Site Inspection	EKI 1992
2004 PCBs in Site Soils Phase I	PAI 2004
2005 PCBs in Site Soils Phase II	ISSi 2005a
2005 FSFA Soil Investigation	ISSi 2005b
Groundwater Sampling	ISSi 2006
2006 and 2007 AOI 14 Phase II Soil Investigation	ISSi 2007
2013 N217 ICAM Data Gap Soil Sampling	NASA 2013
2013 ICAM Baseline Sediment Sampling	ERT 2014a
ICAM Annual Sediment Sampling	ERT 2014b, 2015, 2016

Notes:

EKI Erler and Kalinowski, Inc.
ERT Earth Resource Technology, Inc.
ICAM Interim corrective action measures
ISSi Integrated Science Solutions, Inc.
PAI PAI Corporation

Based on the contamination identified in the previous investigations, NASA conducted an Engineering Evaluation/Cost Analysis (EE/CA) that included a streamlined risk evaluation using data from the previous investigations listed above (Tetra Tech 2015). The streamlined risk evaluation identified lead, total DDTs (sum of 4,4-dichlorodiphenyldichloroethane [DDD], 4,4-dichlorodiphenyldichloroethene [DDE], and 4,4-DDT), and total PCBs (sum of detected results for Aroclors) as COCs in fill material at the FSFA that may pose potential unacceptable risk to industrial workers, residents, and ecological terrestrial and wetland receptors.

INTRODUCTION (CONTINUED)

The AOI 14 Action Memorandum documents NASA's decision to conduct an NTCRA at the FSFA to address the potential unacceptable human health and ecological risks at AOI 14 (Tetra Tech 2017a). NASA intends for the NTCRA to serve as the final action for the site under the Comprehensive Environmental Response, Compensation, and Liability Act and allow for unrestricted use of AOI 14. The objective of the NTCRA is to prevent exposure of human receptors and terrestrial and wetland ecological receptors to surface and subsurface soil and to prevent erosion of soil with COC concentrations that exceed cleanup goals from the FSFA into the SP to protect wetland ecological receptors. The selected action for soil and sediment with COC concentrations that exceed cleanup goals is excavation and off-site disposal.

CONTAMINANTS OF CONCERN AND CONCEPTUAL SITE MODEL

Metals, pesticides, and PCBs have been detected in artificial fill material at the FSFA. Concentrations of lead, total DDTs, and total PCBs exceed background concentrations and screening criteria for industrial workers, hypothetical residents, and/or ecological receptors (both terrestrial receptors and wetland receptors in the adjacent SP). The sample locations where COC concentrations exceed cleanup goals are limited to the northern portion of the FSFA (Figure 3). These contaminants are distributed throughout the artificial fill material in this area, both vertically and horizontally. The site history and apparently random distribution of contaminants suggests that the source of the contaminants is not from AOI 14 activities but is associated with placement of contaminated soil from off site areas at FSFA during filling activities.

The apparent artificial fill, which varies in thickness across the FSFA, is a heterogeneous mixture of gravel, sand, silt, clay, and miscellaneous construction debris. Construction debris consisting of reinforced concrete, asphalt, and metal (rebar, beams, and metal debris) is exposed at the surface along and adjacent to the slopes of the FSFA. The native soil underneath the fill material is primarily clay.

Based on a geophysical survey of the FSFA, the extent of apparent artificial fill, ferrous metal debris fill, and fill with a high density of debris was estimated at the FSFA (Tetra Tech 2016). The lateral boundary of apparent artificial fill (Figure 3) is a based on a combination of the extent of fill that contains ferrous metal debris (magnetic anomaly readings), electrical resistivity readings, aerial photographs, and topographical elevation measurements of the bottom or toe of the FSFA slopes. Magnetic anomalies within the flat areas adjacent to the base of the FSFA slopes indicate that apparent artificial fill extends beyond the toe or base of the slopes at several locations. The apparent artificial fill extent encompasses approximately 6 acres. The portion of apparent artificial fill that contains ferrous metal debris was estimated at approximately 5.5 acres. The apparent artificial fill may extend to depths as great as 18 feet below ground surface (bgs) (at the northern portion of the site) and may be as shallow as 4 feet bgs (at the southern portion of the site) and has an estimated volume of approximately of 65,000 cubic yards, including both ferrous and non-ferrous material.

INTRODUCTION (CONTINUED)

Figure 4 presents the results of the EM31 quadrature readings from the geophysical survey. Red and yellow EM31 quadrature readings represent areas with low-conductivity materials, such as concrete and asphalt. Purple to dark blue readings represents areas with high conductivity (low resistivity) indicating the presence of native soils and evaporated salt-flat areas with higher conductivity.

Potential human exposure pathways for soil at AOI 14 include incidental ingestion of soil, dermal exposure to soil, and inhalation of airborne soil particles.

The FSFA currently provides terrestrial habitat suitable for ecological receptors such as terrestrial plants, soil invertebrates, amphibians, reptiles, and terrestrial birds and mammals, and wetland habitat for birds and mammals along its base where pickleweed grows, that may be exposed to contaminated soil. If contaminated soil migrates to the SP, ecological receptors that could be exposed in the surrounding wetland habitat include wetland plants, benthic invertebrates, birds, and mammals. Exposure routes include root uptake and leaf sorption for plants and dermal contact and ingestion of contaminated soil and food for animals.

As established in the EE/CA and specified in the Action Memorandum (Tetra Tech 2015, 2017a), the AOI 14 numeric cleanup goals are set to equal the Navy IR Site 25 do-not-exceed remediation goals because an objective of the removal action is to address potential contaminant migration to the adjacent SP. These cleanup goals are protective of the most sensitive wetland receptors at Navy IR Site 25. The Navy IR Site 25 do-not-exceed remediation goals for lead, total PCBs, and total DDT are more conservative than the human health screening levels for industrial workers and hypothetical residents and the terrestrial ecological receptor screening levels. Therefore, the removal action will also address the potential risks to industrial workers, hypothetical residents, and terrestrial ecological receptors by addressing the areas at AOI 14 with concentrations of contaminants above the Navy IR Site 25 remediation goals. The 95th upper confidence level on the mean (95UCL) COC concentrations for each DU will be compared with cleanup goals to determine whether soil in that DU will remain on site or be removed and disposed of at an appropriate off-site facility.

Chemical	Cleanup Goal (mg/kg)
Lead	93.8
Total DDTs[a]	0.109
Total PCBs[b]	0.210

Notes:

a Total DDT concentrations were calculated by summing the detected concentrations of 4,4-DDT, 4,4-DDD, and 4,4-DDE.

b Total PCB concentrations were calculated by summing the detected concentrations of Aroclor congeners. Aroclor-1254, Aroclor-1260, and Aroclor-1268 were detected at AOI 14.

mg/kg Milligrams per kilogram.

INTRODUCTION (CONTINUED)

In addition to comparing 95UCL COC concentrations for each DU with the established cleanup goals above, residual site-wide average concentrations at AOI 14 will be calculated on a volumetric basis and compared with the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors in the SP (Tetra Tech 2015). The Navy IR Site 25 site-wide average remediation goals are 33 milligrams per kilogram (mg/kg) for lead, 0.016 mg/kg for total DDT, and 0.20 mg/kg for total PCBs.

Soil in the FSFA and sediment within the SP are considered the exposure media for the site. Groundwater is not a medium of concern because fill material is not in contact with groundwater, and sampling results indicate that AOI 14 contamination is not impacting groundwater in the vicinity of AOI 14. There is no surface water at AOI 14, and there is no surface water in the adjacent SP during the dry season. During the wet season, rising water levels in the SP can inundate soil along the perimeter of AOI 14 and carry soil into the surrounding SP, and rain may carry soil from the surface of AOI 14 into the surrounding SP. This pathway is currently controlled by the ICAM silt fence placed around the toe of the FSFA slope (ERT 2014a). Therefore, surface water is not a medium of concern for the removal action at AOI 14. None of the contaminants detected in soil at AOI 14 are volatile, and groundwater exists below the bay mud in the vicinity of AOI 14; therefore, soil gas is not a medium of concern for AOI 14.

SUMMARY OF CONTAMINANT FATE AND TRANSPORT

The potential fate and transport mechanisms for lead, pesticides, and PCBs present in FSFA soil were evaluated in the AOI 14 EE/CA (Tetra Tech 2015). Under typical environmental conditions, the primary fate of lead is to remain sorbed to soil particles; therefore, the main transport mechanism for lead is expected to be soil erosion from the FSFA to the adjacent SP. Pesticides and PCBs have strong affinities for soil and do not readily partition into water, so low concentrations of these chemicals have low mobilities. The most likely potential for migration of pesticides and PCBs would be transport via soil erosion from the FSFA to the adjacent SP. The major fate of pesticides and PCBs in soil is degradation and transformation by microbial metabolism. Fate and transport of PCBs in soil is affected by the degree of chlorination of the PCB compound. PCBs with higher numbers of chlorines persist longer in the environment, often for decades.

CORRECTIVE ACTIONS TO DATE

NASA completed an ICAM at the FSFA to stabilize and address soil contaminated with PCBs, pesticides, and metals that threatened to discharge pollutants into the surrounding SP. NASA installed an ICAM silt fence, an erosion control barrier along the base of the northern portion of the FSFA. The ICAM was completed in consultation with the U.S. Fish and Wildlife Service to monitor the potential impacts to natural resources. After the barrier was constructed, 15 sediment samples were collected approximately 5 feet outside of the barrier to provide baseline concentrations of contaminants in the SP adjacent to the FSFA (Figure 3; location IDs preceded by “FSFA-SDS” are ICAM sampling locations). NASA conducts monthly inspections of the

INTRODUCTION (CONTINUED)

ICAM and annual sediment sampling and submits quarterly reports to EPA and the San Francisco Bay Regional Water Quality Control Board. These activities will continue until the AOI 14 removal action objectives have been met.

DESIGN SITE CHARACTERIZATION INVESTIGATION

Further investigation is required to generate a more detailed understanding of the extent of contamination in the FSFA soil and fill and in sediment in two areas of the adjacent SP to better inform the removal action design and plan removal action construction activities. The results of this design site characterization investigation will identify specific surface and subsurface DUs as either (1) containing soil with COC concentrations less than cleanup goals (soil available for on-site backfill or grading purposes) or (2) containing soil with COC concentrations exceeding cleanup goals (soil requiring removal and off-site disposal). The lateral extent of the excavation units will be equivalent to the lateral extent of the IAGs established at AOI 14 (Figure 3). The vertical extent of the excavation units will be established based on a comparison of the 95UCL of COC results from surface and subsurface DUs to cleanup goals. All surface DUs will be no deeper than 2 feet; subsurface DU depths will vary from 2 to 4 feet.

This investigation will be implemented in two phases, pilot study and full-scale investigation, both involving collection of ISM samples. The pilot study will consist of an evaluation of triplicate field samples at three predetermined Fill IAGs and will be conducted before sampling of the remaining IAGs during full-scale investigation. Results from the triplicate samples (set of three field replicates) in three Fill IAGs will determine the statistical confidence interval (95UCL) that will be applied to all investigation DU sample results for comparison to the cleanup goals. The 95UCLs will be calculated based on an evaluation of the RSDs for each COC using the triplicate results from the pilot study. NASA and the regulatory agencies will review the calculated RSDs and select the most appropriate RSD(s) to be applied to all DUs, thereby enabling calculation of a 95UCL for each COC in all DUs.

The pilot study will consist of collecting ISM samples from three Fill IAGs with 30 increments, each in triplicate (set of three field replicates), from multiple depth intervals (Figure 4). Each increment will be composed of a small segment of a boring called a core wedge (Figure 5). Three sets of 30 borings will be advanced at each of the IAGs using direct-push technology (DPT) to the bottom of fill, estimated at up to 18 feet bgs in the northern part of AOI 14, and 8 feet bgs in the southern part of AOI 14. Borings will be advanced in a gridded pattern, and triplicate samples will be collected in an overlapping array, resulting in borings approximately 18 to 20 feet apart within the pilot study IAGs (Figure 4).

Within each pilot study IAG, up to 13 DUs will be established at different depth horizons. Each IAG will be made up of one surface DU (0 to 2 feet bgs), up to four 4-foot subsurface DUs (2 to 6, 6 to 10, 10 to 14, and 14 to 18 feet bgs), and up to eight 2-foot DUs (2 to 4, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 feet bgs), depending on the depth of fill. If the total

INTRODUCTION (CONTINUED)

depth of fill is greater than 18 feet, additional subsurface 4-foot and 2-foot DUs will be established below 18 feet bgs to the depth of the bottom of fill, as applicable.

The full-scale investigation will involve collecting ISM samples from the remaining 21 Fill IAGs, each with 30 increments in a gridded pattern from multiple depth intervals, resulting in borings approximately 20 feet apart. In addition, 30-increment ISM samples will be collected from two SP DUs from two depth intervals, resulting in borings approximately 3 to 5 feet apart. The subsurface DU intervals in the remaining Fill IAGs will be collected consistent with the intervals identified above for the pilot study IAGs, with the exception that samples from subsurface 2-foot interval DUs will only be analyzed if a 95UCL result for the corresponding 4-foot subsurface DU exceeds one or more of the cleanup goals.

The collection methods for the full-scale investigation will be the same as for the pilot study, with the exception that in the IAGs located on the perimeter of the FSFA, additional sampling methods will be used to collect material from the FSFA side slopes in the incremental samples. Two methods will be used: (1) a portion of the direct-push borings will be advanced at 30 degrees from vertical using DPT angle-hole methods to the bottom of fill and (2) a hand auger or soil corer will be used to collect soil on the side slopes. From each increment location collected using these additional methods, a volume of soil equivalent to the soil volumes from each of the other increments will be incorporated into the ISM samples at the appropriate depth horizons.

Drill rigs cannot work on the down side of the FSFA slopes or at the toe of slope. Soil collected from vertical borings and from 30 degree angle borings (from the top into the side slopes) is representative of about 95 percent of the total volume of FSFA soil. Hand augering on side slopes and at the toe of slope is intended to capture representative increments from the remaining 5 percent of the total soil volume of apparent artificial fill in the FSFA that comprises the side slope and toe of slope areas, based on a volumetric analysis of soil within the side slopes compared to the volume of the rest of the IAG. Two hand auger borings per perimeter Fill IAG are proposed, which equates to 5 to 10 percent of the borings representing the remaining 5 percent of the FSFA soil volume. One hand auger boring will be located near the toe of the slope to a depth of approximately 1 foot bgs and the other will be at a location on the side slope and advanced to an average depth of 2.5 feet bgs. The height of the side slopes around the perimeter of the FSFA ranges from about 5 feet to 10 feet above the surrounding SP bottom. Where the height of the FSFA is closer to 10 feet above the surrounding SP bottom, hand auger borings will be advanced to a depth of approximately 4 feet bgs.

ISM samples from the SP IAGs will consist of 30 increments collected in a gridded pattern. Two vertical DUs have been established at each SP DU; the top interval ranges from 0 to 0.5 foot bgs, and the bottom interval ranges from 0.5 to 1 foot bgs. ISM sample increments will be collected from both intervals at each of the two SP IAGs.

INTRODUCTION (CONTINUED)

NASA will use the ISM data to determine which soil may be left on site and which soil must be removed from the site. Soil with 95UCL COC concentrations exceeding cleanup goals will be permanently removed and disposed of at an appropriate off-site facility.

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION

Site Name/Number:	**Area of Investigation (AOI) 14**
Operable Unit:	**National Aeronautics and Space Administration (NASA) Ames Research Center (Ames)**
Contractor Name:	**Tetra Tech, Inc. (Tetra Tech)**
Contract Number:	**Contract Number NNK16CA54T (Task Order 23)**

1. This Design Site Characterization Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the "Uniform Federal Policy for Implementing Environmental Quality Systems. Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs" (UFP-QAPP) (U.S. Environmental Protection Agency [EPA 2005, 2012) and "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5" (EPA 2001).

2. This SAP complies with the requirements of implementing the Comprehensive Environmental Response, Compensation, and Liability Act and is consistent with the National Contingency Plan and other EPA guidelines.

3. This SAP is a project-specific SAP.

4. A pre-draft SAP scoping session was held on October 27, 2016, to discuss the scope of work outlined in this SAP with the regulatory agencies (Worksheet #9). Post-draft SAP conference calls were held on February 9, March 6, March 21, and April 10, 2017, to obtain concurrence on the refined scope of the SAP.

5. Plans and reports from previous investigations relevant to this project include the Phase I and II polychlorinated biphenyl (PCB) soils investigations (PAI Corporation [PAI] 2004; Integrated Science Solutions, Inc. [ISSi] 2005a), Former Soil Fill Area (FSFA) soil investigation (ISSi 2005b), AOI 14 Phase II soil investigation (ISSi 2007), groundwater sampling (ISSi 2006), N217 and N217A fill area interim corrective action measure (ICAM) data gap sampling (NASA 2013), baseline and annual sampling for the ICAM Silt Fence (Earth Resource Technology Corporation, Inc. [ERT] 2014a, 2014b, 2015, 2016), Engineering Evaluation/Cost Analysis (EE/CA) (Tetra Tech 2015), AOI 14 Action Memorandum (Tetra Tech 2017a), and AOI 14 geophysical survey report (Tetra Tech 2016).

6. The organizational partners (stakeholders) and connection with lead organization are listed below:

   NASA is the lead agency responsible for the work described in this SAP. The AOI 14 Project Team includes representatives from EPA Region 9 and the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) as the lead regulatory agencies for the removal action. These agencies have been provided a copy of this SAP for review and comment. In addition, the U.S. Fish and Wildlife Service (USFWS) is the lead regulatory agency for the Biological Assessment

SAP WORKSHEET #2 — SAP IDENTIFYING INFORMATION (CONTINUED)

being prepared for the removal action. The California Department of Fish and Wildlife - Office of Spill Prevention and Response (CDFW-OSPR) provides recommendations to NASA on appropriate remedial cleanup values and biological measures to protect special-status species.

8. All SAP elements required under the UFP-QAPP template are applicable to this site-specific SAP, and each element is therefore included. None of the required SAP elements has been omitted from this document.

SAP WORKSHEET #3 — DISTRIBUTION LIST

Recipient Category	Name and Address of SAP Recipient	Phone	Distribution (Compact Disc [CD] or Hard Copy [HC])
NASA	Kimberly Finch NASA Ames Restoration Project Manager (PM) NASA Ames Research Center Moffett Field, CA 94035-1000 kimberly.s.finch@nasa.gov	(650) 604-1294	2 HC 2 CD
NASA	Don Chuck NASA Ames Environmental Management Division Chief NASA Ames Research Center Moffett Field, CA 94035-1000 donald.m.chuck@nasa.gov	(650) 604-0237	1 CD
Regulatory Agency	Elizabeth Wells, Moffett Field PM Regional Water Board, Region 2 1515 Clay Street, Suite 1400 Oakland, CA 94612 ewells@waterboards.ca.gov	(510) 622-2440	1 HC 1 CD
Regulatory Agency	Yvonne Fong, Moffett Field PM EPA, Region 9 Floor SFD 8-3 75 Hawthorne Street San Francisco, CA 94105 fong.yvonneW@epa.gov	(415) 947-4117	1 HC 1 CD
Regulatory Agency	Marlon Mezquita, Quality Assurance (QA) Reviewer EPA, Region 9 Floor SFD 8-3 75 Hawthorne Street San Francisco, CA 94105 mezquita.marlon@epa.gov	(415) 972-3808	1 HC 1 CD
Regulatory Agency	Anne Mankowski, USFWS Fish and Wildlife Biologist Bay Delta Fish and Wildlife Office 650 Capitol Mall, Suite 8-300 Sacramento, CA 95814 anne_mankowski@fws.gov	(916) 930-5673	1 CD
Regulatory Agency	Allen C.L. Tsao, Associate Toxicologist CDFW-OSPR 1700 K Street, Suite 250 Sacramento, CA 95811 allen.tsao@wildlife.ca.gov	(916) 323-4731	1 CD
Regulatory Agency	Tami Nakahara, Senior Environmental Scientist (Specialist) CDFW-OSPR 1700 K Street, Suite 250 Sacramento, CA 95811 Tami.nakahara@wildlife.ca.gov	(916) 324-8452	1 CD

SAP WORKSHEET #3 — DISTRIBUTION LIST (CONTINUED)

Recipient Category	Name and Address of SAP Recipient	Phone	Distribution (Compact Disc [CD] or Hard Copy [HC])
Contractor	Kevin Bricknell Tetra Tech Lead PM 1999 Harrison Street, Suite 500 Oakland, CA 94612 kevin.bricknell@tetratech.com	(510) 302-6306	1 CD

SAP WORKSHEET #4 — PROJECT PERSONNEL SIGN-OFF SHEET

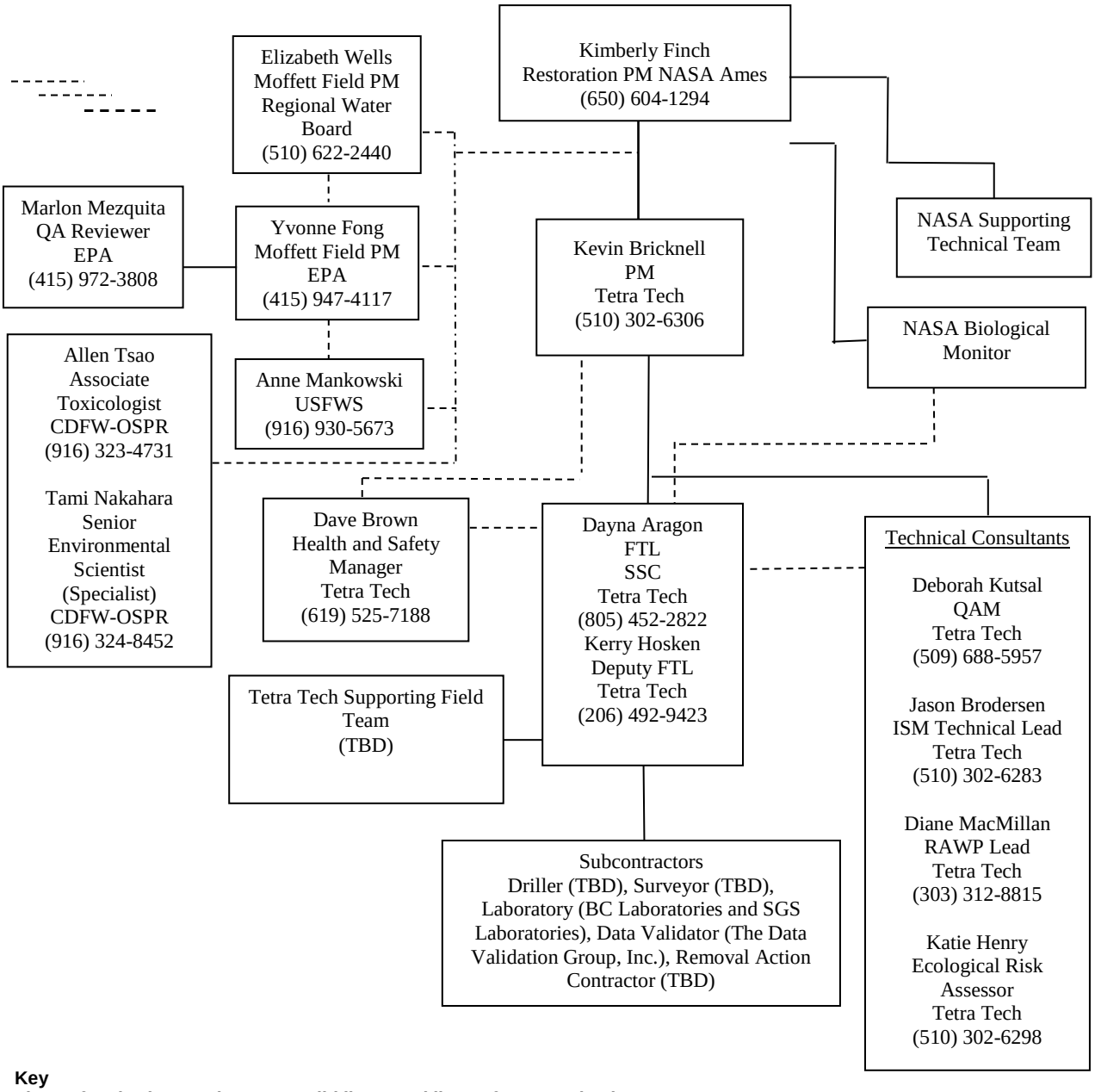
The Project Personnel Sign-Off Sheet documents that all key project personnel performing work have read this site-specific SAP and will carry out the tasks as described. The PM, Site Safety Coordinator (SSC), and other oversight personnel are responsible for communicating the requirements of the applicable portions of the SAP to all field personnel. To ensure that on-site field personnel have read and understood the SAP, the supervisory personnel will meet with each member of the field staff and review the SAP before any work is conducted on site. The sign-off sheet, which will be included in the central project file, will be signed by all on-site personnel after they read the SAP. However, if only a portion of the SAP was reviewed, then personnel will note which sections were reviewed on the sign-off sheet.

Name	Organization/Title/Role	Telephone Number (optional)	Signature/Email Receipt	SAP Section Reviewed	Date SAP Read
Kevin Bricknell	Tetra Tech/PM	(510) 302-6306			
Dayna Aragon	Tetra Tech Field Team Lead (FTL)/SSC	(805) 452- 2822			
Kerry Hosken	Tetra Tech Deputy FTL	(206) 492-9423			
Jason Brodersen	Tetra Tech/Incremental Sampling Methodology (ISM) Technical Lead	(510) 302-6283			
Katie Henry	Tetra Tech/Ecological Risk Technical Lead	(510) 302-6298			
Deborah Kutsal	Tetra Tech/Quality Assurance Manager (QAM)	(509) 688-5957			
Diane MacMillan	Tetra Tech/Removal Action Work Plan (RAWP) Technical Lead	(303) 312-8815			
Jean Michaels	Tetra Tech/Engineer	(510) 302-6346			
Dave Brown	Tetra Tech/Health and Safety Manager	(619) 525-7188			
To be determined (TBD)	NASA Biological Monitor	TBD			
Molly Meyers	BC Laboratories/PM for soil and sediment analytical testing	(661) 496-6757			
Elvin Kumar	SGS Laboratories/PM for soil and sediment analytical testing	(408) 588-0200 ext. 3515			
Staff (TBD)	Tetra Tech field personnel	TBD	See separate sign-off sheet (as noted above)		

Note:

Personnel will be responsible for reviewing and signing off only on select sections of the SAP.

SAP WORKSHEET #5 — PROJECT ORGANIZATIONAL CHART



Key
Lines of authority are shown as solid lines, and lines of communication are dashed.

CDFW-OSPR – California Department of Fish and Wildlife
EPA – U.S. Environmental Protection Agency
ERT – Earth Resources Technology, Inc.
FTL – Field Team Lead
ISM – Incremental Sampling Methodology
NASA – National Aeronautics and Space Administration
PM – Project Manager
QA – Quality Assurance
RAWP – Removal Action Work Plan
Regional Water Board – San Francisco Bay Regional Water Quality Control Board
SSC – Site Safety Coordinator
TBD – To be determined
USFWS – U.S. Fish and Wildlife Service

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS

Communication Drivers	Responsible Affiliation	Name	Phone Number or Email	Procedure
Program management	NASA Ames, Environmental Management Division	Kimberly Finch	(650) 604-1294	PM will be involved in project decision-making, and will communicate the results of the investigation to interested parties.
Project management	Tetra Tech PM	Kevin Bricknell	(510) 302-6306	PM will manage contractual issues and ensure implementation of the QA/quality control (QC) processes. PM will manage field and project personnel and serve as liaison to NASA and team members.
QC management	Tetra Tech QAM	Deborah Kutsal	(509) 688-5957	QAM will ensure implementation of the SAP by performing on-site field QC audits, as appropriate. Tetra Tech QAM will be the point of contact with NASA Program Manager for quality-related matters.
Coordination and communication of field work activities related to sampling	Tetra Tech FTL	Dayna Aragon	(510) 302-6242	FTL will communicate relevant field information to the PM and analytical coordinator. FTL will also report all drilling or sampling equipment problems to the PM immediately via phone or email. The FTL will serve as liaison to subcontractors.
Daily QC reports	Tetra Tech FTL	Dayna Aragon	(510) 302-6242	FTL will email QC reports daily to NASA Program Manager and Tetra Tech PM.
Coordination of laboratory supplies for field activities	Tetra Tech Analytical Coordinator	Dayna Aragon	(510) 302-6242	The analytical coordinator will contact the laboratory to provide all necessary sample containers and appropriate shipping materials (such as coolers and bubble wrap) to be delivered on site before field sampling begins and throughout the project.
Submittal of samples to the laboratory	Tetra Tech FTL	Dayna Aragon	(510) 302-6242	Sampling personnel will package and ship samples in accordance with this SAP.
Daily chain-of-custody records and shipping documentation	Tetra Tech FTL	Dayna Aragon	(510) 302-6242	Chain-of-custody records and shipping documentation will be submitted via fax or email to the analytical coordinator at the end of each day that samples are collected.
Sample shipping/receipt issues	Laboratory PM – BC Laboratories/ SGS Laboratories	Molly Meyers/ Elvin Kumar	(616) 496-6757/ (408) 588 0200 ext. 3515	The laboratory PM will report all sample shipping and receipt issues associated with the investigation to Tetra Tech's analytical coordinator within 2 business days.

SAP WORKSHEET #6 — COMMUNICATION PATHWAYS (CONTINUED)

Communication Drivers	Responsible Affiliation	Name	Phone Number or Email	Procedure
Reporting laboratory data quality issues	Laboratory PM - BC Laboratories/ SGS Laboratories	Molly Meyers/ Elvin Kumar	(616) 496-6757/ (408) 588 0200 ext. 3515	All QA and QC issues will be reported by the laboratory PM to the analytical coordinator in writing within 2 business days.
Field and analytical corrective actions	Tetra Tech Analytical Coordinator	Dayna Aragon	(510) 302-6242	The analytical coordinator will immediately notify the QA Coordinator (QAC) in writing of any field or analytical procedures that were not performed in accordance with this SAP. The Analytical Coordinator, in coordination with the QAC, will complete documentation of the non-conformance and corrective actions to be taken. The Analytical Coordinator will verify that the corrective actions have been implemented.
Minor deviations from SAP procedures identified during field activities	Tetra Tech FTL	Dayna Aragon	(510) 302-6242	The FTL will prepare a field change request for any minor changes in sampling procedures that occur as a result of conditions in the field. This request will be submitted to the QAC for approval before the change is initiated.
SAP amendments	Tetra Tech QAM	Deborah Kutsal	(509) 688-5957	Substantive changes to the SAP will require the QAM to prepare an addendum that will be approved by the NASA Program Manager before any field activities begin.

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

Name / Phone Number	Title/Role	Organizational Affiliation	Responsibilities
Kimberly Finch (650) 604-1294	Restoration PM	NASA Ames	Responsible for providing management and technical oversight of the project. Responsible for all QA issues for all site work. Has authority to suspend affected project or site activities if approved technical or quality requirements are not adequately met. Reviews and approve technical deliverables. Approves payment milestone schedule. Reviews status reports.
Kevin Bricknell (510) 302-6306	PM	Tetra Tech	Has ultimate authority and responsibility for all technical, contractual, safety, and administrative matters for the project. Monitors contract and task funds and schedules and ensures implementation of the QA/QC processes. Provides management oversight and assistance in completing the technical work; act as liaison with NASA; oversees administrative and technical performance, and maintains compliance with schedules and budgets.
Deborah Kutsal (509) 688-5957	QAM	Tetra Tech	Provides QA/QC of technical work at AOI 14; works closely with and reviews work by the Tetra Tech project team; and reviews deliverables to verify conformance with QA/QC procedures.
Diane McMillan (303) 312-8815	Professional Engineer/RAWP Lead	Tetra Tech	Develops technical approach and conceptual site model for the RAWP. Participates in development of RAWP.
Dave Brown (619) 525-7188	Health and Safety Manager	Tetra Tech	Responsible for administration of the Health and Safety Plan (HASP) and acts as an advisor to the PM and FTL to implement the HASP.
Dayna Aragon (510) 302-6242	FTL and SSC	Tetra Tech	FTL: Directs the day-to-day field activities and oversees all subcontractors; verifies that field measurement and sampling procedures are conducted in accordance with this SAP; and reports directly to the PM on planning, cost and schedule control, and data management information needs. SSC: Responsible for implementing the HASP in the field and has authority to correct and change site control measures and the required level of health and safety protection, to enforce the HASP policies and provisions; and to stop work for any unsafe condition.
TBD	Supporting Field Team Members	Tetra Tech	Support field activities when needed. Collects ISM soil samples and supports FTL with field tasks.

SAP WORKSHEET #7 — PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE (CONTINUED)

Name / Phone Number	Title/Role	Organizational Affiliation	Responsibilities
TBD	Geologists	Tetra Tech	Participates in field investigation; log soil cores. Reviews all boring logs and technical deliverables related to geochemistry and hydrogeology interpretation and oversees relevant field activities.
Dayna Aragon, Jean Michaels, Diane McMillan	Document Authors	Tetra Tech	Develop SAP, HASP, and Removal Action Completion Report (RACR).
Ann Zoidis, Angela Lortie	Document Authors	Tetra Tech	Develop Biological Assessment
Deborah Kutsal (509) 688-5957	Project Chemist	Tetra Tech	Coordinates analytical tests required in the SAP; verifies that the laboratory implements the requirements of the SAP; and reviews laboratory data before they are released.
TBD	NASA Wildlife Biologist	TBD	Provides background information on biological resources at AOI 14 for biological surveys; conducts biological monitoring during all field activities.
TBD	Land Surveyor	TBD	Locates corners of AOI 14 Fill investigation area grids (IAG)
TBD	Driller	TBD	Conducts Geoprobe activities.
TBD	Excavation Waste Removal Contractor	TBD	Excavates contaminated soil; transports investigation-derived waste (IDW) from NASA Ames to waste facility. Stockpiles clean soil and regrades remaining soil on site to final grade, as specified in the RAWP.
TBD	Nonhazardous or Hazardous Waste Disposal Facility	TBD	Receives and disposes of waste from the site.
Molly Meyers (616) 496-6757/Elvin Kumar (408) 588-0200 ext. 3515	Analytical Laboratories	BC Laboratories/ SGS Laboratories	Conducts off-site chemical analysis of soil and sediment samples.
Sandra Obleas (949) 709-7442	Data Validator	Data Validation Group (DVG)	Conducts data validation of all data prepared by the laboratory.

Note:

Before the SAP is finalized and crews mobilize to the field, all missing information in Worksheet #7 will be updated.

SAP WORKSHEET #8 — SPECIAL PERSONNEL TRAINING REQUIREMENTS

This section outlines the training and certification required to complete the activities described in this SAP.

All samples will be collected by personnel experienced with all sampling procedures. All personnel who work at hazardous waste project sites are required to meet the Occupational Safety and Health Administration training requirements defined in Title 29 Code of Federal Regulations Part 1910.120(e). These requirements include (1) 40 hours of formal off-site instruction; (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor; and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training. SSCs receive 30 hours of construction safety training. At least two members of the on-site Tetra Tech and subcontractor field team will maintain current certification in the American Red Cross Multimedia First Aid and Cardiopulmonary Resuscitation Modular, or equivalent.

Field staff experienced classifying soils will log soils from all borings in accordance with the techniques described in this SAP. Tetra Tech personnel experienced in soil sampling will collect all samples in accordance with the techniques described in this SAP. In addition to the requirements in the following sections, personnel involved in field tasks are required to read the site-specific HASP and the SAP and sign their names and requested information on the Compliance Agreement Form and Daily Site Log provided in the HASP. All employees will attend a safety briefing and complete the Tailgate Meeting Sign-Off Sheet before they conduct on-site work each day.

SAP WORKSHEET #9 — PROJECT SCOPING SESSIONS

Project Name: AOI 14 Design Site Characterization **Projected Date(s) of Sampling:** October 2017 **Project Manager:** Kevin Bricknell	**Site Name:** AOI 14 **Site Location:** NASA Ames, Moffett Field, California

Date of Session: October 27, 2016; **Scoping Session Purpose:** **Pre-Draft** Scoping Meeting

Name	Title	Affiliation	Phone Number	E-Mail Address	Project Role
Kimberly Finch	NASA Ames Restoration PMr	NASA Ames	(650) 604-1294	kimberly.s.finch@nasa.gov	NASA PM
Elizabeth Wells	Moffett Field PM	Regional Water Board	(510) 622-2353	ewells@waterboards.ca.gov	Lead Regulatory Agency PM
Yvonne Fong	Moffett Field PM	EPA	(415) 947-4117	fong.yvonnew@epa.gov	Lead Regulatory Agency PM
Marlon Mezquita	Quality Assurance Officer (QAO)	EPA	(415) 972-3808	mezquita.marlon@epa.gov	SAP Review
Derrick Williamson	QAO	EPA	(415) 972-3698	williamson.derrick@epa.gov	SAP Review
Tami Nakahara	Senior Environmental Scientist (Specialist)	(CDFW-OSPR)	(916) 324-8452	tnakahara@wildlife.ca.gov	State Natural Resource Trustee
Allen Tsao	Associate Toxicologist	CDFW-OSPR	(916) 323-4731	allen.tsao@wildlife.ca.gov	State Natural Resource Trustee
Joe Lukas	Environmental Restoration Specialist	ERT	(650) 604-2057	joseph.r.lukas@nasa.gov	Environmental Restoration Specialist
Chris Alderete	Wildlife Biologist	Leidos	(650) 963-6647	christopher.s.alderete@nasa.gov	Wildlife Biologist
Kevin Bricknell	PM	Tetra Tech	(510) 302-6306	kevin.bricknell@tetratech.com	PM, Tetra Tech
Carolyn Hunter	Community Involvement Manager	Tetra Tech	(916) 853-4556	carolyn.hunter@tetratech.com	Community Support, Meeting Minutes
Jason Brodersen	ISM Technical Lead	Tetra Tech	(510) 302-6306	jason.brodersen@tetratech.com	ISM Technical Lead
Diane MacMillan	Chemical Engineer	Tetra Tech	(303) 312-8815	diane.macmillan@tetratech.com	RAWP Lead
Jean Michaels	Chemical Engineer	Tetra Tech	(510) 302-6346	jean.michaels@tetratech.com	Engineer, SAP Developer
Dayna Aragon	Environmental Scientist	Tetra Tech	(510) 302-6242	dayna.aragon@tetratech.com	SAP Developer, FTL, SSC
Katie Henry	Ecological Risk Assessor	Tetra Tech	(510) 302-6298	katie.henry@tetratech.com	Ecological Risk Assessor

SAP WORKSHEET #9 — PROJECT SCOPING SESSIONS (CONTINUED)

Project Name: AOI 14 Design Site Characterization **Projected Date(s) of Sampling:** October 2017 **Project Manager:** Kevin Bricknell	**Site Name:** AOI 14 **Site Location:** NASA Ames, Moffett Field, California

Date of Session: October 27, 2016; **Scoping Session Purpose:** **Pre-Draft** Scoping Meeting

Ann Zoidis	Biologist	Tetra Tech	(510) 302-6358	ann.zoidis@tetratech.com	Biological Assessment Lead
Angela Lortie	Biologist	Tetra Tech	(303) 441-7908	angela.lortie@tetratech.com	Biological Assessment Support
Jeff Eddo	Geophysicist	Tetra Tech	(619) 321-6735	jeff.eddo@tetratech.com	Geophysical Investigator

SAP WORKSHEET #9 — PROJECT SCOPING SESSIONS (CONTINUED)

A description of the investigation plan was presented during a meeting with the regulatory agencies on October 27, 2016. The following items were discussed:

- The investigation would be conducted in two phases: a pilot study and subsequent full-scale investigation.
- The three pilot study IAGs will be selected to represent areas with varying contaminant levels.
- The three pilot study IAGs will be located in the interior of the FSFA, away from the SP boundary.
- NASA will review the results of the pilot study with EPA and the Regional Water Board for concurrence on the recommended number of sampling increments for the full-scale investigation. (As a result of discussions with EPA and the Regional Water Board subsequent to Draft SAP submittal, this discussion item is no longer relevant.)
- Confirmation samples at the bottom of each excavation were not recommended or proposed.; ISM sample results with contaminant of concern (COC) concentrations less than cleanup goals located immediately below the deepest subsurface decision unit (DU) with COC concentrations greater than cleanup goals in each IAG will serve as confirmation sample results. Native soil is assumed to have COC concentrations less than cleanup goals; therefore, if soil from an entire IAG is excavated to native soil, confirmation samples will not be required.

The Draft SAP was submitted in December 2016. EPA comments on the draft SAP/QAPP dated July 2, 2017 (Appendix A) are the result of consultation by EPA and Regional Water Board with NASA on the Draft SAP. CDFW comments dated August 29, 2017 (Appendix A) are the result of a review of a redline version of the SAP submitted incorporating responses to EPA comments. Responses to additional comments from CDFW submitted on December 14, 2017 are also included in Appendix A.

SAP WORKSHEET #10 — PROBLEM DEFINITION

Further investigation is desired to generate a more detailed understanding of the extent of contamination in the FSFA soil/fill and in sediment in two areas of the adjacent stormwater retention pond to better inform the removal action design and plan removal action construction activities. The results of this design site characterization investigation will identify specific excavation units as either (1) containing soil with COC concentrations less than cleanup goals (soil available for on-site backfill or grading purposes) or (2) containing soil with COC concentrations exceeding cleanup goals (soil requiring removal and off-site disposal). ISM will be used to characterize soil in excavation units, which are referred to as IAGs (Figure 3). Surface and subsurface DUs within each IAG have been established both in areas within the FSFA known to contain fill and debris, referred to as Fill IAGs, and SP IAGs. The FSFA at AOI 14 has been divided into 24 Fill IAGs, each representing the approximate area (100 feet by 100 feet, or about 10,000 square feet) based on reasonable soil volumes to be managed by the heavy-construction equipment to be used during the removal action. Two SP IAGs have been established in two areas of the stormwater retention pond immediately surrounding the FSFA, where discrete samples collected outside the ICAM silt fence had concentrations of COCs exceeding cleanup goals (see Figure 3). The cleanup goals, listed in the table below, were established in the EE/CA and specified in the Action Memorandum (Tetra Tech 2015, 2017a). The 95th percentile upper confidence limit on the mean (95UCL) concentrations for each COC at each DU will be compared to cleanup goals to determine whether soil in that DU will remain on site or be removed and disposed of at an appropriate off-site facility.

Chemical	Cleanup Goal (mg/kg)
Lead	93.8
Total DDTs[a]	0.109
Total PCBs[b]	0.210

Notes:

a Total DDT concentrations were calculated by summing the detected concentrations of 4,4- Dichlorodiphenyltrichloroethane (DDT), 4,4- Dichlorodiphenyldichloroethane (DDD), and 4,4-Dichlorodiphenyldichloroethene (DDE).

b Total PCB concentrations were calculated by summing the detected concentrations of Aroclor congeners. Aroclor-1254, Aroclor-1260, and Aroclor-1268 were detected at AOI 14.

mg/kg Milligrams per kilogram

In addition to comparing 95UCL concentrations for each DU with the established cleanup goals above, residual site-wide average concentrations at AOI 14 will be calculated following the design site characterization on a volumetric basis and compared with the Department of the Navy (Navy) Installation Restoration (IR) Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors in the stormwater retention pond (SP) (Tetra Tech 2015). The Navy IR Site 25 site-wide average remediation goals are 33 mg/kg for lead, 0.016 mg/kg for total DDT, and 0.20 mg/kg for total PCBs.

SAP WORKSHEET #10 — PROBLEM DEFINITION (CONTINUED)

The introduction to this SAP discusses the site background, conceptual site model, contaminant fate and transport, and corrective actions to date and provides a summary of the design site characterization investigation.

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY

STEP 1: STATE THE PROBLEM – DEFINE THE PROBLEM(S) THAT NECESSITATES THE STUDY.

Additional soil analytical data for lead, total DDTs, and total PCBs (as Aroclors) are needed to better define the spatial limits of the removal action at the FSFA. ISM will be used to characterize the distribution of these COCs throughout the FSFA and two portions of the SP. The application of a confidence interval, defined as the 95UCL for this study, will be applied to each ISM DU result as an additional measure to help ensure the ISM result does not underestimate the true concentration. The 95UCL will be selected based on an evaluation of the RSD of each triplicate sample set from three FSFA IAGs investigated during the pilot study.

STEP 2: IDENTIFY THE GOALS OF THE STUDY – IDENTIFY THE DECISIONS THAT NEED TO BE MADE AND POSSIBLE ACTIONS THAT MAY BE TAKEN AS A RESULT OF THE DECISION.

The goal of the pilot study is to determine the appropriate relative standard deviation as a percentage (RSD) to use to calculate the 95UCL concentrations for each DU before comparing COC concentrations with the cleanup goals. The RSD(s) will be identified through evaluation of triplicate results from the three predetermined IAGs.

STEP 3: IDENTIFY INFORMATION INPUTS – IDENTIFY SPECIFIC INFORMATION NEEDED TO MAKE DECISIONS AND ACHIEVE STUDY GOAL.

The existing data used to develop the pilot study include data from the following:

- EE/CA (Tetra Tech 2015)
- Final Geophysical Report (Tetra Tech 2016)
- Boring logs from prior investigations at AOI 14, EE/CA Appendix A (Tetra Tech 2015)
- October 27, 2016, scoping meeting feedback (Worksheet #9)
- EPA comments and responses to EPA comments (Appendix A)

The following new data inputs, accompanied by the existing data inputs, will be used to determine the appropriate RSD(s) for use in calculation of 95UCL concentrations in each DU:

- ISM sample results for lead, total DDTs, and total PCBs from up to 13 DUs within each of the three pilot study IAGs, collected in triplicate (set of three field replicates) at each IAG. In total, there will be up to 117 results for each analyte (13 subsurface DUs * 3 pilot study IAGs * 3 field replicates = 117 results for each analyte); however, the total number of DUs will be determined by the depth of fill.

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY (CONTINUED)

- Triplicate ISM samples (set of three field replicates) will be collected in an overlapping array by stepping out two times within a few feet from the original boring locations.

- Results for total DDTs will be calculated by summing detected results for 4,4-DDD, 4,4-DDE, and 4,4-DDT, and results for total PCBs will be calculated by summing detected results for Aroclors.

- If there are one or two non-detect results for a given analyte in the triplicate set, the nonparametric Kaplan-Meier product limit method will be used to estimate the concentration, SD, and RSD for that triplicate (Kaplan and Meier 1958). If all three triplicate results are non-detect, it will be assumed that the triplicate meets goals for the RSD, and a 95UCL will not be calculated. The DU mean will be estimated as the average of the non-detect concentrations and will be compared to the cleanup goal.

- The following surface and subsurface DUs have been established in each IAG, resulting in a total of up to 13 DUs in each IAG:
  - One surface 2-foot depth interval (0 to 2 feet below ground surface [bgs])
  - Four 4-foot depth intervals throughout the remainder of the fill material (2 to 6, 6 to 10, 10 to 14, and 14 to 18 feet bgs)
  - Eight 2-foot depth intervals throughout the remainder of the fill material (2 to 4, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 feet bgs). If the total depth of fill is greater than 18 feet, additional subsurface 2-foot and 4-foot DUs will be established below 18 feet bgs to the depth of the bottom of fill.

- Three pilot study IAGs have been established, each with three sets of 30 sample increment locations. An equal amount of soil from all sample increments within each DU will be combined to create one ISM soil sample representing a DU for each depth interval in accordance with standard ISM sampling procedures (Interstate Technology Regulatory Council [ITRC] 2012) before analysis of the COCs (see Worksheet #17).

- The RSD of the triplicate results, calculated for each COC in each of the DUs (13 subsurface DUs * 3 pilot study IAGs = 39 DUs)

- Evaluation of RSDs in conjunction with the ISM sample results for lead, total DDTs, and total PCBs relative to the established cleanup goals for AOI 14.

- Application of appropriate RSD(s) following review, evaluation, and input by NASA and the regulatory agencies.

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY (CONTINUED)

STEP 4: DEFINE THE BOUNDARIES OF THE STUDY – DEFINE SPATIAL AND TEMPORAL BOUNDARIES CONSIDERING SITE-SPECIFIC CONTAMINANTS, POTENTIAL MIGRATION PATHWAYS, AND CURRENT AND FUTURE USES OF SITE.

- Spatial boundaries:
  - Vertical: AOI 14 ground surface to the bottom of fill (expected to be approximately 16 feet bgs in pilot study IAGs but may extend to 18 feet bgs).
  - Lateral: The lateral extent of the pilot study will consist of three IAGs (IAG06, IAG09, IAG20) intentionally selected based on previously collected discrete data for COCs (see Figure 3); only IAGs located in the interior of the FSFA were considered based on input provided by the regulatory agencies at the scoping meeting on October 27, 2016 (see Worksheet #9). IAG06 was selected as a pilot study IAG based on concentrations minimally exceeding cleanup goals for PCBs and DDTs (based on results from locations PEN-30 and FSDA-H003), IAG09 was selected based on concentrations of total PCBs and total DDTs exceeding cleanup goals (based on results from location PEN-27), and IAG20 was selected based on low concentrations of all COCs (based on results from location PEN-14). Three IAGs were selected to represent approximately 10 percent of the total IAGs.
- Temporal boundaries:
  - Work is expected to begin in fall 2017 and continue for approximately 2 weeks.

STEP 5: DEVELOP THE ANALYTIC APPROACH – DEFINE SPECIFIC PARAMETERS OF INTEREST, SPECIFY ACTION LEVELS/CRITERIA TO BE CONSIDERED, AND BASIS FOR SELECTED ACTION LEVELS.

ISM will be used to characterize soils and fill material at multiple depth horizons in each AOI 14 FSFA Fill IAG. ISM is a structured, composite, sampling, and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling (ITRC 2012).

The pilot study will consist of collecting ISM samples from three IAGs with 30 increments, each in triplicate (set of three field replicates), from multiple depth intervals. Each increment will be composed of a small segment of a boring, called a core wedge (Figure 5). Each boring will be advanced using direct-push technology (DPT) to the bottom of fill, estimated as 18 feet bgs in the deepest portions of the project area. Borings will be approximately evenly spaced within the IAG, forming an approximate gridded pattern, resulting in borings from the same triplicate set being approximately 20 feet apart and all borings being approximately 18 to 20 feet apart.

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY (CONTINUED)

Within each IAG, 13 subsurface DUs will be established at multiple depth horizons – depending on the total depth of each boring. Each pilot study IAG will include one surface DU (0 to 2 feet bgs), eight 2-foot subsurface DUs, and four 4-foot subsurface DUs, for a total of 13 depth-specific DUs for those borings extending to 18 feet bgs. For borings shallower than 18 feet bgs, the deepest DUs will be truncated according to final depth. If the total depth of fill is greater than 18 feet, additional 4-foot and 2-foot DUs will be established below 18 feet bgs to the depth of the bottom of fill. Soil from each of the 30 increments within each DU will be combined to create one ISM soil sample that will be submitted to the laboratory to be processed in accordance with ISM standards (ITRC 2012) before analyzing the soil for the COCs (see Worksheet #17).

Triplicate samples (set of three field replicates) will be collected from each IAG in an overlapping array by stepping out two times within a few feet from the original boring locations, resulting in borings approximately 20 feet apart. ISM soil samples will be analyzed for lead, 4,4-DDE, 4,4-DDD, 4,4-DDT, and PCBs as Aroclors on a 5-day turnaround time (TAT).

Results from the triplicate analysis will be used to calculate RSDs for the ISM results for the COCs within each DU at each of the three pilot study IAGs (13 DUs * 3 pilot study IAGs = 39 RSDs for each COC). The RSD provides a quantitative evaluation of the ability of the increments to represent the contaminant heterogeneity and thereby measures the confidence of the reproducibility of chemical analytical results for each DU. The RSD(s) will be used to calculate a 95UCL for each DU result in the full-scale investigation as an additional measure to help ensure that the ISM is not underestimating the concentrations of each COC. The SD and RSD will be calculated as depicted in Equations 1 and 2 (where *SD* is the standard deviation of a set of triplicate results, *x* is each result in the triplicate dataset, x_{avg} is the mean of all results in the data set, and *n* is the number of replicates):

Equation 1:
$$SD_{triplicates} = \sqrt{\frac{\sum(x - x_{avg})^2}{n-1}}$$

Equation 2:
$$RSD\ (\%)_{triplicates} = \frac{SD_{triplicates}}{x_{avg}} \times\ 100\%$$

The SDs and RSDs will be calculated through evaluation of the triplicate data for each pilot study DU; the SD and RSD contribute to the 95UCL calculation to be applied to each DU result, using Equation 4 below based on the Chebyshev inequality (where C_{avg} is the mean concentration of the triplicate samples, *SD* is the standard deviation, α is the Type I error rate based on a 95 percent confidence [0.05], and *n* is the number of replicates [3]]):

Equation 3:
$$95UCL = C_{avg} + SD \times \sqrt{\frac{\left(\frac{1}{\alpha} - 1\right)}{n}}$$

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY (CONTINUED)

Based on the results of the pilot study, an appropriate RSD will be applied to all 24 Fill IAGs and two SP IAGs to calculate a 95UCL for each DU result. The appropriate RSD will be determined based on evaluation of the RSD data set for each COC (the average RSD for each analyte during the pilot study may be selected, for example). This RSD will be used to estimate the SD using a rearrangement of the equation given in Step 3, which will then be used to calculate the 95UCL for each DU. Equation 3 will be used for the full-scale investigation IAGs, with the substitution of *C* (the measured concentration) for C_{avg}, and $SD_{estimated}$ for *SD*, resulting in Equation 4:

Equation 4: $$95UCL = C + SD_{estimated} \times \sqrt{\frac{\left(\frac{1}{\alpha}-1\right)}{n}} = C + \left(C \times RSD_{appropriate}\right) \times \sqrt{\frac{\left(\frac{1}{\alpha}-1\right)}{n}}$$

Typically, an RSD of 35 percent indicates good precision for estimates of the average (ITRC 2012) and reliable data for decision making (Hawai'i Department of Health [DOH] 2016). Good precision implies that the sampling method used, including the number, spacing, size, and shape of increments collected, was adequate to represent and reflect small- and large-scale heterogeneity of contaminant distribution within the DU and that error in the laboratory processing and analysis methods was low. The greater the RSD, the less confidence there is that the mean contaminant concentration estimated for any individual DU is representative of the true mean for the DU (Hawai'i DOH 2016). The lower confidence associated with a high RSD is eliminated when applying a 95UCL to the DU result, because the confidence interval incorporates the higher RSD.

After all pilot study ISM results are available, NASA will calculate RSDs for each COC in each DU and present the information in the format illustrated in Table 1.

The following information will be reviewed and evaluated to select the appropriate RSD to use to calculate 95UCL concentrations for each DU in the full-scale investigation:

- The RSDs of triplicate results for lead, total DDTs, and total PCBs in each DU (up to 13 subsurface DUs * 3 pilot study IAGs = 39 RSDs for each analyte).
- ISM sample results for lead, total DDTs, and total PCBs relative to the established cleanup goals for AOI 14.
- Variability of RSDs within each IAG and geographically within AOI 14.

NASA will conduct a meeting with EPA, the Regional Water Board, and CDFW-OSPR to discuss the pilot study results and determine the methodology for applying the RSDs to all IAGs and DUs.

SAP WORKSHEET #11a — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE PILOT STUDY (CONTINUED)

STEP 6: SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA – HOW TO ADDRESS INHERENT UNCERTAINTY? CONSIDER CONSEQUENCES OF INCORRECT CONCLUSIONS AND SPECIFY THE DEGREE OF CERTAINTY DECISIONS MUST ACHIEVE BY DEFINING ACCEPTANCE LIMITS

- Data must provide a representative estimate of the mean concentration of lead, total DDTs, and total PCBs for each DU in soil.
- Performance and acceptance criteria are the outcome of the triplicate RSD analysis conducted during the pilot study.
- Worksheets #12 and #28 show the measurement performance criteria that are needed for the quality indicators.
- Performance and acceptance criteria for the analytical laboratory are addressed independently through the evaluation of laboratory QC samples, such as matrix spike (MS) and matrix spike duplicate (MSD) samples, and through data validation. Worksheet #20 shows the field QC samples required.
- Data should allow for reliable risk management decision-making within the specified project action limits (PAL) identified in Worksheet #15.

STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA – DEVELOP APPROACHES TO ACHIEVE THE GOAL OF THE STUDY IN THE MOST RESOURCE-EFFECTIVE WAY

The following effective techniques and approaches will be used to achieve the study goals:

1. ISM is a proven technique to maximize confidence in site decision-making. It minimizes decisions based on false positive and false negative data resulting in prioritization on eliminating known contamination.
2. The evaluation of the triplicate samples enables the assessment of representativeness at the onset of the project.
3. Accelerated sample TAT enables data evaluation to be conducted while the pilot study is ongoing in the event that any field modifications are recommended.
4. DPT is proven effective at collecting soil samples at depth in debris areas.

Investigation methods are described in detail in Worksheet #17.

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION

STEP 1: STATE THE PROBLEM – DEFINE THE PROBLEM(S) THAT NECESSITATES THE STUDY.

Construction debris and fill was placed in the FSFA from 1968 through the 1987. Previous investigation results show that lead, total DDTs, and total PCBs detected in fill in the northern portion of the FSFA pose potential current and future unacceptable risks to human and ecological receptors. Soil eroding from the surface of the FSFA, which may pose a current potential risk to wetland receptors, is controlled by an ICAM composed of a silt fence. The Action Memorandum documents NASA's decision to conduct a non-time-critical removal action (NTCRA) at the FSFA to address the potential unacceptable human health and ecological risks at AOI 14 (Tetra Tech 2017a). The objective of the NTCRA is to prevent exposure of human receptors and terrestrial ecological receptors to surface and subsurface soil with COC concentrations exceeding cleanup goals and to prevent erosion of soil with COC concentrations exceeding cleanup goals from the FSFA into the SP to protect wetland ecological receptors. The selected action for soil and sediment with cleanup goals exceedances is excavation and off-site disposal.

As described in Step 1 of Worksheet #11a, additional soil data for lead, total DDTs, and total PCBs (as Aroclors) are needed to define the spatial limits of the removal action at the FSFA. In addition, additional analytical data are needed to determine whether and where concentrations of lead, total DDTs, and total PCBs (as Aroclors) in sediment in two areas of the SP bordering the FSFA exceed cleanup goals.

STEP 2: IDENTIFY THE GOALS OF THE STUDY – IDENTIFY THE DECISIONS THAT NEED TO BE MADE AND POSSIBLE ACTIONS THAT MAY BE TAKEN AS A RESULT OF THE DECISION.

The goals of the full-scale design site characterization study at FSFA are to (1) identify areas at the FSFA where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in soil and fill and (2) identify whether and where concentrations of lead, total DDTs, and total PCBs in sediment in two areas of the SP outside the ICAM silt fence (Figure 3) exceed cleanup goals.

STEP 3: IDENTIFY INFORMATION INPUTS – IDENTIFY SPECIFIC INFORMATION NEEDED TO MAKE DECISIONS AND ACHIEVE STUDY GOAL.

The data inputs that have been used to develop this SAP and determine locations for proposed investigation of the site include the following.

- EE/CA and Current Conditions Report (Tetra Tech 2015)
- Action Memorandum (Tetra Tech 2017a)
- Final Geophysical Investigation Report (Tetra Tech 2016)

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

- Navy IR Site 25 decision documents (Record of Decision, Remedial Action Closure Report, Biological Assessment [Navy 2010]; Innovative Technical Solutions, Inc. [ITSI] 2012; ITSI Gilbane Company 2013)
- AOI 14 ICAM sediment monitoring reports (ERT 2014a, 2014b, 2015, 2016)
- Results of the pilot study to identify the appropriate RSD(s) to use to calculate the 95UCL for each of the full-scale investigation DUs before comparing COC concentrations with the cleanup goals (see Worksheet #11a)

The following new data inputs, accompanied by the existing data inputs, will be used to identify areas of soil and sediment that require removal based on exceedances of cleanup goals.

- Results for lead, total DDTs, and total PCBs from ISM samples from up to 13 DUs within each of 21 Fill IAGs (Figure 3).
    - The following surface and subsurface DUs have been established in each Fill IAG, resulting in a total of up to five DUs in each IAG to be initially analyzed (depending on the depth of fill) and up to an additional eight DUs to be analyzed in the case that an adjusted sample result from a 4-foot DU exceeds a cleanup goal. ISM samples will be collected from the following depth intervals at each IAG.
        - One surface 2-foot depth interval (0 to 2 feet bgs).
        - Four-foot depth subsurface intervals throughout the remainder of the fill material (2 to 6, 6 to 10, 10 to 14, and 14 to 18 feet bgs) (up to four DUs).
        - If a 95UCL for 4-foot DUs exceeds one of the COC cleanup goals, the 4-foot DU will be split into two 2-foot subsurface DUs, resulting in up to an additional eight DUs: 2 to 4, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 feet bgs. If the total depth of fill is greater than 18 feet, additional subsurface 2-foot and 4-foot DUs will be established below 18 feet bgs to the depth of the bottom of fill.
    - Results for total DDTs will be calculated by summing detected results for 4,4-DDD, 4,4-DDE, and 4,4-DDT, and results for total PCBs will be calculated by summing detected results for Aroclors.
    - ISM samples for each DU will consist of 30 increments. Soil from all increments within each DU of each IAG will be combined to create one ISM soil sample for each depth interval, which will be submitted to the laboratory to be processed in accordance with standard ISM protocols (ITRC 2012) before analyzing the soil for the COCs (see Worksheet #17).

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

- Results for lead, total DDTs, and total PCBs from ISM soil samples collected from SP DUs.
    - Two vertical DUs have been established at each SP DU; the top interval ranges from 0 to 0.5 foot bgs, and the bottom interval ranges from 0.5 to 1 foot bgs.
    - Thirty ISM sample increments will be collected from both intervals at each of the two SP DUs. ISM samples from the top interval will be analyzed for lead, 4,4-DDT, 4,4-DDD, 4,4-DDE, and PCBs as Aroclors. Bottom ISM samples will be analyzed if the top interval DU results exceed one or more of the COC cleanup goals.
- The RSD used in calculation of the 95UCL for each DU ISM result.
- Result contribution to site-wide average. The residual volumetric site-wide average concentrations at AOI 14 will be calculated as described in the Removal Action Work Plan (Tetra Tech 2017, Section 2.1) and compared to the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors at the SP (Tetra Tech 2015). The Navy IR Site 25 site-wide average remediation goals are 33 mg/kg for lead, 0.016 mg/kg for total DDT, and 0.20 mg/kg for total PCBs. The residual volumetric average concentrations of lead, total DDT, and total PCBs will be calculated using the results of this design site characterization investigation prior to establishing the final removal action excavation plan.

STEP 4: DEFINE THE BOUNDARIES OF THE STUDY – DEFINE SPATIAL AND TEMPORAL BOUNDARIES CONSIDERING SITE-SPECIFIC CONTAMINANTS, POTENTIAL MIGRATION PATHWAYS, AND CURRENT AND FUTURE USES OF SITE.

- Spatial boundaries of Fill IAGs:
    - Vertical: AOI 14 surface to bottom of fill (expected to be between 8 and 18 feet bgs). Each Fill IAG will be subdivided vertically into 2-foot surface DUs, and 4-foot and 2-foot subsurface DUs.
    - Lateral: AOI 14 will be divided into 24 Fill IAGs (three of which will be investigated as part of the pilot study) (Figure 3). Each IAG is assumed to represent an approximate minimum area of 100 feet by 100 feet, or about 10,000 square feet (Figure 3).
- Spatial boundaries of SP IAGs:
    - Vertical: SP surface to a maximum depth of 1 foot bgs.

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

- Lateral: SP IAGs have been established to evaluate sediments around two locations on the northeastern and eastern sides of the FSFA where sample results from discrete surface sediment samples exceeded cleanup goals. SP IAGs are located on the surface of the SP and have a horizontal area extending 20 feet from a previous sampling point in SPIAG01 and 30 feet from a previous sampling point in SPIAG02. SPIAG01 is approximately 660 square feet, and SPIAG02 is approximately 2,000 square feet (Figure 3).

- Temporal boundaries:
  - Work will begin following completion of the pilot study IAGs and will continue for approximately 2 months until work is complete.

STEP 5: DEVELOP THE ANALYTIC APPROACH – DEFINE SPECIFIC PARAMETERS OF INTEREST, SPECIFY ACTION LEVELS/CRITERIA TO BE CONSIDERED, AND BASIS FOR SELECTED ACTION LEVELS.

ISM will be used to characterize soils and fill material at multiple depth horizons in each Fill DU. ISM is a structured, composite, sampling, and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling (ITRC 2012).

The full-scale investigation will consist of collecting ISM samples from 21 Fill IAGs with 30 increments in a gridded pattern from multiple depth intervals, resulting in borings approximately 20 feet apart. In addition, 30-increment ISM samples will be collected from two SP IAGs from two depth intervals, resulting in borings approximately 3 to 5 feet apart. One ISM sample will be collected from each surface and subsurface DU (see Worksheet #17). The DU intervals for the Fill IAGs in the full-scale investigation will consist of one 2-foot surface DU, four 4-foot subsurface DUs, and potentially eight 2-foot subsurface DUs. The 2-foot subsurface DUs will be analyzed only when a 95UCL result for the corresponding 4-foot subsurface DU exceeds one or more of the cleanup goals.

The collection methods in the full-scale investigation will be the same as for the pilot study, with the exception that in the IAGs located on the perimeter of the FSFA, additional sampling methods will be used to obtain representative material from the FSFA side slopes in the incremental sample. Two methods will be used: (1) a portion of the direct-push borings will be advanced at 30 degrees from vertical using DPT angle-hole methods to bottom of fill and (2) a hand auger or soil corer will be used to collect soil on the side slopes and at or near the toe of the slope (Figure 4). From each increment location collected using these additional methods, a volume of soil equivalent to the soil volumes from each of the other increments will be incorporated into the ISM samples at the appropriate depth horizons.

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

Drill rigs cannot work on the down side of the FSFA slopes or at the toe of slope. Soil collected from vertical borings and 30-degree angle borings (from the top into the side slopes) is representative of about 95 percent of the total volume of FSFA soil. Hand augering (or coring) on side slopes and at the toe of slope is intended to capture representative samples from the 5 percent of the total soil volume of apparent artificial fill in the FSFA that comprises the side slope and toe of slope areas, based on a volumetric analysis of soil within the side slopes compared with the volume of the rest of the IAG. Two hand auger borings per perimeter Fill IAG are proposed, which equates to 5 to 10 percent of the borings representing the remaining 5 percent of the FSFA soil volume. One hand auger boring will be located near the toe of the slope to a depth of approximately 1 foot bgs and the other will be at a location on the side slope and drilled to an average depth of 2.5 feet bgs. The height of the side slopes around the perimeter of the FSFA ranges from about 5 feet to 10 feet above the surrounding SP bottom. Where the height of the FSFA is closer to 10 feet above the surrounding SP bottom, hand auger borings will be drilled to a depth of approximately 4 feet bgs.

If refusal is encountered while drilling either vertical or angle-hole DPT borings, the increment boring will be abandoned and a replacement increment boring will be advanced at a location approximately 5 feet from the originally proposed location. Stepping out in this manner will continue until either the increment boring can be completed or the next increment boring location is reached. Attempts will be made to keep placement of angle-hole borings along the edge of the slope of the FSFA. If either vertical or angle-hole borings cannot be completed, debris in the area, as defined by borings where refusal is encountered (including riprap and soil below the slope), will be excavated and disposed of off site.

SP IAG ISM samples will consist of 30 increments collected in a gridded pattern. Two vertical DUs have been established at each SP IAG; the top interval DU ranges from 0 to 0.5 foot bgs, and the bottom interval DU ranges from 0.5 to 1 foot bgs. ISM sample increments will be collected from both DUs at each of the two SP IAGs.

For each COC, 95UCL concentrations will be calculated for each DU, using the RSD(s) determined following the pilot study, and compared to the cleanup goals to determine whether soil or sediment within each DU will remain on site or be removed from the site. See Worksheet #11a, Step 5, for details on the method and equations for calculating the 95UCL. Results for each COC will be considered independently when determining whether the 4-foot DUs should be divided into 2-foot DUs (see Figure 6). For example, if lead and total PCB concentrations for a 4-foot DU are less than cleanup goals, but the 4-foot DU total DDTs concentration exceeds the cleanup goal, further analysis for both lead and total PCBs is not required in the two 2-foot DUs, but further analysis for total DDTs is required. Figure 7 presents the decision logic for the following independent evaluation of DU COC results:

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

- The 95UCL concentrations for lead, total DDTs, and total PCBs from each DU in each IAG will be compared with the cleanup goals.

    1. If all 95UCL COC concentrations in the 2-foot or 4-foot ISM Fill DUs are less than cleanup goals, all soil within the DU may remain in place or be stockpiled and then reused on site for backfill or grading purposes. ISM sample results from the DU with COC concentrations less than cleanup goals located immediately below the deepest subsurface DU with COC concentrations greater than cleanup goals in each IAG will serve as confirmation sample results for purposes of the removal action (Figures 6 and 7).
    2. If any of the 95UCL COC concentrations in the 4-foot ISM Fill DUs exceed any of the cleanup goals, the 4-foot DU will be split into two 2-foot DUs, and ISM samples from the two 2-foot DUs will be analyzed for the COCs that exceed cleanup goals.
    3. If any of the 95UCL COC concentrations in the 2-foot ISM Fill DUs exceed any of the cleanup goals, all soil within that DU will be removed and disposed of off site. Native soil is assumed to have COC concentrations less than cleanup goals; therefore, if soil from an entire IAG is excavated to native soil, confirmation samples will not be required for purposes of the removal action.

- The 95UCL concentrations for lead, total DDTs, and total PCBs from the top interval of SP IAGs will be compared with cleanup goals as follows:

    1. If the 95UCL COC concentrations for the top interval of the ISM SP DU are less than cleanup goals, all sediment and vegetation within the SP IAG may remain in place.
    2. If top interval ISM SP DU 95UCL concentrations for any of the COCs exceed cleanup goals, the bottom interval ISM sample will be analyzed for the COCs that exceed cleanup goals. Sediment from the top interval DU (0 to 0.5 foot bgs) will be excavated and disposed of off site.
    3. If bottom interval ISM SP DU 95UCL COC concentrations do not exceed any of the cleanup goals, COC concentrations within the entire SP DU bottom interval will be considered less than cleanup goals, and sediment in the bottom interval DU may remain in place.
    4. If bottom interval ISM SP DU 95UCL COC concentrations exceed cleanup goals, sediment from 0 to 1 foot bgs will be excavated and disposed of off site.

SAP WORKSHEET #11b — PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR THE FULL-SCALE INVESTIGATION (CONTINUED)

STEP 6: SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA – HOW TO ADDRESS INHERENT UNCERTAINTY? CONSIDER CONSEQUENCES OF INCORRECT CONCLUSIONS AND SPECIFY THE DEGREE OF CERTAINTY DECISIONS MUST ACHIEVE BY DEFINING ACCEPTANCE LIMITS.

- Data must provide a representative estimate of the mean concentrations of lead, total DDTs, and total PCBs for each DU in soil and sediment.
- Application of the RSD(s) and 95UCL(s) to the result of each DU will effectively manage any uncertainty associated with sample results.
- Worksheets #12 and #28 show the measurement performance criteria that are needed for the quality indicators.
- Performance and acceptance criteria for the analytical laboratory are addressed independently through the evaluation of laboratory QC samples, such as MS and MSD samples, and through data validation. Worksheet #20 shows the field QC samples required.
- Data should allow for reliable risk management decision-making within the specified PALs identified in Worksheet #15.

STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA – DEVELOP APPROACHES TO ACHIEVE THE GOAL OF THE STUDY IN THE MOST RESOURCE-EFFECTIVE WAY.

The following effective techniques and approaches will be used to achieve the study goals:

1. ISM is a proven technique to maximize confidence in site decision-making. It minimizes decisions based on false-positive and false-negative data, resulting in prioritization on eliminating known contamination.
2. Accelerated sample TAT enables data evaluation to be conducted quickly in the event that any field modifications are recommended.
3. DPT is proven effective at collecting soil samples at depth in debris areas.
4. Use of multiple subsurface DUs will result in the optimal removal of soil volumes with 95UCL COC concentrations known to exceed site cleanup goals and will enable soil with 95UCL COC concentrations less than cleanup goals to be stockpiled and then reused on site for backfill or grading purposes.

Investigation methods are described in detail in Worksheet #17.

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA

Measurement Performance Criteria – Field QC Samples

QC Sample/Matrix	Analytical Group and Method	Frequency	Data Quality Indicators (DQI)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
Field replicate/soil	Lead (EPA 6010B/6010C), organochlorine pesticides (EPA 8081A/8081B), PCBs (EPA 8082/8082A)	One set of triplicates (set of three field replicates) per DU in each of 3 Fill IAGs during the pilot study	Precision	RSD≤35	S & A
Equipment rinsate blank/water	Lead (EPA 6010B/6010C), Organochlorine pesticides (EPA 8081A/8081B), PCBs (EPA 8082/8082A)	1 per day when reusable equipment is used	Accuracy/bias - Contamination	No COCs ≥ Limit of quantitation (LOQ)	S & A
Source water blank/water	Lead (EPA 6010B/6010C), organochlorine pesticides (EPA 8081A/8081B), PCBs (EPA 8082/8082A)	1 per source of equipment rinsate water	Accuracy/bias - contamination	No COCs ≥ LOQ	S & A
Temperature blank/water	Not analyzed	1 per cooler	Not applicable	Temperature within 4 +/- 2º C	S

Notes:

Soil field replicates will only be collected during the pilot study as discussed in Worksheets #11a, #14, and #17.

Collection of equipment rinsate and source water blanks is not anticipated during sampling at the interior Fill IAGs because dedicated/disposable equipment will be used. These QC samples will be required when reusable sampling equipment such as a hand auger is used, during sampling at the SP IAGs, and during sampling with a hand auger at the perimeter Fill IAGs.

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)

12.1 SUMMARY OF QA/QC TASKS

Tetra Tech will assess the quality of analytical data through collection and analysis of field QC samples. The following sections discuss the types and purposes of field QC samples that will be collected for this project. Equipment rinsate and source water blank samples will not be collected during interior Fill DU sample collection because all sampling equipment will be dedicated; these QC samples will be required when reusable sampling equipment (hand auger), which is anticipated during SP DU sampling and during sampling with a hand auger at the perimeter Fill IAGs.

12.1.1 Triplicates - Set of Three Field Replicates

Ten percent of samples will be analyzed in triplicate (set of three field replicates) to help evaluate the confidence associated with each ISM sample. The collection of triplicate samples during the pilot study will satisfy this requirement for this investigation. Triplicate samples will help evaluate the potential for false positive or false negative results for the subsurface interval samples. In the pilot study, triplicate results will be used to help determine the appropriate RSD(s) to use to calculate 95UCL concentrations for each full-scale investigation DU (Worksheet #11a).

12.1.2 Equipment Rinsate Blanks

Equipment rinsate blanks will be collected at a rate of one per day on days when reusable sampling tools are used. The only reusable tools that are expected to come in contact with soil samples are hand augers or other sampling tools that will be used to collect surface and shallow soil samples in the SP IAGs and from the side slopes of the Fill IAGs located on the perimeter of the FSFA. Equipment rinsate blanks will not be collected during use of the DPT rig because disposable acetate sleeves will be used to extract the samples.

Equipment rinsate blanks will be collected by pouring distilled water over or through the decontaminated sampling tool into a sample container and sent to the laboratory for analysis. Equipment rinsate blanks will be collected to evaluate the accuracy/bias of the sample results and to verify that the decontamination process is adequate.

Analytical results for equipment rinsate blanks will be used during data validation to qualify the data (if needed) based on accuracy/bias and to modify (if needed) the decontamination process.

12.1.3 Source Water Blanks

One source water blank will be collected for each source of distilled water used to decontaminate the hand auger or other disposable equipment and collect rinsate blank samples. Source water blank samples are collected to verify that the water used for decontamination and equipment rinsate blanks is free of target analytes.

SAP WORKSHEET #12 — MEASUREMENT PERFORMANCE CRITERIA TABLE (CONTINUED)

12.1.4 Temperature Blanks

One temperature blank will be included in each shipping container of samples. Temperature blanks are water samples that originate at the laboratory and are used to measure the temperature of the samples in the shipping container upon arrival at the laboratory.

SAP WORKSHEET #13 — SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

Secondary Data	Data Source (originating organization, report title, and date)	Data Generator(s) (originating organization, data types, data generator and collection dates)	How Data Will Be Used	Limitations on Data Use
Historical aerial photographs	Various sources; compiled by NASA Ames	Unknown	Define historical fill episodes at FSFA.	None
Site history and historical analytical data	Tetra Tech, Final AOI 14 EE/CA, Appendix A—Current Conditions Report, September 2015 (Tetra Tech 2015)	Tetra Tech, NASA Ames analytical data	Data for COCs used to determine locations of pilot study borings; soil boring logs will be used to estimate depth to Bay Mud or native fill.	None
Sediment analytical data	ERT, Annual AOI 14 ICAM Sediment Monitoring Reports (ERT 2014a, 2014b, 2016)	NASA Ames	Define sediment DUs based on previous discrete sediment samples that exceed cleanup goals.	None
Geophysical data	Tetra Tech, Final Geophysical Investigation Report, November 2016 (Tetra Tech 2016)	Tetra Tech, geophysical data	Define subsurface areas of debris and potentially define different fill zones.	None
Biological assessment data	Tetra Tech, Biological Assessment Report, March 2017 (Tetra Tech 2017b)	Tetra Tech, biologists	Define biologically sensitive areas that may require clearing of biological species prior to action; define mitigation and conservation measures required during implementation to address potential impacts to biological species.	None

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS

14.1 PROJECT OBJECTIVES

As stated in SAP Worksheets #11a and #11b, the primary objectives of the pilot study and full-scale investigations are:

1. Pilot Study: Identify the appropriate confidence interval to apply to all DU results before comparing COC concentrations with the cleanup goals through evaluation of RSDs of triplicate results.

2. Full-Scale Investigation:

   a. Identify areas at AOI 14 where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals (Worksheet #10). Soil from DUs that exceed cleanup goals will be excavated and disposed of off site. Soil from DUs that do not exceed cleanup goals will be left in place or excavated and stockpiled for later use as backfill.

   b. Determine whether concentrations of lead, total DDTs, or total PCBs in sediment in two IAGs within the adjacent SP bottom exceed cleanup goals (Worksheet #10). Sediment from DUs that exceed cleanup goals will be excavated and disposed of offsite. Areas that do not exceed cleanup goals will be left in place.

The specific data collection activities planned for AOI 14 are summarized below and detailed in Step 3 of Worksheets #11a and #11b. The basis and rationale for these data collection activities are presented in Worksheet #17.

14.1.1 Pilot Study Tasks

The proposed work under the pilot study includes the following activities:

- Survey horizontal and vertical positions and stake the corners of the IAGs for the entire FSFA to an accuracy of 0.1 feet. Pilot study data will be collected from within three 100-foot by 100-foot IAGs. Boring increment locations will be marked in the field with a wooden stake. The horizontal locations of all sample increment borings will be recorded using a hand-held global positioning system (GPS) device with sub-meter accuracy and the locations will be indicated on a figure in the RACR.

- Advance pilot study borings in triplicate (set of three field replicates).

- Collect ISM soil samples from up to 13 depth horizons (DUs) at each IAG, in triplicate. Submit samples to laboratory for analysis of lead, DDD, DDE, DDT, and PCBs as Aroclors.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

- Calculate the RSD for each COC in each DU at each of the three pilot study IAGs. Evaluate the data and appropriate confidence interval to apply to all DU results before comparing COC concentrations to cleanup goals through evaluation of RSDs of triplicate results.

- Present recommendations and rationale to regulatory agencies to obtain concurrence on the appropriate RSD(s) to use to calculate the 95UCL at each of the full-scale investigation DUs.

Project quality objectives (PQO) for the proposed work are provided in Worksheet #11a, and a detailed description of the sampling methods is provided in Worksheet #17.

14.1.2 Full-Scale Investigation Project Tasks

The proposed work under the full-scale investigation includes the following activities for sampling the Fill IAGs (upland portion of the FSFA) and SP IAGs:

- Conduct a utility location survey focusing on the area with a linear anomalous feature detected during the geophysical survey running north to south on the southeastern portion of the FSFA (Tetra Tech 2016).

- In each Fill IAG, advance 30 borings using DPT to the interface between fill and underlying native pond surface. A hand auger or soil corer will also be used to collect soil on the side slopes at Fill IAGs on the perimeter of the FSFA.

- Collect ISM soil samples from each DU at the depths described in Worksheets #11b and #17.

- In each SP IAG, hand auger top and bottom interval surface sediment samples from 0 to 0.5 and 0.5 to 1 foot bgs.

- Analyze surface and 4-foot subsurface Fill DUs and top interval SP DU ISM samples for lead, DDD, DDE, DDT, and PCBs as Aroclors on a 5-day TAT, as needed; compare 95UCL COC concentrations in each DU with cleanup goals. Analyze 2-foot subsurface Fill DU ISM samples and bottom interval SP DU ISM samples according to the sample analysis protocol and decision logic presented in Step 5 of the PQOs (Worksheet #11b), as illustrated on Figures 6 and 7.

- Identify areas and depths for excavation based on comparison of 95UCL COC concentrations for ISM sample results in each DU to cleanup goals. Soil and sediment with 95UCL COC concentrations greater than the cleanup goals will be excavated and disposed of off site. Soil with 95UCL COC concentrations that do not exceed cleanup goals will be left in place or excavated and stockpiled for later use as backfill. Sediment with 95UCL COC concentrations that do not exceed cleanup goals will be left in place.

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

PQOs for the proposed work are provided in Worksheet #11b, and a detailed description of the sampling methods is provided in Worksheet #17.

14.2 SUMMARY OF QUALITY ASSURANCE AND QUALITY CONTROL TASKS

Tetra Tech will assess the quality of field data through regular collection and analysis of field QC samples. Worksheet #12 discusses the types and purposes of field QC samples that will be collected for this project. QC will also be evaluated through data assessments (Worksheets #34 and 35) and data validation (Worksheet #36).

14.3 SUMMARY OF SURVEYS, INVESTIGATION-DERIVED WASTE, AND EQUIPMENT DECONTAMINATION

The following subsections describe sample location surveys, equipment decontamination procedures, and management of IDW for this investigation.

14.3.1 Geophysical Survey/Anomaly Avoidance

A geophysical survey was conducted in October 2016 to identify any subsurface anomalies, such as concrete and rebar, that may affect placement of planned soil borings. Details regarding the approach, procedures, and operational methods that were used were provided under separate cover (Tetra Tech 2016).

14.3.2 Biological Survey and Monitoring

No more than 3 days prior to sampling, a USFWS-approved biologist will conduct a walking survey of the FSFA and a visual survey of the surrounding environs to determine the presence or absence of special status species in the area. The USFWS-approved biologist will be on site daily during sampling activities. Additional conservation measures are described in the Biological Assessment (Tetra Tech 2017b).

14.3.3 Underground Utilities

No records of subsurface utilities at AOI 14 exist; however, the geophysical investigation identified a linear anomalous feature that may be evidence of a former utility corridor oriented north to south in the southern portion of the site within FIAG16, FIAG19, FIAG22, and FIAG24. Utility location will be conducted prior to working in these IAGs. Sampling increment boring locations in the immediate proximity of the line will be adjusted to avoid the linear feature.

14.3.4 Sample Location and Recording

Prior to the pilot study, a surveyor will locate the corners of each IAG to 0.1-foot accuracy and mark the corners with wooden stakes less than 3 feet tall to avoid creating a perch for raptors. DPT

SAP WORKSHEET #14 — SUMMARY OF PROJECT TASKS (CONTINUED)

locations within each IAG will be located using a chalk line and measuring tape and marked in the field with a wooden stake. The horizontal locations of all sample increment borings will be recorded using a hand-held global positioning system GPS device with sub-meter accuracy and the locations will be indicated on a figure in the RACR.

14.3.5 Equipment Decontamination

All reusable hand sampling tools (i.e., hand augers and soil corers) will be decontaminated before sampling begins and between sampling at IAGs. Soil and sediment sampling tools will be decontaminated by scrubbing in a solution of potable water and nonphosphate detergent (Alconox or Liquinox). The tools will then be double-rinsed with distilled water. Sampling tools that are not used immediately after decontamination will be air dried and then wrapped in plastic or stored in a dedicated case. DPT equipment will be decontaminated between IAGs using steam-cleaning methods.

14.3.6 Management of Investigated-Derived Waste

The design site characterization investigation at AOI 14 will generate IDW consisting of increment soil cores, personal protective equipment, and miscellaneous trash. After ISM soil samples have been collected, soil increment cores will be managed in accordance with requirements for the most contaminated depth interval of the IAG and transported off site for disposal. If no depth interval of the IAG requires off-site disposal, all increment cores from that IAG will be added to the backfill stockpiles.

Personal protective equipment and miscellaneous waste from sampling (paper towels, aluminum foil, and plastic sheeting) will be placed in large garbage bags, sealed, and disposed of in NASA Ames trash receptacles.

14.4 DATA MANAGEMENT

Tetra Tech PMs have the primary responsibility for defining project-specific data reporting requirements and for managing data. Data management requirements and tasks are addressed in Worksheet #29.

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE

(15a) Metals
Analytical Group: EPA 6010B/6010C
Matrix: Soil/Sediment

Chemical	CAS Number	Project Action Limit (PAL)[a] (mg/kg)	PAL Reference	Project Quantitation Limit Goal[b] (mg/kg)	Laboratory	Laboratory-Specific		
						LOQ (mg/kg)	Limit of Detection (LOD) (mg/kg)	Detection Limit (DL) (mg/kg)
Lead	7439-92-1	11	Eco-SSL (minimum)	5.5	BC Laboratories	2.50	1.00	0.28
					SGS Laboratories	1	0.2	0.05

Notes:

a Lesser of the (1) AOI 14 cleanup goal (98.3 mg/kg) (Tetra Tech 2017a), (2) Navy IR Site 25 site-wide (area-weighted) average remediation goal (33 mg/kg) (Tetra Tech 2017a) (3) EPA residential RSL (EPA 2015a), (4) DTSC residential screening level (DTSC 2016), (5) Eco-SSLs for plants, invertebrates, mammals, and birds (EPA 2016a), and (6) ORNL screening levels for plants and invertebrates (Efroymson and others 1997a, 1997b).

b The project quantitation limit goal is 1/2 the PAL, unless otherwise noted.

CAS Chemical Abstracts Service

DTSC California Department of Toxic Substances Control

Eco-SSL EPA Ecological Soil Screening Level, minimum of plant, invertebrate, mammal, and bird screening levels, available on-line at: http://www.epa.gov/chemical-research/ecological-soil-screening-level

EPA U.S. Environmental Protection Agency

IR Investigation Restoration

ORNL Oak Ridge National Laboratory, minimum of plant and invertebrate screening benchmarks, available online at: https://rais.ornl.gov/tools/eco_search.php

RSL Regional Screening Level

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15b)
Pesticides
Analytical Group: EPA 8081A/8081B
Matrix: Soil/Sediment

Chemical	CAS Number	Project Action Limit (PAL)[a] (mg/kg)	PAL Reference	Project Quantitation Limit Goal[b] (mg/kg)	Laboratory	Laboratory-Specific		
						LOQ (mg/kg)	Limit of Detection (LOD) (mg/kg)	Detection Limit (DL) (mg/kg)
4,4'-DDD	72-54-8	0.021	Eco-SSL (minimum)	0.0105	BC Laboratories	0.001	0.0003	0.000063
					SGS Laboratories	0.0033	0.00083	0.00046
4,4'-DDE	72-55-9	0.021	Eco-SSL (minimum)	0.0105	BC Laboratories	0.001	0.0003	0.000045
					SGS Laboratories	0.0033	0.00083	0.0006
4,4'-DDT	50-29-3	0.021	Eco-SSL (minimum)	0.0105	BC Laboratories	0.001	0.0003	0.000031
					SGS Laboratories	0.0033	0.00083	0.0005

Notes:

a Lowest of the (1) AOI 14 cleanup goal (0.109 for total DDTs) (Tetra Tech 2017a), (2) Navy IR Site 25 site-wide (area-weighted) average remediation goal (0.016 mg/kg for total DDTs) (Tetra Tech 2017a), (3) EPA residential RSL (EPA 2015b), (4) DTSC residential DTSC-screening levels (DTSC 2016), (5) Eco-SSLs for plants, invertebrates, mammals, and birds (EPA 2016a), and (6) ORNL screening levels for plants and invertebrates (Efromyson and others 1997a, 1997b). The sum of 4,4'-DDD , 4,4'-DDE and 4,4'-DDT must be less than the PAL.

b The PQL goal is one-half of the PAL, unless otherwise noted.

c Laboratory-specific LODs presented here represent verified LODs. The actual statistically based LOD has been rounded to the closest one-digit value and verified at a concentration at a minimum of two times that value via a laboratory spike.

CAS Chemical Abstracts Service

DTSC California Department of Toxic Substances Control

Eco-SSL EPA Ecological Soil Screening Level, minimum of plant, invertebrate, mammal, and bird screening levels, available on-line at: http://www.epa.gov/chemical-research/ecological-soil-screening-level

EPA U.S. Environmental Protection Agency

IR Investigation Restoration

ORNL Oak Ridge National Laboratory, minimum of plant and invertebrate screening benchmarks, available online at: https://rais.ornl.gov/tools/eco_search.php

RSL Regional Screening Level

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

(15c) PCBs
Analytical Group: EPA 8082/8082A
Matrix: Soil/Sediment

Analyte	CAS Number	Project Action Limit (PAL)[a] (mg/kg)	PAL Reference	Project Quantitation Limit Goal[b] (mg/kg)	Laboratory	Laboratory-Specific		
						LOQ (mg/kg)	Limit of Detection (LOD) (mg/kg)	Detection Limit (DL) (mg/kg)
Aroclor-1016	12674-11-2	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.0027
					SGS Laboratories	0.017	0.012	0.0066
Aroclor-1221	11104-28-2	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.1	BC Laboratories	0.02	0.008	0.0050
					SGS Laboratories	0.017	0.012	0.0083
Aroclor-1232	11141-16-5	0.17	EPA 2016 Residential RSL	0.085	BC Laboratories	0.02	0.008	0.0012
					SGS Laboratories	0.017	0.012	0.0083
Aroclor-1242	53469-21-9	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.00162
					SGS Laboratories	0.017	0.012	0.0066
Aroclor-1248	12672-29-6	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.0012
					SGS Laboratories	0.017	0.012	0.0066
Aroclor-1254	11097-69-1	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.00078
					SGS Laboratories	0.017	0.012	0.0066
Aroclor-1260	11096-82-5	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.00220
					SGS Laboratories	0.017	0.012	0.0066
Aroclor-1268	11100-14-4	0.20	Navy IR Site 25 site-wide (area-weighted) average remediation goal	0.105	BC Laboratories	0.02	0.008	0.0022
					SGS Laboratories	0.017	0.012	0.0066

SAP WORKSHEET #15 — REFERENCE LIMITS AND EVALUATION TABLE (CONTINUED)

Notes:

a	Lowest of the (1) AOI 14 cleanup goal (0.21 mg/kg for total PCBs) (Tetra Tech 2017a), (2) Navy IR Site 25 site-wide (area-weighted) average remediation goal (0.20 mg/kg for total PCBs) (Tetra Tech 2017a), (3) EPA residential RSL (EPA 2015b), and (4) ORNL screening levels for plants and invertebrates (Efroymson and others 1997a, 1997b). DTSC residential DTSC-SLs (DTSC 2016) or Eco-SSLs (EPA 2016a) are not available. The sum of the eight Aroclors must be less than the PAL.
b	The Project Quantitation Limit Goal is 1/2 the PAL, unless otherwise noted.
c	Laboratory-specific LODs presented here represent a verified LOD. The actual, statistically based LOD has been rounded to the closest one-digit value and verified at a concentration at a minimum of 2X that value via a laboratory spike.
CAS	Chemical Abstracts Service
DTSC	California Department of Toxic Substances Control
Eco-SSL	EPA Ecological Soil Screening Level, minimum of plant, invertebrate, mammal, and bird screening levels, available on-line at: http://www.epa.gov/chemical-research/ecological-soil-screening-level
EPA	U.S. Environmental Protection Agency
IR	Investigation Restoration
ORNL	Oak Ridge National Laboratory, minimum of plant and invertebrate screening benchmarks, available online at: https://rais.ornl.gov/tools/eco_search.php
RSL	Regional Screening Level

SAP WORKSHEET #16 — PROJECT SCHEDULE/TIMELINE TABLE

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable	Deliverable Date
Draft SAP	Tetra Tech	10/3/2016	12/19/2016	Draft SAP	12/19/2016
Draft RAWP	Tetra Tech	10/3/2016	1/11/2017	Draft RAWP and SAP	1/11/2017
Final SAP	Tetra Tech	7/10/2017	October 2017	Final SAP	October 2017
Final RAWP	Tetra Tech	3/16/2017	November 2017	Final RAWP and SAP	November 2017
Biological Survey, Pre-Field Work Mitigation Measures	Tetra Tech	One week before Pilot Study Investigation	TBD	Biological Survey	NA
Mobilization of Sampling Equipment	Tetra Tech	TBD – One day before Pilot Study Investigation	TBD	NA	NA
Pilot Study Sampling Investigation	Tetra Tech	TBD	TBD	ISM Samples	Throughout investigation
Pilot Study Sample Analysis	Lab TBD	TBD	TBD	Data Packages	Preliminary results due 5 to 14 days after submittal to lab; full data package due 21 days after submittal
Meeting with EPA, Regional Water Board, and CDFW-OSPR to present Pilot Study Results	Tetra Tech	TBD	TBD	Summary Analysis of Pilot Study Results	TBD - 2 weeks after the completion of the Pilot Study
Full-scale Sampling Investigation	Tetra Tech	TBD – Immediately after Pilot Study Completion	TBD	ISM Samples	Throughout investigation
Full-scale Sample Analysis	Lab TBD	TBD	TBD	Data Packages	Preliminary results due 5 to 14 days after submittal to lab; full data package due 21 days after submittal

SAP WORKSHEET #16 — PROJECT SCHEDULE/TIMELINE TABLE (CONTINUED)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable	Deliverable Date
Meeting with EPA, Regional Water Board, and CDFW-OSPR to present Full-scale results and decisions for case-by-case DUs	Tetra Tech	TBD	TBD	Summary Analysis of Full-scale Investigation Results	TBD - 4 weeks after the completion of the Full-scale Investigation
Removal Action	TBD	TBD	TBD	NA	NA
Draft Removal Action Completion Report	TBD	TBD	TBD	NA	NA
Final Removal Action Completion Report	TBD	TBD	TBD	NA	NA

Note:

NA Not applicable.

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE

17.1 SAMPLING PROCESS DESIGN

This section describes the sampling design and rationale in terms of the media that will be sampled, the analytical groups, the sampling methods and locations, and the number of samples to be collected. The history and results of previous investigations of AOI 14, as well as cleanup goals established for the site, are described in the introduction.

Two types of IAGs are identified for design site characterization:

- Fill IAGs are 100 feet by 100 feet with depths to the bottom of fill/surface of underlying native soil (up to approximately 18 feet bgs) (see Figure 3). Each Fill IAG consists of up to 13 DUs, one 2-foot surface DU, up to four 4-foot subsurface DUs (depending on depth), and potentially eight 2-foot subsurface DUs. ISM sampling will be conducted to identify the areas and depth intervals containing soil with concentrations of COCs exceeding the cleanup goals.

- SP IAGs are defined as the area extending laterally from the FSFA where COC concentrations in discrete surface sediment samples collected within 5 feet from the toe of the FSFA exceeded cleanup goals (see Figure 3). SP IAGs are located on the surface of the SP with a horizontal area extending 20 feet from a previous sampling point in SPIAG01 and 30 feet from a previous sampling point in SPIAG02. Each SP IAG consists of two DUs, 0 to 0.5 foot bgs and 0.5 to 1 foot bgs. ISM sampling will be conducted to identify the SP DUs where surface sediment COC concentrations exceed cleanup goals. ISM samples will be analyzed for the project COCs, lead (by EPA 6010B or 6010C), total DDTs (by EPA 8081A or 8081B), and total PCBs as Aroclors (by EPA 8082 or 8082A). The following sections describe the process of collecting ISM soil samples for this investigation.

17.2 SAMPLE PROCEDURES

The following sections describe the procedures for sampling, including subsurface and surface soil sampling in Fill IAGs, and surface soil sampling in SP IAGs.

17.2.1 Subsurface and Surface Soil Sampling in Fill DUs

A Geoprobe DPT drill rig will be used to collect soil cores from 0 to approximately 18 feet bgs (until the bottom of fill is reached) at Fill IAGs. Soil sampling at each boring location will involve collection of continuous cores in disposable standard 4-foot acetate liners. If refusal is encountered before the target depth is achieved because of contact with a hard surface such as concrete or metal, the probe will be withdrawn, moved to an adjacent location (within 5 feet), and boring advancement will proceed there.

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE (CONTINUED)

A geologist (licensed or under a supervision of a Professional Geologist) will log each boring to indicate percent recovery for each push, as well as the depths of the bottom of debris fill and to the bottom of artificial fill, top of native soil, and visual discolorations or sheens. If oily debris is observed, the Geoprobe operation will be halted at that location, and the rig will be moved over 5 feet to avoid contamination of soil at deeper depth intervals.

At Fill IAGs that are located on the perimeter of the FSFA, soil borings will not be conducted vertically along the side slopes because the DPT rig cannot be positioned safely on a slope. Instead, the DPT rig will position itself along the top surface immediately adjacent to the slope and advance the probe using angle-hole methods at an angle of 30 degrees to characterize the material in the side slopes. Two additional increments from the surface of the side slope will be incorporated in the perimeter Fill IAGs. A hand auger or soil corer will be used to collect soil at one location near the center of the DU perimeter along the side slope at a depth of 4 feet below the surface of fill at that location. From each increment location collected using these additional methods, a volume of soil equivalent to the soil volumes from each of the other increments will be incorporated into the ISM samples at the appropriate depth horizons (based on the elevation of the sample location, which will be determined using differential leveling methods). The hand auger or soil corer will be decontaminated between IAGs according to the procedures described in Section 14.3.5. Figure 4 shows example increment locations at the perimeter IAGs where the angle-hole DPT borings and hand auger borings will be conducted.

All soil borings will be abandoned by placing a secure cover over the hole to prevent wildlife from entering the boring. The horizontal locations of all borings will be surveyed using GPS equipment. DPT equipment will be decontaminated between IAGs and DUs according to the procedures described in Section 14.3.5.

A core wedge (Figure 5) from each boring is one ISM sample increment; therefore, soil from all 30 borings within the Fill IAG will be composited appropriately to create each ISM sample per target DU. Borings will be located in a gridded pattern within each IAG. Triplicate (set of three field replicates) samples will be collected for the pilot study to accomplish the goals of the pilot study. Triplicate samples will be collected in an overlapping array by stepping out two times within a few feet from the original boring locations (see Figure 4). Triplicate samples collected in the pilot study Fill IAGs will be used to meet QC requirements in the full-scale study; therefore, one ISM sample will be collected from each DU in the remaining 21 Fill IAGs. A single wedge of soil (the increment) will be collected from the entire vertical column of the soil core within the DU depth interval using a spoon, knife, or similar implement that facilitates collection of equal volumes of soil from each boring to create the ISM samples (Figure 5).

Individual wedges from all the borings within the Fill IAG will then be combined to form the surface and subsurface DU ISM samples. The depth to the bottom of fill may vary for increments (borings) in the same IAG; for this scenario, the DU ISM sample will consist of those increments where fill exists. A minimum of 1 kilogram of soil will be submitted to enable the laboratory to

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE (CONTINUED)

process the sample (through weighing, drying, sieving, and then subsampling) following ITRC guidance (ITRC 2012), as described in Section 17.2.3.

ISM samples from each IAG will be packed into coolers, sealed, and shipped to the laboratory for analysis under chain-of-custody procedures. For the pilot study, the laboratory will be instructed to analyze all ISM samples (up to 13 DUs in each of three IAGs, in triplicate [13 DUs x 3 IAGs x 3 replicates = 117 samples]) for all COCs (lead, DDTs, and PCBs) for each IAG on a 5-day TAT. For the full-scale investigation, the laboratory will be instructed to analyze the surface 2-foot DU ISM samples and the subsurface 4-foot DU samples for all COCs (lead, DDTs, and PCBs) on a 5-day TAT and to archive the subsurface 2-foot DU ISM samples until further notice. The sample analysis decision logic presented in Step 5 of Worksheet #11b and Figure 7 will then be followed to determine which subsurface 2-foot DU samples to analyze based on comparison of 95UCL COC concentrations to the cleanup goals, and whether soil from each DU will remain in place or will be excavated during the removal action.

17.2.2 Surface Sediment Sampling at Stormwater Retention Pond DUs

Thirty ISM sample increments will be collected at SP IAGs using a hand auger. Within each SP IAG, a top and bottom interval ISM sample will be collected; the top interval ranges from 0 to 0.5 foot bgs, and the bottom interval ranges from 0.5 to 1 foot bgs.

Sediment from each boring will be placed on a piece of clean plastic next to the boring location. A single wedge of sediment will be collected separately from the entire length of each sampled depth interval (0 to 0.5 and 0.5 to 1 foot bgs) of each boring using a spoon, knife, or similar implement to create the ISM samples. Individual wedges from all the borings within the SP IAGs will then be combined to form the top and bottom interval ISM samples. SP ISM samples will be collected in a gridded pattern. ISM samples will be subsampled and sent to the laboratory using the procedures described in Section 17.2.1. The hand auger or soil corer will be decontaminated between IAGs and DUs according to the procedures described in Section 14.3.5. The boreholes will be filled with sediment from the surrounding area.

The ISM sample for the SP IAG top interval will be analyzed first. The sample analysis decision logic presented in Step 5 of Worksheet #11b will then be followed to determine whether the SP IAG bottom interval will be analyzed and whether sediment from each DU will remain in place or will be excavated during the removal action.

17.2.3 Laboratory Processing of ISM Samples

The laboratory will process the 1 kilogram ISM samples using the following processing methods, as suggested in the ITRC guidance (ITRC 2012). Processing includes determining weight, percent moisture, sample conditioning, selecting of particle size, and subsampling. Prior to sample conditioning, the weight and percent moisture of the sample will be recorded. Sample conditioning will be accomplished by either processing the sample as received or drying via air drying

SAP WORKSHEET #17 — SAMPLING DESIGN AND RATIONALE (CONTINUED)

(laboratory to provide criteria for determining when either conditioning process would be performed, and will depend on the percent moisture in the sample). Air-drying was selected as the drying method as the AOI 14 COCs are chemically stable when exposed to air and have sufficiently high boiling points such that they are unlikely to volatilize during extended air exposure at the selected drying temperature. Particle size selection will be accomplished by sieving using a # 10 (< 2 millimeter) sieve. This method was selected because it will sufficiently accomplish particle size reduction while maintaining the qualities of the soil to which human and ecological receptors would be exposed. Milling and grinding was not selected because it would reduce the particle size to a level that is not representative of the exposure scenario at AOI 14. Sieving is not expected to dilute contaminant concentrations as large pieces of lead are not expected to be present. Thirty subsampling increments will be collected using multiple methods including subsampling using the 2-D slabcake method, a sectoral splitter, a riffle splitter, or a rotary splitter.

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Pilot Study Investigation [b]									
FIAG06	FDU06A-R1	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG06	FDU06A-R2	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG06	FDU06A-R3	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG06	FDU06B-R1	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG06	FDU06B-R2	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG06	FDU06B-R3	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG06	FDU06C-R1	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG06	FDU06C-R2	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG06	FDU06C-R3	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG06	FDU06D-R1	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG06	FDU06D-R2	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG06	FDU06D-R3	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG06	FDU06E-R1	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG06	FDU06E-R2	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG06	FDU06E-R3	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG06	FDU06F-R1	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG06	FDU06F-R2	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG06	FDU06F-R3	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG06	FDU06G-R1	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG06	FDU06G-R2	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG06	FDU06G-R3	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG06	FDU06H-R1	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG06	FDU06H-R2	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG06	FDU06H-R3	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG06	FDU06I-R1	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Pilot Study Investigation [b] (Continued)									
FIAG06	FDU06I-R2	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG06	FDU06I-R3	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG06	FDU06J-R1	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG06	FDU06J-R2	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG06	FDU06J-R3	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG06	FDU06K-R1	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG06	FDU06K-R2	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG06	FDU06K-R3	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG06	FDU06L-R1	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG06	FDU06L-R2	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG06	FDU06L-R3	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG06	FDU06M-R1	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG06	FDU06M-R2	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG06	FDU06M-R3	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG09	FDU09A-R1	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG09	FDU09A-R2	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG09	FDU09A-R3	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG09	FDU09B-R1	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG09	FDU09B-R2	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG09	FDU09B-R3	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG09	FDU09C-R1	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG09	FDU09C-R2	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG09	FDU09C-R3	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG09	FDU09D-R1	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG09	FDU09D-R2	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Pilot Study Investigation [b] (Continued)									
FIAG09	FDU09D-R3	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG09	FDU09E-R1	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG09	FDU09E-R2	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG09	FDU09E-R3	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG09	FDU09F-R1	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG09	FDU09F-R2	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG09	FDU09F-R3	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG09	FDU09G-R1	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG09	FDU09G-R2	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG09	FDU09G-R3	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG09	FDU09H-R1	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG09	FDU09H-R2	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG09	FDU09H-R3	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG09	FDU09I-R1	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG09	FDU09I-R2	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG09	FDU09I-R3	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG09	FDU09J-R1	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG09	FDU09J-R2	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG09	FDU09J-R3	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG09	FDU09K-R1	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG09	FDU09K-R2	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG09	FDU09K-R3	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG09	FDU09L-R1	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG09	FDU09L-R2	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG09	FDU09L-R3	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Pilot Study Investigation [b] (Continued)									
FIAG09	FDU09M-R1	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG09	FDU09M-R2	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG09	FDU09M-R3	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG20	FDU20A-R1	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG20	FDU20A-R2	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG20	FDU20A-R3	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG20	FDU20B-R1	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG20	FDU20B-R2	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG20	FDU20B-R3	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG20	FDU20C-R1	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG20	FDU20C-R2	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG20	FDU20C-R3	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG20	FDU20D-R1	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG20	FDU20D-R2	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG20	FDU20D-R3	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG20	FDU20E-R1	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG20	FDU20E-R2	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG20	FDU20E-R3	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG20	FDU20F-R1	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG20	FDU20F-R2	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG20	FDU20F-R3	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG20	FDU20G-R1	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG20	FDU20G-R2	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG20	FDU20G-R3	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG20	FDU20H-R1	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Pilot Study Investigation [b] (Continued)									
FIAG20	FDU20H-R2	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG20	FDU20H-R3	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG20	FDU20I-R1	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG20	FDU20I-R2	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG20	FDU20I-R3	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG20	FDU20J-R1	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG20	FDU20J-R2	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG20	FDU20J-R3	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG20	FDU20K-R1	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG20	FDU20K-R2	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG20	FDU20K-R3	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG20	FDU20L-R1	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG20	FDU20L-R2	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG20	FDU20L-R3	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG20	FDU20M-R1	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG20	FDU20M-R2	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG20	FDU20M-R3	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
Full-Scale Investigation									
Fill DUs [c]									
FIAG01	FDU01A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG01	FDU01B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG01	FDU01C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG01	FDU01D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG01	FDU01E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG01	FDU01F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG01	FDU01G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG01	FDU01H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG01	FDU01I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG01	FDU01J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG01	FDU01K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG01	FDU01L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG01	FDU01M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG02	FDU02A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG02	FDU02B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG02	FDU02C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG02	FDU02D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG02	FDU02E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG02	FDU02F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG02	FDU02G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG02	FDU02H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG02	FDU02I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG02	FDU02J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG02	FDU02K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG02	FDU02L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG02	FDU02M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG03	FDU03A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG03	FDU03B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG03	FDU03C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG03	FDU03D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG03	FDU03E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG03	FDU03F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG03	FDU03G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG03	FDU03H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG03	FDU03I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG03	FDU03J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG03	FDU03K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG03	FDU03L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG03	FDU03M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG04	FDU04A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG04	FDU04B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG04	FDU04C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG04	FDU04D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG04	FDU04E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG04	FDU04F	Soil	Subsurface (4-foot)	2-4	X	X	X	1	Worksheet #17
FIAG04	FDU04G	Soil	Subsurface (4-foot)	4-6	X	X	X	1	Worksheet #17
FIAG04	FDU04H	Soil	Subsurface (4-foot)	6-8	X	X	X	1	Worksheet #17
FIAG04	FDU04I	Soil	Subsurface (4-foot)	8-10	X	X	X	1	Worksheet #17
FIAG04	FDU04J	Soil	Subsurface (4-foot)	10-12	X	X	X	1	Worksheet #17
FIAG04	FDU04K	Soil	Subsurface (4-foot)	12-14	X	X	X	1	Worksheet #17
FIAG04	FDU04L	Soil	Subsurface (4-foot)	14-16	X	X	X	1	Worksheet #17
FIAG04	FDU04M	Soil	Subsurface (4-foot)	16-18	X	X	X	1	Worksheet #17
FIAG05	FDU05A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG05	FDU05B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG05	FDU05C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG05	FDU05D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG05	FDU05E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG05	FDU05F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG05	FDU05G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG05	FDU05H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG05	FDU05I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG05	FDU05J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG05	FDU05K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG05	FDU05L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG05	FDU05M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG07	FDU07A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG07	FDU07B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG07	FDU07C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG07	FDU07D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG07	FDU07E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG07	FDU07F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG07	FDU07G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG07	FDU07H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG07	FDU07I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG07	FDU07J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG07	FDU07K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG07	FDU07L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG07	FDU07M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG08	FDU08A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG08	FDU08B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG08	FDU08C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG08	FDU08D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG08	FDU08E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG08	FDU08F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG08	FDU08G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG08	FDU08H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG08	FDU08I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG08	FDU08J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG08	FDU08K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG08	FDU08L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG08	FDU08M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG10	FDU10A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG10	FDU10B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG10	FDU10C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG10	FDU10D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG10	FDU10E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG10	FDU10F	Soil	Subsurface (4-foot)	2-4	X	X	X	1	Worksheet #17
FIAG10	FDU10G	Soil	Subsurface (4-foot)	4-6	X	X	X	1	Worksheet #17
FIAG10	FDU10H	Soil	Subsurface (4-foot)	6-8	X	X	X	1	Worksheet #17
FIAG10	FDU10I	Soil	Subsurface (4-foot)	8-10	X	X	X	1	Worksheet #17
FIAG10	FDU10J	Soil	Subsurface (4-foot)	10-12	X	X	X	1	Worksheet #17
FIAG10	FDU10K	Soil	Subsurface (4-foot)	12-14	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG10	FDU10L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG10	FDU10M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG11	FDU11A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG11	FDU11B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG11	FDU11C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG11	FDU11D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG11	FDU11E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG11	FDU11F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG11	FDU11G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG11	FDU11H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG11	FDU11I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG11	FDU11J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG11	FDU11K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG11	FDU11L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG11	FDU11M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG12	FDU12A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG12	FDU12B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG12	FDU12C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG12	FDU12D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG12	FDU12E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG12	FDU12F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG12	FDU12G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG12	FDU12H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG12	FDU12I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG12	FDU12J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG12	FDU12K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG12	FDU12L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG12	FDU12M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG13	FDU13A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG13	FDU13B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG13	FDU13C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG13	FDU13D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG13	FDU13E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG13	FDU13F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG13	FDU13G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG13	FDU13H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG13	FDU13I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG13	FDU13J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG13	FDU13K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG13	FDU13L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG13	FDU13M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG14	FDU14A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG14	FDU14B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG14	FDU14C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG14	FDU14D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG14	FDU14E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG14	FDU14F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG14	FDU14G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG14	FDU14H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG14	FDU14I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG14	FDU14J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG14	FDU14K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG14	FDU14L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG14	FDU14M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG15	FDU15A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG15	FDU15B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG15	FDU15C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG15	FDU15D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG15	FDU15E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG15	FDU15F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG15	FDU15G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG15	FDU15H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG15	FDU15I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG15	FDU15J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG15	FDU15K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG15	FDU15L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG15	FDU15M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG16	FDU16A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG16	FDU16B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG16	FDU16C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG16	FDU16D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG16	FDU16E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG16	FDU16F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG16	FDU16G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG16	FDU16H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG16	FDU16I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG16	FDU16J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG16	FDU16K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG16	FDU16L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG16	FDU16M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG17	FDU17A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG17	FDU17B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG17	FDU17C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG17	FDU17D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG17	FDU17E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG17	FDU17F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG17	FDU17G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG17	FDU17H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG17	FDU17I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG17	FDU17J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG17	FDU17K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG17	FDU17L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG17	FDU17M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG18	FDU18A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG18	FDU18B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG18	FDU18C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG18	FDU18D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG18	FDU18E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG18	FDU18F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG18	FDU18G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG18	FDU18H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG18	FDU18I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG18	FDU18J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG18	FDU18K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG18	FDU18L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG18	FDU18M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG19	FDU19A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG19	FDU19B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG19	FDU19C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG19	FDU19D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG19	FDU19E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG19	FDU19F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG19	FDU19G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG19	FDU19H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG19	FDU19I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG19	FDU19J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG19	FDU19K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG19	FDU19L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG19	FDU19M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG21	FDU21A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG21	FDU21B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG21	FDU21C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG21	FDU21D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG21	FDU21E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG21	FDU21F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG21	FDU21G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG21	FDU21H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG21	FDU21I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG21	FDU21J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG21	FDU21K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG21	FDU21L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG21	FDU21M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG22	FDU22A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG22	FDU22B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG22	FDU22C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG22	FDU22D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG22	FDU22E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG22	FDU22F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG22	FDU22G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG22	FDU22H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG22	FDU22I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG22	FDU22J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG22	FDU22K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG22	FDU22L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG22	FDU22M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG23	FDU23A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG23	FDU23B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG23	FDU23C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG23	FDU23D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG23	FDU23E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG23	FDU23F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG23	FDU23G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG23	FDU23H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG23	FDU23I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG23	FDU23J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17
FIAG23	FDU23K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG23	FDU23L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG23	FDU23M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
FIAG24	FDU24A	Soil	Surface (2-foot)	0-2	X	X	X	1	Worksheet #17
FIAG24	FDU24B	Soil	Subsurface (4-foot)	2-6	X	X	X	1	Worksheet #17
FIAG24	FDU24C	Soil	Subsurface (4-foot)	6-10	X	X	X	1	Worksheet #17
FIAG24	FDU24D	Soil	Subsurface (4-foot)	10-14	X	X	X	1	Worksheet #17
FIAG24	FDU24E	Soil	Subsurface (4-foot)	14-18	X	X	X	1	Worksheet #17
FIAG24	FDU24F	Soil	Subsurface (2-foot)	2-4	X	X	X	1	Worksheet #17
FIAG24	FDU24G	Soil	Subsurface (2-foot)	4-6	X	X	X	1	Worksheet #17
FIAG24	FDU24H	Soil	Subsurface (2-foot)	6-8	X	X	X	1	Worksheet #17
FIAG24	FDU24I	Soil	Subsurface (2-foot)	8-10	X	X	X	1	Worksheet #17
FIAG24	FDU24J	Soil	Subsurface (2-foot)	10-12	X	X	X	1	Worksheet #17

SAP WORKSHEET #18 — SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE (CONTINUED)

Point ID	Sample ID	Matrix	ISM Sample Type	Depth (feet bgs)[a]	Lead (EPA 6010B/ 6010C)	DDTs (EPA 8081A/ 8082B)	PCBs as Aroclors (8082/ 8082A)	Number of Samples	Sampling SOP Reference
Full-Scale Investigation (Continued)									
Fill DUs [c] (Continued)									
FIAG24	FDU24K	Soil	Subsurface (2-foot)	12-14	X	X	X	1	Worksheet #17
FIAG24	FDU24L	Soil	Subsurface (2-foot)	14-16	X	X	X	1	Worksheet #17
FIAG24	FDU24M	Soil	Subsurface (2-foot)	16-18	X	X	X	1	Worksheet #17
SP DUs [d]									
SPIAG01	SPDU01A	Sediment	Top	0-0.5	X	X	X	1	Worksheet #17
SPIAG01	SPDU01B	Sediment	Bottom	0.5-1.0	X	X	X	1	Worksheet #17
SPIAG02	SPDU02A	Sediment	Top	0-0.5	X	X	X	1	Worksheet #17
SPIAG02	SPDU02B	Sediment	Bottom	0.5-1.0	X	X	X	1	Worksheet #17

Notes:

a. The bottom depths of subsurface ISM soil samples in Fill IAGs will be determined based on the bottom depth of fill. If the total depth of fill is only 10 feet, the bottom 4-foot subsurface DU would be 6 to 10 feet bgs If the total depth of fill is greater than 18 feet, additional 2-foot and 4-foot DUs will be established below 18 feet bgs to the depth of the bottom of fill, as applicable.

b. Triplicate (set of three field replicate samples) ISM soil samples will be collected during the pilot study investigation (see Worksheet #11a). An "-R1", "-R2", or "-R3" is appended to the sample ID to indicate the replicate number. All samples from the pilot study will be analyzed.

c. During the full-scale investigation, 2-foot subsurface Fill DU ISM samples will be analyzed only in the case that a 95UCL COC concentration for the encompassing 4-foot DU ISM sample exceeds cleanup goals.

d. The bottom depth interval (0.5 to 1 foot bgs) of SP IAG samples will be analyzed only in the case that a 95UCL COC concentration from the top depth interval (0 to 0.5 foot bgs) exceeds cleanup goals.

95UCL	95th percentile upper confidence limit on the mean	DU	Decision unit	ISM	Incremental sampling methodology
bgs	Below ground surface	EPA	U.S. Environmental Protection Agency	PCB	Polychlorinated biphenyl
COC	Contaminant of concern	IAG	Investigation area grid	SOP	Standard Operating Procedure
DDT	Dichlorodiphenyltrichloroethane	ID	Identification	SP	Stormwater retention pond

SAP WORKSHEET #19 — ANALYTICAL SOP REQUIREMENTS TABLE

Matrix	Analytical Group	Analytical Method / SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (preparation / analysis)
Soil/Sediment	Metals	BC Laboratories: EPA 6010B/SW-846/BCMET013 SGS Laboratories: EPA 6010C/ SW-846/MET 100	Gallon-sized plastic zip-type bag	1 kilogram	Cool, 4+/- 2˚ C	180 days
Soil/Sediment	Organochlorine pesticides	BC Laboratories: EPA 8081A/ SW-846/BCORG014 SGS Laboratories: EPA 8081B/ SW-846/ GC 015				14 days/40 days
Soil/Sediment	PCBs	BC Laboratories: EPA 8082/ SW-846/ BCORG019 SGS Laboratories: EPA 8082A/ SW-846/GC 014				None

Note:

ISM soil and sediment samples will be processed by the laboratory according to the methods described in Section 17.2.3. Laboratory preparation methods for soil and sediment ISM samples are provided in Attachment 1, and listed in Worksheet #23.

SAP WORKSHEET #20 — FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Matrix	Analytical Group (Method)	No. of Sampling Locations[a]	No. of Samples Per Location[b]	No. of Field Replicates[c,d]	No. of MS/MSDs[e]	No. of Equip. Rinsates[f]	No. of Source Blanks[f]	No. of Trip Blanks[g]	Total No. of Samples to Laboratory
Pilot Study									
Soil	Metals (Lead only) (EPA 6010B/6010C)	3	13	78	6	0	0	None	117
Soil	Organochlorine pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT only) (EPA 8081A/8081B)	3	13	78	6	0	0	None	117
Soil	PCBs (EPA 8082/8082A)	3	13	78	6	0	0	None	117
Full-Scale Investigation									
Soil/Sediment	Metals (Lead only) (EPA 6010B/6010C)	21	Fill DUs: Between 5 and 13[h] SP DUs: 1 or 2[i]	0	2	4	1	None	TBD
Soil/Sediment	Organochlorine pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT only) (EPA 8081A/8081B)	21	Fill DUs: Between 5 and 13[h] SP DUs: 1 or 2[i]	0	2	4	1	None	TBD

SAP WORKSHEET #20 — FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE (CONTINUED)

Matrix	Analytical Group (Method)	No. of Sampling Locations[a]	No. of Samples Per Location[b]	No. of Field Replicates[c,d]	No. of MS/MSDs[e]	No. of Equip. Rinsates[f]	No. of Source Blanks[f]	No. of Trip Blanks[g]	Total No. of Samples to Laboratory
Soil/Sediment	PCBs (EPA 8082/8082A)	21	Fill DUs: Between 5 and 13[h] SP DUs: 1 or 2[i]	0	2	4	1	None	TBD

Notes:

a In total, there are 24 Fill IAGs and two SP IAGs.

B Actual number of ISM samples will vary by IAG depending on depth of fill and whether the 2-foot subsurface DU ISM samples need to be analyzed (based on results of the 4-foot DU ISM sample results).

C Soil duplicates will not be collected for this project because they cannot be used directly to assess sampling precision because adjacent soil samples incorporate some spatial variability. Furthermore, it is not practical to set QC limits for the relative percent difference of these samples, which precludes their use for QC.

d Triplicate (set of three field replicates) samples will be collected during the pilot study at three Fill IAGs to determine the appropriate confidence interval to apply to the full-scale sampling effort through evaluation of RSDs of triplicate results.

e The laboratory is required to analyze an MS/MSD on one of every 20 samples. Therefore, MS/MSD needs to be marked on the chain of custody for one of 20 samples. The MS/MSDs are not included in the total number of samples to the laboratory.

f Equipment rinsates and source blanks are not anticipated during sampling within most Fill IAGs because dedicated disposable equipment will be used to sample soil. These QC samples will be required when reusable sampling equipment such as a hand auger is used. A hand auger will be used to collect sediment in SP IAGs and to collect soil within the side slopes of Fill IAGs located on the perimeter of the FSFA. This sampling is estimated to take place within a 4-day period, therefore four equipment rinsates and one source water blank is estimated.

g No trip blanks are required because none of the COCs are volatile.

h During the full-scale investigation, 2-foot subsurface Fill DU ISM samples will be analyzed only in the case that a 95UCL COC concentration for the encompassing 4-foot DU ISM sample exceeds cleanup goals.

i The bottom depth interval (0.5 to 1 foot bgs) of SP IAG samples will be analyzed only in the case that a 95UCL COC concentration from the top depth interval (0 to 0.5 foot bgs) exceeds cleanup goals.

SAP WORKSHEET #21 — PROJECT SAMPLING SOP REFERENCES TABLE

Reference Number	Title, Revision Date, and Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comment
SOP 002-3	General Equipment Decontamination	Tetra Tech	DPT rig, hand auger, soil corer; see Worksheet #17	No	See Attachment 1
SOP 005-2	Soil Sampling	Tetra Tech	DPT rig, hand auger, soil corer; see Worksheet #17	No	See Attachment 1
SOP 019-7	Packaging and Shipping	Tetra Tech	See Worksheet #27	No	See Attachment 1
SOP 024-2	Recording of Notes in Field Logbook	Tetra Tech	See Worksheet #27	No	See Attachment 1
SOP 023	Lab Data Verification	Tetra Tech	See Worksheets #34 and 35	No	See Attachment 1

SAP WORKSHEET #22 — FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference	Comments
GPS	Marking boring locations; identifying high anomaly areas based on geophysical investigation results	Beginning of project, if instrument verification strip failure occurs. Beginning and toward end of day.	Real Time Accuracy: sub-foot for Real-time Kinematic GPS and sub-meter for differential GPS precision dilution of position less than 3, number of satellites at least four	Wait for better signal, replace unit, or choose alternate location technique	FTL	Manufacturer's SOP	

SAP WORKSHEET #23 — ANALYTICAL SOP REFERENCES TABLE

Reference Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
BCMET013/ MET 100	EPA 6010B, Revision 19, 04/10/2017/ EPA 6010C, Revision 15, 6/2016	Definitive	Soil/Sediment – Metals	ICP-Atomic Emission Spectroscopy	BC Laboratories/ SGS Laboratories	N
BCORG14/ GC 015	EPA 8081A, Revision 15, 01/23/2017/ EPA 8081B, Revision 14, 8/2017	Definitive	Soil/Sediment – Organochlorine pesticides	GC/ECD	BC Laboratories/ SGS Laboratories	N
BCORG19/ GC 014	EPA 8082, Revision 14, 01/23/2017/ EPA 8082A, Revision 14, 8/2017	Definitive	Soil/Sediment – PCBs	GC/ECD	BC Laboratories/ SGS Laboratories	N
BCPREP014/ MET 104	Splitting and Refrigerating Samples, Revision 0, 10/17/2016 / Appendix A, Digestion of Soils for ICP Analysis, Revision 12, 6,/2016	NA	NA – Incremental Sampling Methodology	NA	BC Laboratories/ SGS Laboratories	Y

Notes:

GC/ECD Gas chromatography/electron capture detector
N No
NA Not applicable
ICP Inductively coupled plasma
Y Yes – Incremental sampling methodology preparation procedure modified to conform to the methods described in Section 17.2.3 of the SAP

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC	ICAL	Initially; as needed	(1) RSD for all analytes ≤ 20% (2) Linear – least squares regression r > 0.995 (3) Non-linear – r^2 > 0.99 (6 points shall be used for second order, 7 points shall be used for third order)	Locate the source of the problem. If expected RSD is not met, check for standard degradation or perform instrument adjustment or maintenance to correct the problem, then repeat initial calibration	Lab Manager, Analyst	BCORG014/ GC 015 BCORG019 GC 014
GC	ICV	Every after ICAL	All analytes within ±20%	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment or maintenance to correct the problem and repeat ICAL.	Lab Manager, Analyst	BCORG014 GC 015 BCORG019 GC 014
GC	DCC	Every 12 hours	All analytes within ±15% or mean %D + 15% of expected value	Prepare fresh standard and re-analyze continuing calibration verification to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment or maintenance to correct the problem and repeat ICAL.	Lab Manager, Analyst	BCORG014 BCORG019

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC	DCC	Before and end of sample analysis and after every 10 field samples	All analytes within ±20%	Prepare fresh standard and re-analyze continuing calibration verification to rule out standard degradation or inaccurate injection. If problem persist perform instrument adjustment or maintenance to correct the problem and repeat ICAL.	Lab Manager, Analyst	GC 015 GC 014
Gravimetric	Analytical balance calibration check	Daily, prior to sample analysis	Within ±0.1% of certified weight	Check that the balance is free from foreign objects. Check that the level indicator is centered, then repeat calibration. Otherwise, use another analytical balance with acceptable calibration.	Lab Manager, Analyst	BCMET013
ICP	ICAL	Daily ICAL prior to sample analysis.	If multiple calibration standards are used, $r^2 \geq 0.99$.	Recalibrate and/or perform necessary equipment maintenance; check calibration standards; reanalyze affected data	Lab Manager, Analyst	MET100
ICP	ICV	Following ICAL, prior to samples analysis	All reported analytes within ± 10% of true value.	Investigate reasons for failure, reanalyze once; if still unacceptable, repeat ICAL	Lab Manager, Analyst	MET100

SAP WORKSHEET #24 — ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP	DCC	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV..	Lab Manager, Analyst	MET100
ICP	Low-level Calibration Check Standard (Low-level ICV)	Daily after ICAL and before samples.	All reported analytes within ± 20% of true value.	Correct problem and repeat ICAL.	Lab Manager, Analyst	MET100

Notes:

%D Percent difference
DCC Daily continuing calibration
GC Gas chromatography
ICAL Initial calibration
ICV Initial calibration verification

SAP WORKSHEET #25 — ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC ICP	Parameter Setup	Physical check	Physical check	Initially; prior to DCC	Autosampler must move to the expected position when activated. Refer to instrument optimize temperature program setup.	If any parameters do not match the SOP, reset them to proper	Lab Manager, Analyst	BCORG014 BCMET013 BCORG019
GC	Endrin and DDT Breakdown Check	Instrument Performance	Conformance to breakdown limits	Every 12 hrs	Degradation ≤15% of each analyte.	Clean or replace the injection liner and repeat breakdown check	Lab Manager, Analyst	BCORG014 BCORG019
ICP	interference check sample (ICS)/Interference check sample analysis	Instrument Performance	Conformance to interference check	Prior to sample analysis	Within + 20% of expected value	Terminate analysis, reanalyze ICS to rule out standard degradation or inaccurate injection. If problem persist, perform instrument maintenance, repeat calibrations and reanalyze all associated samples.	Lab Manager, Analyst	BCMET013
GC/ECD	Injector port, column maintenance, detector cleaning	SW-846 8082A, 8081B	Leak test, column and injector port inspection	Need for maintenance determined by passing calibration and DDT mix in control	Passing calibration	Column clipping and/or reconditioning, seal and liners replacement	Lab Manager, Analyst	GC 015 GC 014

SAP WORKSHEET #25 — ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE (CONTINUED)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	Change capillary and pump tubing, Check liquid argon tank, Replace and realign plasma torch, Clean nebulizer and spray chamber	SW-846 6010C	Check connections, replace worn equipment	Frequency determined by instrument remaining in calibration and free of interference	Passing calibration	Inspect system, correct problem, rerun calibration and affected samples	Lab Manager, Analyst	MET 100

Notes:

ECD Electron capture detector
GC Gas chromatography
ICP Inductively coupled plasma

SAP WORKSHEET #26 — SAMPLE HANDLING SYSTEM

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/Tetra Tech
Sample Packaging (Personnel/Organization): Field Team/Tetra Tech
Coordination of Shipment (Personnel/Organization): Field Team/Tetra Tech
Type of Shipment/Carrier: Federal Express Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Laboratory sample custodian/BC Laboratories
Sample Custody and Storage (Personnel/Organization): Laboratory sample custodian/BC Laboratories
Sample Preparation (Personnel/Organization): Analyst/BC Laboratories
Sample Determinative Analysis (Personnel/Organization): Analytical Chemist/BC Laboratories
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 30 days after delivery of the data package
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 30 days after delivery of the data package
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Laboratory sample custodian/BC Laboratories
Number of Days from Analysis: 30 days after delivery of the data package

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE

27.1 SAMPLE HANDLING AND CUSTODY

The following sections describe sample handling procedures, including sample ID and labeling, documentation, chain of custody, and shipping.

27.1.1 Sample Identification

Field personnel will assign point IDs to each ISM sample, and these point IDs will be associated with the sample data in the Tetra Tech database. Point IDs will be equivalent to the IAG name (Figure 3). Sample IDs will also be assigned that will identify the depth interval of each ISM sample (see Worksheet #18). The point IDs and samples IDs will be recorded on the chain-of-custody forms as well as in the field notes.

The sample IDs for Fill DUs will be arranged in the following manner:

Sample ID: [FDU01][A through M] through [FDU24][A through M]

where:

FDU	=	Fill IAG Decision Unit, the number following "FDU" corresponds to the IAG number
A through M	=	Letter corresponding to depth interval, where:
A	=	0 to 2 feet bgs (Surface 2-foot DU)
B	=	2 to 6 feet bgs (Subsurface 4-foot DU)
C	=	6 to 10 feet bgs (Subsurface 4-foot DU)
D	=	10 to 14 feet bgs (Subsurface 4-foot DU)
E	=	14 to 8 feet bgs (Subsurface 4-foot DU)
F	=	2 to 4 feet bgs (Subsurface 2-foot DU)
G	=	4 to 6 feet bgs (Subsurface 2-foot DU)
H	=	6 to 8 feet bgs (Subsurface 2-foot DU)
I	=	8 to 10 feet bgs (Subsurface 2-foot DU)
J	=	10 to 12 feet bgs (Subsurface 2-foot DU)
K	=	12 to 14 feet bgs (Subsurface 2-foot DU)
L	=	14 to 16 feet bgs (Subsurface 2-foot DU)
M	=	16 to 18 feet bgs (Subsurface 2-foot DU)

As an example, the sample ID for the ISM sample in FIAG04 corresponding to a depth of 10 to 14 feet bgs will be FDU04D. If additional depth intervals are identified for analysis, the deviation from this sampling ID protocol will be clearly marked on the chain-of-custody form and in the field notes.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

Triplicate samples (set of three field replicates) will be collected within each depth interval for the pilot study. The initial portion of the sample ID for these samples will stay the same, but "-R1", "-R2" and "-R3" will be appended to the sample ID to distinguish them. For example, the sample IDs for the pilot study Fill IAG replicate ISM samples from FIAG06 corresponding to a depth of 10 to 12 feet bgs will be FDU06J-R1, FDU06J-R2, and FDU06J-R3 (see Worksheet #18).

The sample IDs for SP DUs will be arranged in the following manner:

Sample ID: [SPDU01][A or B] through [SPDU02][A or B]

where:

SPDU	=	Stormwater Retention Pond IAG Decision Unit, the number following "SPDU" corresponds to the IAG number
A and B	=	Letter corresponding to depth interval, where:
A	=	0-0.5 foot bgs (Top interval)
B	=	0.5-1 foot bgs (Bottom interval)

As an example, the sample ID for the bottom interval ISM sample in SPIAG02 corresponding to a depth of 0.5-1 foot bgs will be SPDU02B.

In addition to the sample IDs, data (location, boring log) about each sampling increment in Fill IAGs will also be collected, as described in Worksheet #17. The increment location IDs will be arranged in the following manner:

Increment Location ID: [FIAG01]SB01 through [FIAG24]SB30

where:

FIAG	=	Fill IAG
SB	=	Soil Boring

As an example, the point ID of FIAG01SB01 will be assigned to the location of the first soil boring increment in IAG01. Soil associated with this increment location will not be sent to the laboratory as separate samples; an equal volume of soil from each sampling increment in the IAG will be composited as an ISM sample (as described in Worksheet #17).

27.1.2 Sample Labels

A sample label will be affixed to all sample containers. The label will be completed with the following information written in indelible ink:

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

- Project name and location
- Sample ID number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Analysis required

After it is labeled, each sample will be refrigerated or placed in a cooler that contains ice to maintain the sample temperature at 4 ± 2 °C.

27.1.3 Sample Documentation

Documentation during sampling is essential to ensure proper sample identification. Tetra Tech personnel will adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

27.1.4 Chain of Custody

Tetra Tech will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time they are collected in the field to the time they are accepted at the laboratory. The chain-of-custody record (see Attachment 2) also will be used to document all samples collected and the analysis requested. Information that the field personnel will record on the chain-of-custody record includes the following:

- Project name and number
- Sampling location
- Name and signature of sampler(s)
- Destination of samples (laboratory name)
- Sample ID number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used (if applicable)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- FedEx Airbill number (if applicable)
- Project contact and phone number

Unused lines on the chain-of-custody record will be crossed out. Field personnel will sign chain-of-custody records that are initiated in the field, and the airbill number will be recorded. The record will be inserted in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills will serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the chain-of-custody record and the airbill will be retained and filed by field personnel before the containers are shipped.

Laboratory chain of custody begins when samples are received and continues until samples are discarded. Laboratories analyzing samples for this contract must follow custody procedures at least as stringent as are required by the EPA Contract Laboratory Program (CLP) Statements of Work

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

(SOW) (EPA 2014, 2015a). The laboratory will designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information on the samples, including the persons who delivered the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample ID numbers, and any unique laboratory ID numbers for the samples. This information will be entered into a computerized laboratory information management system. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples that require special handling — including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics — will be properly stored and maintained prior to analysis.

27.1.5 Sample Shipment

The following procedures will be implemented when samples collected during this project are shipped:

- The cooler will be filled with ice, bubble wrap, sample baggies, sample containers, and packing material. Sufficient packing material will be used to prevent sample containers from breaking during shipment. Enough ice will be added to maintain the sample temperature of below 4 ± 2 °C.

- The chain-of-custody records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The airbill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.

- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, it will be taped shut both inside and outside of the cooler.

- Signed and dated custody seals will be affixed on the front and side of each cooler. Wide clear tape will be placed over the seals to prevent accidental breakage.

- The chain-of-custody record will be transported within the taped sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the chain-of-custody record to document transfer of samples.

SAP WORKSHEET #27 — SAMPLE CUSTODY REQUIREMENTS TABLE (CONTINUED)

Multiple coolers may be sent in one shipment to the laboratory. The outsides of the coolers will be marked to indicate the number of coolers in the shipment.

EXAMPLE SAMPLE LABEL

Company: Tetra Tech	**Project Name and Location:** NASA AOI 14
Sampler: DA	**Sample ID:** FDU01A
Date: 10/15/17	**Time:** 1330
Analysis: See chain-of-custody form	**Preservative:** None

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE

Matrix	Soil/Sediment
Laboratory	BC Laboratory
Analytical Group	Organochlorine pesticides
Analytical Method / SOP Reference	EPA Method 8081A / BCORG014

QC Sample	Frequency or Number	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	One per extraction batch	Correct problem. If required, reprepare and reanalyze MB and all samples processed with the contaminated blank	Laboratory analyst	Accuracy/bias - contamination	See Department of Defense (DoD) Quality Systems Manual (QSM)
Surrogate spike	All samples	Reanalyze sample. If surrogate meets criteria, report reanalysis results. If surrogate does not meet criteria, note in narrative report	Laboratory analyst	Accuracy	See DoD QSM
Laboratory control sample (LCS)	One per analytical batch	Correct problem, then reprepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available	Laboratory analyst	Accuracy	See DoD QSM
MS/MSD	One per extraction batch	Correct problem, then reprepare and reanalyze the MS/MSD and all samples, if sufficient sample material is available	Laboratory analyst	Accuracy/bias and precision	See DoD QSM

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Matrix	Soil/Sediment
Laboratory	SGS Laboratory
Analytical Group	Pesticides/PCBs
Analytical Method / SOP Reference	SW-846 8081B/8082A/ GC 014, GC 015

QC Sample	Frequency or Number	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	One per extraction batch	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	Lab Manager, Analyst	Accuracy/bias - contamination	All analytes must be ≤ ½ LOQ and ≤ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)
Surrogate spike	Each sample, standard and QC, per method.	If surrogates recoveries are high and sample is <LOQ, report with qualification. If surrogates recoveries are low, affected samples are re-extracted and reanalyzed.	Lab Manager, Analyst	Accuracy/bias	%Rs must be within the DoD QSM 5.0 Appendix C; if not listed in the tables, in-house statistical limits are used
Laboratory control sample (LCS)	One per analytical batch	Correct problem, then reprepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available	Lab Manager, Analyst	Accuracy/bias	%Rs must be within the DoD QSM 5.0 Appendix C; if not listed in the tables, in-house statistical limits are used
MS/MSD	One per extraction batch	Evaluate the samples and associated QC and, if the LCS results are acceptable, narrate.	Lab Manager, Analyst	Accuracy/bias and precision	%Rs must be within the DoD QSM 5.0 Appendix C; if not listed in the tables, in-house statistical limits are used RPD ≤ 30%

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Matrix	Soil/Sediment
Laboratory	BC Laboratories
Analytical Group	Metals
Analytical Method / SOP Reference	EPA 6010B / BCMET013

QC Sample	Frequency/Number	Corrective Action	Person(s) Responsible for Corrective Active	DQI	Measurement Performance Criteria
Method blank	One per preparatory batch	Correct problem. If required, reprepare and reanalyze MB and all samples processed with the contaminated blank	Lab Manager, Analyst	Accuracy/bias-contamination	See DoD QSM
LCS	One per analytical batch	Correct problem then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available	Lab Manager, Analyst	Precision and accuracy/bias	See DoD QSM
MS/MSD	One per extraction batch	Correct problem then reprepare and re-analyze the MS/MSD and all samples, if sufficient sample material is available	Lab Manager, Analyst	Precision and accuracy/bias	See DoD QSM

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Matrix	Soil/Sediment
Laboratory	SGS Laboratories
Analytical Group	Metals
Analytical Method / SOP Reference	EPA 6010C / MET100

QC Sample	Frequency/Number	Corrective Action	Person(s) Responsible for Corrective Active	DQI	Measurement Performance Criteria
Method blank	One per preparatory batch	Apply B-qualifier to all affected analytes. Redigest and reanalyze if necessary.	Lab Manager, Analyst	Accuracy/bias-contamination	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
LCS	One per analytical batch	Correct problem, then reprepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available	Lab Manager, Analyst	Precision and accuracy/bias	%Rs must be within the DoD QSM 5.0 Appendix C; if not listed in the tables, in-house statistical limits are used
MS/MSD	One per extraction batch	Evaluate the samples and associated QC and, if the LCS results are acceptable, narrate.	Lab Manager, Analyst	Precision and accuracy/bias	%Rs must be within the DoD QSM 5.0 Appendix C; if not listed in the tables, in-house statistical limits are used RPD ≤ 20%

SAP WORKSHEET #28 — LABORATORY QC SAMPLES TABLE (CONTINUED)

Matrix	Soil/Sediment
Analytical Group	PCBs
Analytical Method / SOP Reference	EPA 8082 / BCORG019

QC Sample	Frequency/Number	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	One per extraction batch	Correct problem. If required, reprepare and reanalyze MB and all samples processed with the contaminated blank	Laboratory Manager, Analyst	Accuracy/bias - contamination	See DOD QSM
LCS	One per analytical batch	Correct problem then reprepare and reanalyze the LCS and all samples in the associated preparatory batch.	Laboratory Manager, Analyst	Precision and accuracy/bias	See DOD QSM
Surrogate spike	All samples	Reanalyze sample. If surrogate meets criteria, report reanalysis results. If surrogate does not meet criteria, note in narrative report.	Laboratory Manager, Analyst	Precision and accuracy/bias	See DOD QSM
MS/MSD	One per preparatory batch	Correct problem then reprepare and reanalyze the MS/MSD and all samples, if sufficient sample material is available	Laboratory Manager, Analyst	Precision and accuracy/bias	See DOD QSM

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE

Document	Where Maintained
SAP and HASP	Project file
Field notes/logbook	Project file
Chain-of-custody records	Project file
Field forms	Project file
Laboratory raw data package (hard copy)	Project file (CD) and laboratory
Audit/assessment checklists/reports	Project file and laboratory
Corrective action forms/reports	Project file and laboratory
Laboratory equipment calibration logs	Laboratory
Sample preparation logs	Laboratory
Run logs	Laboratory
Sample disposal records	Laboratory
Validated data	Project file

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)

29.1 DOCUMENTS AND RECORDS

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This section also describes reports that will be generated as a result of this project.

29.1.1 Field Documentation

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in the SAP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the contract line item number, the site number, and the names of subcontractors, the service client, and the project manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events
- Notes of conversations with coordinating officials
- References to other field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolution
- Discussions of deviations from the SAP or other governing documents
- Description of all photographs taken

The field team will also use the Daily QC Form included in Attachment 2 to record field activities.

29.1.2 Preliminary Data Summary

Preliminary data will be provided by the laboratory within the requested shortened TAT as specified on the chain-of-custody forms (5-day TAT). The data will be provided via email or via an online file share site and will include sample results only. The preliminary data will be used to determine whether to analyze additional samples from each DU, based on whether the results exceed the cleanup goals (see Worksheet #17).

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)

29.1.3 Laboratory Data Package

The laboratory will prepare data packages in accordance with the instructions provided in the EPA CLP SOW (EPA 2014, 2015a). Full level 4 data packages will contain:

- Subcontractor name, project name, contract number, sample delivery group (SDG) number, and a table that cross-references client and laboratory sample ID numbers
- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies
- A list of each instance of manual integration or other manual data interpretations on the part of the analyst in the case narrative, and a statement that each instance of manual interpretation or analyst judgment was approved by a supervisor
- Copies of all associated nonconformance and corrective action forms that will describe the nature of the deficiency and the corrective action taken
- Copies of all associated sample receipt notices
- Raw data

Full level 4 data packages are due to Tetra Tech within 21 days after the last sample in the SDG is received. Unless otherwise requested, the subcontractor will deliver one copy of the full data package electronically as a full Portable Document Format file.

29.1.4 Electronic Data Package Format

The subcontracted laboratory will provide electronic data deliverables in the electronic data deliverable (EDD)/automated data review format for all analytical results. An automated laboratory information management system must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. Results to be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- Method and instrument blanks and preparation and calibration blank results reported for the SDG
- Percent recoveries for the spike compounds in the MS, MSD, blank spikes, or LCS

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)

- Matrix duplicate results reported for the SDG
- All re-analysis, re-extractions, or dilutions reported for the SDG, including any associated with samples and the specified laboratory QC samples

Electronic data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The subcontractor will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained on an electronic data archival system.

29.1.5 Reports Generated

Results from this investigation will be used incorporated into a RACR for AOI 14. The report will include summaries of the results of this field investigation, field and sampling procedures for this investigation, target analyte concentration and associated QC data, site maps, and conclusions and recommendations for removal of fill.

29.1.6 Data Management

Field and analytical data collected from this project and other environmental investigations are critical to site characterization efforts and guidance of the non-time –critical removal action. An information management system is necessary to ensure efficient access so that decisions based on the data can be made in a timely manner.

After the field and laboratory data reports are reviewed and validated, the data will be entered into Tetra Tech's database for NASA Ames. The database contains data for (1) summarizing observations on contamination and geologic conditions, (2) preparing reports and graphics, (3) using with geographic information systems, and (4) transmitting in an electronic format. Tetra Tech's data tracking procedures, data pathways, and overall data management strategy for NASA Ames are described in the following paragraphs.

29.1.7 Data Tracking Procedures

All data that are generated in support of the NASA program at NASA Ames are tracked through a database created by Tetra Tech. Information related to receipt and delivery of samples, project order fulfillment, and invoicing for laboratory and validation tasks is stored in the Tetra Tech program, SAMTRAK. All data are filed according to the SDG number once the final document has been submitted.

29.1.8 Data Pathways

Data are generated from three primary pathways at the site: data derived from field activities, laboratory analytical data, and validated data. Data from all three pathways must be entered into

SAP WORKSHEET #29 — PROJECT DOCUMENTS AND RECORDS TABLE (CONTINUED)

the database. Data pathways must be established and well documented to evaluate whether the data have been accurately loaded into the database in a timely manner.

Data generated during field activities are recorded using field forms (Attachment 2). The Analytical Coordinator or FTL reviews these forms for completeness and accuracy. Data from the field forms, including the chain-of-custody record, are entered into SAMTRAK.

Data generated during laboratory analysis are recorded electronically and in EDDs after the samples have been analyzed. The laboratory will send the EDD records to the Analytical Coordinator. The Analytical Coordinator reviews the data deliverable for completeness, accuracy, and format. After the format has been approved, the electronic data are manipulated and downloaded into the database. Tetra Tech data entry personnel will then update SAMTRAK with the total number of samples received and number of days required to receive the data.

After validation, the analytical coordinator reviews the data for accuracy and then Tetra Tech will update the database with the appropriate data qualifiers. SAMTRAK is also updated to record associated laboratory and data validation costs.

29.1.9 Data Management Strategy

Tetra Tech's short- and mid-term data management strategies require that the database for the site will be updated once the data are collected and validated. The data consist of chemical and field data from NASA contractors, entered into an Oracle (Version 7.3) database. The database can be used to generate reports using available computer-aided drafting and design and contouring software. Data will be transmitted within 30 days after the final validation report is received.

The data will be loaded into the database at Tetra Tech for storage, further manipulation, and retrieval after laboratory and field reports are reviewed and validated to satisfy long-term data management goals. The database will be used to provide data for chemical and geologic analysis and for preparing reports and graphic representations of the data. Additional field activity data are recorded on field forms (see Attachment 2) that the analytical coordinator or FTL reviews for completeness and accuracy (Worksheet #34). Hard copies of forms, data, and chain-of-custody records are filed in a secure storage area according to project and SDG numbers. Laboratory data packages and reports will be archived at Tetra Tech offices. Laboratories that generated the data will archive hard-copy data for a minimum of 10 years (Worksheet #30).

29.2 DATA VALIDATION

Analytical data will be validated by an independent third-party contractor in accordance with EPA national functional guidelines (EPA 2008, 2010). Validation procedures are detailed in Worksheet #36.

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE

Matrix	Analytical Group	Analytical Method	Data Package TAT[a]	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization (name and address, contact person and telephone number)
Soil/Sediment	Metals (Lead only)	EPA 6010B/6010C	5-day TAT, Standard TAT	BC Laboratories Molly Meyers 4100 Atlas Court Bakersfield, CA 93308 (661) 496-6757	SGS Laboratories - Orlando Elvin Kumar 4405 Vineland Road, Suite C-15 Orlando FL 32811 (408) 588-0200 ext. 3515
Soil/Sediment	Organochlorine pesticides (4,4-DDD, 4,4-DDE, and 4,4-DDT only)	EPA 8081A/8081B			
Soil/Sediment	PCBs as Aroclors	EPA 8082/8082A			

Note:

a TATs will be selected based on the stage of the project to enable field decision-making. All pilot study samples will be analyzed on a 5-day TAT. During most of the full-scale study, samples will be analyzed on a 5-day TAT. A standard TAT may be selected for 2-foot subsurface DU samples during the first month of the full-scale investigation.

ISM soil samples will be processed by the laboratory according to ITRC guidance (ITRC 2012), and will include determining percent moisture, air drying (if necessary), and sieving of the entire 1 kilogram sample mass using a #10 (<2 millimeter) sieve, then subsampling.

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

Requirements for Data Packages – Organic Analysis	Requirements for Data Packages – Inorganic Analysis
Summary (Level III)	**Summary (Level III)**
Section I **Case Narrative**	**Section I** **Case Narrative**
1. Case narrative	1. Case narrative
2. Copies of nonconformance and corrective action forms	2. Copies of nonconformance and corrective action forms
3. Chain-of-custody forms	3. Chain-of-custody forms
4. Copies of sample receipt notices	4. Copies of sample receipt notices
5. Internal tracking documents, as applicable	5. Internal tracking documents, as applicable
Section II **Sample Results – Form I for the following:**	**Section II** **Sample Results – Form I for the following:**
1. Environmental samples, including dilutions and re-analysis, reported on a dry-weight basis	1. Environmental sample including dilutions and re-analysis, reported on a dry-weight basis
Section III **QA/QC Summaries – Forms II through XI for the following:**	**Section III** **QA/QC Summaries – Forms II through XIV for the following:**
1. System monitoring compound and surrogate recoveries (Form II)	1. Initial and continuing calibration verifications (Form II)
2. MS and MSD recoveries and RPDs (Forms I and III)	2. Project-required reporting limit standard (Form II)
3. Blank spike or LCS recoveries (Forms I and III-Z)	3. Detection limit standard (Form II-Z)
4. Method blanks (Forms I and IV)	4. Method blanks, continuing calibration blanks, and preparation blanks (Form III)
5. Performance check (Form V)	5. ICP interference-check samples (Form IV)
6. Initial calibrations with retention time information (Form VI)	6. MS and post-digestion spikes (Forms V and V-Z)
7. Continuing calibrations with retention time information (Form VII)	7. Sample duplicates (Form VI)
8. Quantitation limit standard (Form VII-Z)	8. LCSs (Form VII)
9. Internal standard areas and retention times (Form VIII)	9. Method of standard additions (Form VIII)
10. Analytical sequence (Forms VIII-D and VIII-Z)	10. ICP serial dilution (Form IX)
11. Gel permeation chromatography (GPC) calibration (Form IX)	11. Instrument detection limit (Form X)
12. Single component analyte identification (Form X)	12. ICP inter element correction factors (Form XI)
13. Multicomponent analyte identification (Form X-Z)	13. ICP linear working range (Form XII)
14. Matrix-specific method detection limit (Form XI-Z)	
Full (Level IV):	**Full (Level IV):**
Sections I, II, and III **Same as Summary Package**	**Sections I, II, III** **Same as Summary Package**

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

Requirements for Data Packages – Organic Analysis	Requirements for Data Packages – Inorganic Analysis
Section IV Sample Raw Data – indicated form, plus all raw data	**Section IV Instrument Raw Data - Sequential measurement readout records for ICP, graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:**
1. Analytical results, including dilutions and re-analysis (Forms I and X)	1. Environmental samples, including dilutions and re-analysis
2. Tentatively identified compounds (Form I — volatile organic analysis)	2. Initial calibration
	3. Initial and continuing calibration verifications
Section V QC Raw Data – indicated form, plus all raw data	4. Detection limit standards
1. Method blanks (Form I)	5. Method blanks, continuing calibration blanks, and preparation blanks
2. MS and MSD samples (Form I)	6. ICP interference check samples
3. Blank spikes or LCSs (Form I)	7. MS and post-digestion spikes
	8. Sample duplicates
Section VI Standard Raw Data – indicated form, plus all raw data	9. LCSs
1. Performance check (Form V)	10. Method of standard additions
2. Initial calibrations, with retention-time information (Form VI)	11. ICP serial dilution
3. Continuing calibrations, with retention-time information (Form VII)	**Section V Other Raw Data**
4. QL standard (Form VII-Z)	1. Percent moisture for soil samples
5. GPC calibration (Form IX)	2. Sample digestion, distillation, and preparation logs, as necessary
Section VII Other Raw Data	3. Instrument analysis log for each instrument used
1. Percent moisture for soil samples	4. Standard preparation logs, including initial and final concentrations for each standard used
2. Sample extraction and cleanup logs	5. Formula and a sample calculation for the initial calibration
3. Instrument analysis log for each instrument used (Form VIII-Z)	6. Formula and a sample calculation for soil sample results
4. Standard preparation logs, including initial and final concentrations for each standard used	
5. Formula and a sample calculation for the initial calibration	
6. Formula and a sample calculation for soil sample results	

SAP WORKSHEET #30 — ANALYTICAL SERVICES TABLE (CONTINUED)

30.1 SELECTION OF ANALYTICAL LABORATORIES

Laboratories for this investigation will be selected from a list of reputable laboratories qualified to support NASA contracts and known to be capable of providing the necessary laboratory services for this project (see Section 30.2). The quality of services furnished by subcontract laboratories was considered during project planning. Work performed by subcontract laboratories must be performed in compliance with an established quality system (such as a Laboratory QA Plan). Laboratories must be able to fulfill the technical and quality requirements of the scope of work of the project to be selected. The laboratories must also demonstrate their understanding of the scope of work and commitment to meeting the project technical and quality requirements.

30.2 LABORATORY EVALUATION AND PREQUALIFICATION

All selected laboratories will also be evaluated to assure that the laboratories meet the technical requirements of this project and produce data of acceptable quality. Laboratories must be currently certified, as applicable, by the California State Health Department, Environmental Laboratory Accreditation Program for each method and analyte specified. The certifications and accreditations must be obtained before the laboratory begins work. Laboratory certifications are provided in Attachment 3.

SAP WORKSHEET #31 — PLANNED PROJECT ASSESSMENTS TABLE

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Field Readiness Review	Before mobilization for the project and before major phases of work are initiated	Internal	Tetra Tech	PM, Tetra Tech	PM, Tetra Tech	PM, Tetra Tech	Project QAM, Tetra Tech
Field Sampling Surveillance	Once during field sampling	Internal	Tetra Tech	Analytical Coordinator, Tetra Tech	FTL and PM, Tetra Tech	PM, Tetra Tech	Project QAM and Analytical Coordinator, Tetra Tech

SAP WORKSHEET #32 — ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Field Readiness Review	Email documentation	PM, Project QAM, FTL, and Analytical Coordinator, Tetra Tech	2 days	Email documentation	PM, Project QAM, FTL, and Analytical Coordinator, Tetra Tech	2 days
Field Sampling Surveillance	Email documentation	PM, Project QAM, and FTL, Tetra Tech	2 days	Email documentation	PM, Project QAM, and FTL, Tetra Tech	2 days

SAP WORKSHEET #33 — QA MANAGEMENT REPORTS TABLE

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Daily Progress Report	Daily	At the end of each field day	FTL, Tetra Tech	PM, Tetra Tech Program Manager, NASA
Monthly Status Report	Monthly	At the end of each month	PM, Tetra Tech	Program Manager, NASA
QC Summary Report	With Report Submittal	Submitted in Final Report	PM, Tetra Tech	Program Manager, NASA

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Audit reports	When the report is complete, a copy of all audit reports will be placed in the project file. If corrective actions are required, a copy of the documented corrective action taken will be attached to the appropriate audit report in the project file. At the beginning of each week and at the completion of the site work, project file audit reports will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the PM will be notified to ensure action is taken.	I	PM, Tetra Tech
Field notes/logbook	Field notes will be reviewed internally and placed in the project file. A copy of the field notes will be attached to the final report.	I	FTL, Tetra Tech
Sample receipt	For samples shipped via commercial carrier, the analytical coordinator will verify receipt of samples by the laboratory the day following shipment.	I	Analytical Coordinator, Tetra Tech
Sample logins	Sample login information will be reviewed and verified for completeness in accordance with the chain-of-custody forms.	I, E	Analytical Coordinator, Tetra Tech Laboratory PM, BC Laboratories/ SGS Laboratories
Chain-of-custody records	Chain-of-custody forms will be reviewed internally when they are completed and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody form should be initialed by the reviewer, a copy of the chain-of-custody form will be retained in the project file, and the original and remaining copies will be taped inside the cooler for shipment.	I	FTL, Tetra Tech
Laboratory data prior to release	Laboratory data will be reviewed and verified for completeness against analyses requested on the chain-of-custody forms.	E	Laboratory PM, BC Laboratories/ SGS Laboratories
Laboratory data due at TAT listed on chain-of-custody	Laboratory data will be verified that the analyses reported are consistent with the analytical suite requested on the chain-of-custody forms.	I	Analytical coordinator, Tetra Tech
Laboratory data packages	All laboratory data packages will be verified for completeness by the laboratory performing the work. Data packages will then be reviewed by the analytical coordinator for completeness. Subsequently, data packages will be evaluated externally by undergoing data validation.	I, E	Laboratory PM, BC Laboratories/ SGS Laboratories Analytical Coordinator, Tetra Tech Third-party data validator, DVG

SAP WORKSHEET #34 — VERIFICATION (STEP I) PROCESS TABLE (CONTINUED)

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Laboratory data	All laboratory data packages will be verified for completeness and technical accuracy internally by the laboratory performing the work before they are submitted. All received data packages will be verified externally according to the data validation procedures specified in Worksheet #36.	I, E	Laboratory PM, BC Laboratories/ SGS Laboratories Third-party data validator, DVG
Field and electronic data	One hundred percent of manual entries will be reviewed against the hardcopy information, and 10 percent of electronic uploads will be checked against the hardcopy.	I	Analytical Coordinator, Tetra Tech

SAP WORKSHEET #35 — VALIDATION (STEPS IIa AND IIb) PROCESS TABLE

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Field logbook	Field logbooks will be reviewed weekly for accuracy associated with each sampling event. The inspection will be documented in daily QC reports.	PM, Tetra Tech
IIa	Chain-of-custody forms	Chain-of-custody forms will be reviewed daily to ensure that project information, sample analyses requested, number of field QC samples collected, and percent level III or IV validation chosen is accurate and in accordance with the requirements in this SAP.	Analytical Coordinator, Tetra Tech
IIa	Sample receipt	The sample cooler will be checked for compliance with temperature and packaging requirements.	Laboratory sample custodian, BC Laboratories/ SGS Laboratories
IIa	Sample logins	Sample login will be reviewed for accuracy against the chain-of-custody form.	Analytical Coordinator, Tetra Tech Team Laboratory PM, BC Laboratories/ SGS Laboratories
IIa	Laboratory data prior to release	Laboratory data will be reviewed to ensure that the data are accurate and meets the requirements in this SAP. Before they are released, data will be validated as follows:	Laboratory PM, BC Laboratories/ SGS Laboratories
		100 percent of the data comply with the method- and project-specific requirements; any deviations or failure to meet criteria are documented for the project file.	Laboratory Analyst, BC Laboratories/ SGS Laboratories
		100 percent of manual entries are free of transcription errors and manual calculations are accurate; computer calculations are spot-checked to verify program validity; data reported are compliant with method- and project-specific QC requirements; raw data and supporting materials are complete; spectral assignments are confirmed; descriptions of deviations from method or project requirements are documented; significant figures and rounding have been appropriately used; reported values include dilution factors; and results are reasonable.	Laboratory Peer Analyst, BC Laboratories/ SGS Laboratories
		Data reported comply with method- and project-specific QC requirements; the reported information is complete; the information in the report narrative is complete and accurate; and results are reasonable.	Laboratory Supervisor, BC Laboratories/ SGS Laboratories
		Data reported comply with method- and project-specific QC; analytical methods are performed in compliance with approved SOPs. This review may be conducted after release of data since they involve only on 10 percent of the data.	Laboratory QAM, BC Laboratories/ SGS Laboratories

SAP WORKSHEET #35 — VALIDATION (STEPS IIA AND IIB) PROCESS TABLE (CONTINUED)

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Laboratory data due at TAT listed on chain of custody	Laboratory data will be reviewed to ensure that the data reported met the analyte list and limits listed in Worksheet #15.	Analytical Coordinator, Tetra Tech
	Laboratory data packages	All laboratory data packages will be validated by the laboratory performing the work for technical accuracy before they are submitted.	Laboratory PM, BC Laboratories/ SGS Laboratories
		Data packages will then be reviewed for accuracy against the laboratory data that were faxed or emailed at the TAT listed on the chain of custody.	Analytical Coordinator, Tetra Tech
		Data packages will be evaluated externally by undergoing data validation.	Third-party data validator, DVG
IIb	Data validation reports	Data validation reports will be reviewed in conjunction with the project data quality objectives and DQIs.	Analytical Coordinator, Tetra Tech

Note:

1 IIa=compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.].

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIa AND IIb) SUMMARY TABLE

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa / IIb	Soil/Sediment	Metals	In accordance with this SAP, EPA 6010B, EPA 6010C, and BC SOP BCMET013, Revision 19, 04/10/2017/ / SGS SOP MET 100, Revision 15, 6/2016	QAM, Tetra Tech; Molly Meyers, BC Laboratories/ Elvin Kumar, SGS Laboratories; Sandra Obleas, DVG
IIa / IIb	Soil/Sediment	Pesticides	In accordance with this SAP, EPA 8081A, EPA 8081B, and BC SOP BCORG014, Revision 15, 01/23/2017/ SGS SOP GC 015, Revision 14, 8/2017	QAM, Tetra Tech; Molly Meyers, BC Laboratories/ Elvin Kumar, SGS Laboratories; Sandra Obleas, DVG
IIa / IIb	Soil/Sediment	PCBs as Aroclors	In accordance with this SAP, EPA 8082, EPA 8082A, and BC SOP BCORG019, Revision 14, 01/23/2017/ SGS SOP GC 014, Revision 14, 8/2017	QAM, Tetra Tech; Molly Meyers, BC Laboratories/ Elvin Kumar, SGS Laboratories; Sandra Obleas, DVG

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIa AND IIb) SUMMARY TABLE (CONTINUED)

36.1 DATA VALIDATION AND USABILITY

This section describes the procedures that are planned to review, verify, and validate field and laboratory data. This section also discusses procedures for verifying that the data are adequate to meet PQO and measurement quality objectives for the project.

36.1.1 Data Review, Verification, and Validation

Validation and verification of the data generated during field and laboratory activities are essential to obtaining defensible data of acceptable quality. Verification and validation methods for field and laboratory activities are presented below.

36.1.2 Field Data Verification

Project personnel will verify field data through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in this SAP so that defensible and justifiable data are obtained.

Data values that are significantly different from the population are called “outliers.” A systematic effort will be made to identify any outliers or errors before field personnel report the data. Outliers can result from improper sampling or measurement methodology, data transcription errors, calculation errors, or natural causes. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

36.1.3 Laboratory Data Verification

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any nonconformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

36.1.4 Laboratory Data Validation

An independent third-party contractor will validate all laboratory data in accordance with this QAPP and the following references: (1) the EPA method, and (2) EPA national functional guidelines (EPA 2008, 2010). Ninety percent of the data for contaminants of concern will undergo

SAP WORKSHEET #36 — ANALYTICAL DATA VALIDATION (STEPS IIa AND IIb) SUMMARY TABLE (CONTINUED)

cursory validation, and 10 percent of the data for contaminants of concern will undergo full validation for this project. Requirements for cursory and full validation are listed below.

36.1.5 Cursory Data Validation

Cursory validation (Level 3) will be completed on 90 percent of the summary data packages for analysis of contaminants of concern. (The remaining 10 percent of the packages will be subjected to full validation.) The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of the data from the review process is not allowed. All data will be qualified as necessary in accordance with established criteria. Data summary packages will consist of sample results and QC summaries, including calibration and internal standard data.

36.1.6 Full Data Validation

Full validation (Level 4) will be completed on 10 percent of the full data packages for analysis of contaminants of concern. The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of data from the review process is not allowed. All data will continue through the validation process and will be qualified in accordance with established criteria. Data summary packages will consist of sample results, QC summaries, and all raw data associated with the sample results and QC summaries.

36.1.7 Data Validation Criteria

Worksheets #12, #24, #25, #28, and #36, along with the analytical methods and laboratory SOPs, list the QC checks and criteria that will be reviewed for both cursory and full data validation. The data validation criteria selected from the following table will be consistent with the project-specific analytical methods referenced in Worksheet #19.

SAP WORKSHEET #37 — USABILITY ASSESSMENT

37.1 MEASUREMENT QUALITY OBJECTIVES

All analytical results will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. Of these PARCC parameters, precision, and accuracy will be evaluated quantitatively by collecting the QC samples listed in Worksheet #12.

The following subsections describe each of the PARCC parameters and how they will be assessed within this project.

37.1.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Usually, combined field and laboratory precision are evaluated by collecting and analyzing field replicates and then calculating the variance between the samples, typically as a relative percent difference (RPD):

$$RPD = \frac{|A-B|}{(A+B)/2} \quad x \quad 100\%$$

where:

A	=	First duplicate concentration
B	=	Second duplicate concentration

Field sampling precision is evaluated by analyzing field replicate samples.

Laboratory analytical precision is evaluated by comparing analytical results of field samples with those of field replicates, laboratory matrix duplicates, or by analyzing MS of field samples along with MSD. For this project, MS/MSD samples will be generated for all organic analytes. MS/MSDs or matrix duplicates will be used to assess precision for inorganic analytes. The results of the analysis of each MS/MSD or duplicate pair will be used to calculate an RPD for evaluating precision. Worksheet #28 presents the precision goals for this project.

37.1.2 Accuracy

Field accuracy will be evaluated by analyzing field replicate samples and calculated RSDs, per the objectives presented in Worksheet #12. These QC samples will be used to evaluate the potential for target analytes to enter samples as a result of sampling processes.

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, LCS or blank spikes, surrogate standards, and

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

method blanks. MS samples will be prepared and analyzed at a frequency of 5 percent for samples that will require analysis for inorganic chemicals. LCS or blank spikes are also analyzed at a frequency of 5 percent or per extraction batch, whichever is most frequent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$Percent\ Recovery = \frac{S - C}{T}\ x\ 100$$

where:

S	=	Measured spike sample concentration
C	=	Sample concentration
T	=	True or actual concentration of the spike

Worksheet #28 presents accuracy goals for this investigation based on the percent recovery of laboratory, matrix, and surrogate spikes. Results that fall outside the accuracy goals will be evaluated further on the basis of the results of other QC samples.

37.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through the implementation of ISM and appropriate replicate sampling.

Laboratory representativeness of data will also be ensured through consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

37.1.4 Completeness

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this investigation.

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

As discussed further in Section 37.2, completeness will also be evaluated as part of the data quality assessment process (EPA 2006). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

37.1.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be evaluated through the collection of field replicates. Field procedures will be standardized to ensure comparability. The comparability of laboratory data will be assured by use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, or similar units), and consistency in reporting units (parts per million, parts per billion, and so forth).

37.1.6 Detection and Quantitation Limits

The DL is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The LOD is the smallest concentration that must be present in a sample in order to be detected at a high level of confidence. The LOQ represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a specific sample matrix within specified limits of precision and bias. Laboratory LOQs are contractually specified maximum quantitation limits for specific analytical methods and sample matrices, such as water, and are typically several times higher than the DL to allow for matrix effects. PQLs, which are established by Tetra Tech in the scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

Analytical methods have been selected for this project so that the PQL for each target analyte is below the applicable comparison criteria wherever practical. Worksheet #15 compares the LOQs for the selected analytical methods with comparison criteria. This comparison shows that the analytical methods selected and the associated laboratory LOQs and PQLs are capable of quantifying the contaminants of concern at concentrations below the applicable screening criteria, in most cases. The laboratory LOQ listed reflects the maximum sensitivity of current, routinely used analytical methods. All analytes will be reported as estimated values if concentrations are less than LOQs but greater than LODs. This procedure is being adopted to help ensure that analytical results can effectively be compared with comparison criteria for certain compounds where the screening criteria are near or below the LOQ. This procedure also will help to ensure that subsequent statistical evaluations of the data will not be biased by high-value nondetect results.

37.2 RECONCILIATION WITH USER REQUIREMENTS

After environmental data have been reviewed, verified, and validated in accordance with the procedures, the data must be further evaluated to determine whether PQOs have been met.

SAP WORKSHEET #37 — USABILITY ASSESSMENT (CONTINUED)

To the extent possible, Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Data Quality Assessment: A Reviewer's Guide" (EPA 2006). The DQA process includes five steps: (1) review the PQOs and sampling design; (2) conduct a preliminary data review; (3) select a statistical test; (4) verify the assumptions of the statistical test; and (5) draw conclusions from the data.

Tetra Tech will systematically assess data quality and data usability when the five-step DQA process is not completely followed because the PQOs are qualitative. This assessment will include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives
- A review of project-specific data quality indicators for PARCC and quantitation limits to evaluate whether acceptance criteria have been met
- A review of project-specific PQOs to determine whether they have been achieved by the data collected
- An evaluation of any limitations associated with the decisions to be made based on the data collected

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

REFERENCES

California Department of Toxic Substances Control (DTSC). 2016. HHRA Note #3. January.

Department of the Navy (Navy). 2010. Final Record of Decision, Site 25, Former Naval Air Station, Moffett Field, California. January.

Earth Resource Technology, Inc. (ERT). 2014a. "Area of Investigation 14, Former Soil Fill Area, Final Interim Corrective Action Measures Completion Report, NASA Ames Research Center, Moffett Field, California." June.

ERT. 2014b. "NASA Area of Investigation 14, Former Soils Fill Area, Interim Corrective Action Measures Quarter 3, 2014 Inspection Report, NASA Ames Research Center, Moffett Field, California." October.

ERT. 2015. "NASA Area of Investigation 14 Former Soils Fill Area Interim Corrective Action Measures, Quarter 3, 2015 Inspection Report, NASA Ames Research Center, Moffett Field, California." October.

ERT. 2016. "NASA Area of Investigation 14 Former Soils Fill Area Interim Corrective Action Measures, Quarter 3, 2016 Inspection Report, NASA Ames Research Center, Moffett Field, California." October.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. "Toxicological Benchmarks for Screening Chemicals of Potential Concern for Effects on Terrestrial Plants: 1997 Revision." Oak Ridge National Laboratory. Oak Ridge, Tennessee. ES/Gr/TM-85.

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997b. "Toxicological Benchmarks for Chemicals of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision." Oak Ridge National Laboratory, Oak Ridge Tennessee. ES/ER/TM-126/R2.

Erler and Kalinowski Inc. (EKI). 1992. isting Site Inspection for NASA Ames Research Center, June.

Hawai'i Department of Health (DOH). 2016. Interim Final Technical Guidance Manual for the Implementation of the Hawai'i State Contingency Plan. Section 4.2.7 Replicate Samples. August. (State of Hawai'i DOH). Accessed in November 2016 at: www.Hawai'idoh.org/tgm.aspx

Innovative Technical Solutions, Inc. (ITSI). 2012. Remedial Design and Remedial Action Work Plan, Remedial Action at IR Site 25, Former NAS Moffett Field, Moffett Field, California. March.

ITSI Gilbane Company. 2013. emedial Action Completion Report, Remedial Action at IR Site 25, Former NAS Moffett Field, Moffett Field, California. July.

Integrated Science Solutions, Inc. (ISSi). 2005a. "Report of Findings PCB in Site Soils Phase II, NASA Ames Research Center, Moffett Field, California." July.

ISSi. 2005b. Draft Report of Findings, Former Soil Fill Area, Summer 2005 Soil Investigation. December.

ISSi. 2006. "Regional Groundwater Remediation 2004 Program Progress Report, Restoration Program, NASA Ames Research Center, Moffett Field, California." April.

ISSi. 2007. "Report of Findings, Area of Investigation 14, Phase II Soil Investigation, Former Soil Fill Area, Building N217 Fill Area, and Building N217A Fill Area, NASA Ames Research Center, Moffett Field, California." April.

Interstate Technology Regulatory Council (ITRC). 2012. Technical and Regulatory Guidance, Incremental Sampling Methodology. February 2012. Accessed in March 2015 at: http://www.itrcweb.org/ism-1/

Kaplan E.L., and P. Meier. 1958. "Nonparametric Estimator from Incomplete Observations." ournal of the American Statistical Association. Volume 53. ages 457-481.

National Aeronautics and Space Administration. 2013. "Draft Report of Findings, Area of Investigation 14, N217 and N217A Fill Areas Interim Corrective Action Measures Data Gap Soil Sampling, NASA Ames Research Center, Moffett Field, California." December.

PAI Corporation (PAI). 2004. "Draft Report of Findings, PCBs in Site Soils, NASA Ames Research Center, Moffett Field, California." November.

Tetra Tech, Inc. 2015. Area of Investigation 14 Engineering Evaluation/Cost Analysis, NASA Ames Research Center, Moffett Field, CA. September.

Tetra Tech, Inc. 2016. Final Area of Investigation 14 Geophysical Survey Report, NASA Ames Research Center, Moffett Field, CA. November.

Tetra Tech, Inc. 2017a. Final Area of Investigation 14 Action Memorandum, NASA Ames Research Center, Moffett Field, CA. March.

Tetra Tech, Inc. 2017b. Draft Area of Investigation 14 Biological Assessment, NASA Ames Research Center, Moffett Field, CA. March.

U.S. Environmental Protection Agency (EPA). 2001. "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5." ffice of Environmental Information. Washington, D.C. EPA/240/B-01/003. March.

EPA. 2005. "Uniform Federal Policy for Implementing Environmental Quality Systems. Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs." Intergovernmental Data Quality Task Force. EPA-505-F-03-001. March.

EPA. 2006. "Data Quality Assessment: A Reviewer's Guide", EPA QA/G-9R." Office of Environmental Information. Washington, D.C. EPA/240/B-06/002. February.

EPA. 2008. "National Functional Guidelines for Superfund Organic Methods Data Review." OSWER 9240.1-48, EPA 540-R-08-01. USEPA Contract Laboratory Program. June.

EPA. 2010. National Functional Guidelines for Inorganic Superfund Data Review, OSWER 9240.1-51, EPA 540-R-10-011. USEPA Contract Laboratory Program. January.

EPA. 2012. "Uniform Federal Policy for Quality Assurance Project Plans. Optimized UFP-QAPP Worksheets." Intergovernmental Data Quality Task Force. March. Available on-line at: https://www.epa.gov/sites/production/files/documents/ufp_qapp_worksheets.pdf

EPA. 2014. "U.S. EPA Contract Laboratory Program Statement of Work for Inorganic Superfund Analysis, Multi-Media, Multi-Concentration." Document Number ISM02.2. August.

EPA. 2015a. EPA Contract Laboratory Program Statement of Work for Organic Superfund Methods Multi-Media, Multi-Concentration, SOM02.3. September.

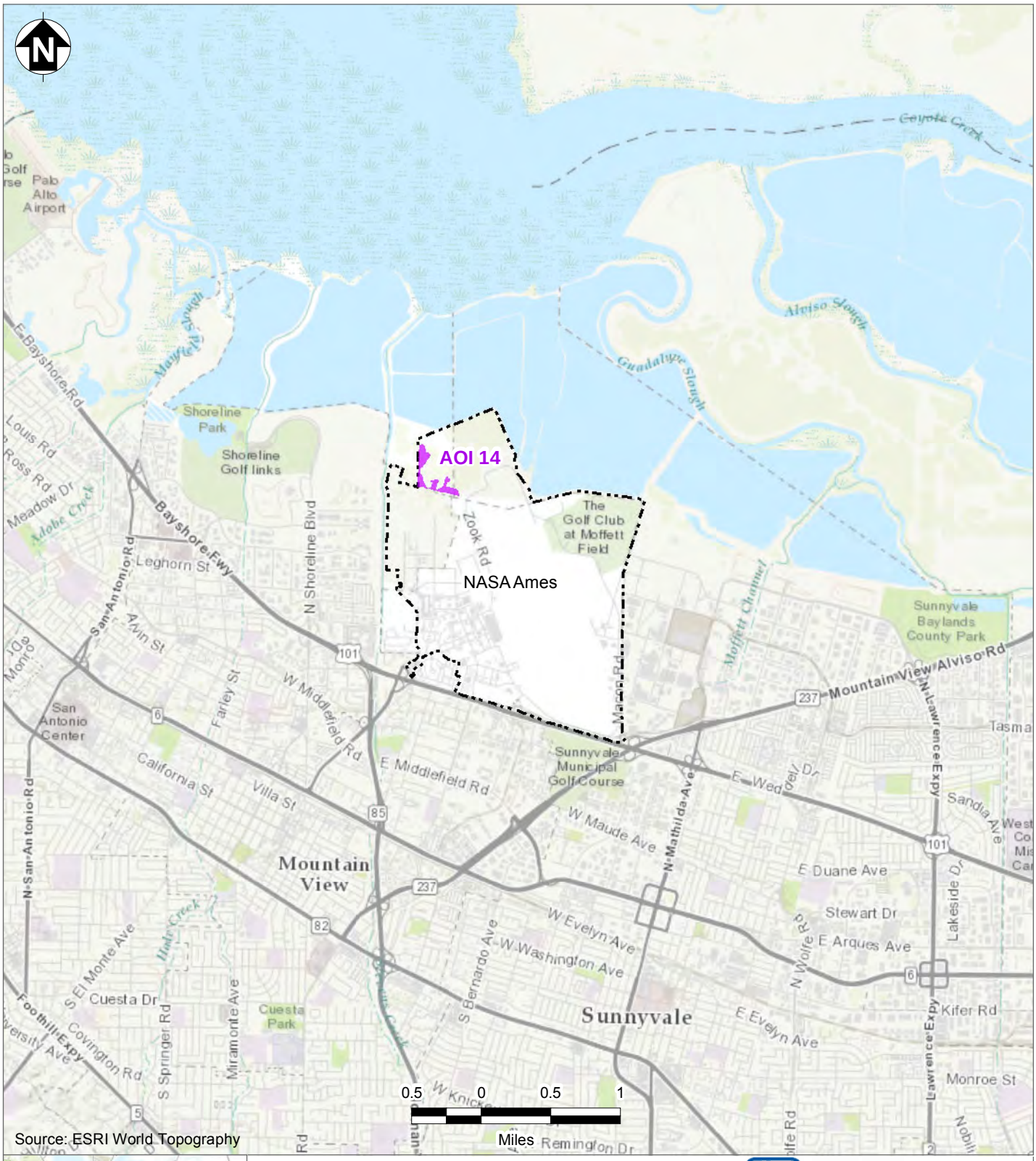
EPA. 2015b. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November. Available on-line at: http://www.epa.gov/risk/risk-based-screening-table-generic-tables

EPA. 2016a. Interim Ecological Soil Screening Levels. Available on-line at: http://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents

EPA. 2016b. National Recommended Water Quality Criteria - Aquatic Life Criteria. Available on-line at: http://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

EPA. 2016c. National Recommended Water Quality Criteria - Human Health Criteria. Available on-line at: http://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

FIGURES



AOI 14

NASA Ames

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center

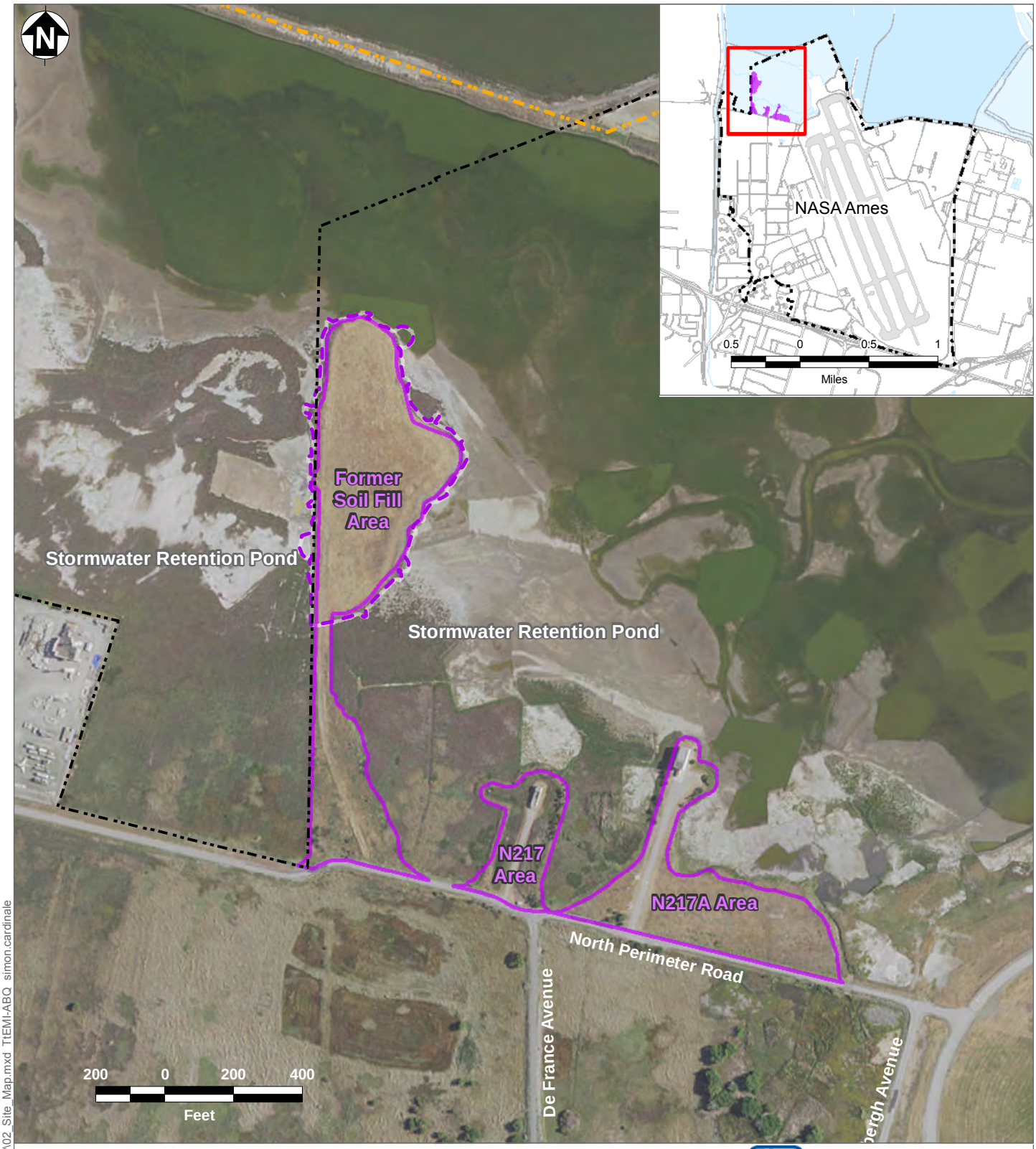
TETRA TECH

AOI 14, NASA Ames Research Center
Moffett Field, California

Figure 1

AOI 14 Site Location

Design Site Characterization Sampling and Analysis Plan



AOI 14

AOI 14 Former Soil Fill Area Removal Action Boundary (Toe and Bottom of Slope and Geophysical Survey Results)

NASA Ames

Bay Trail

Notes:

AOI	Area of Investigation
IR	Installation Restoration
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

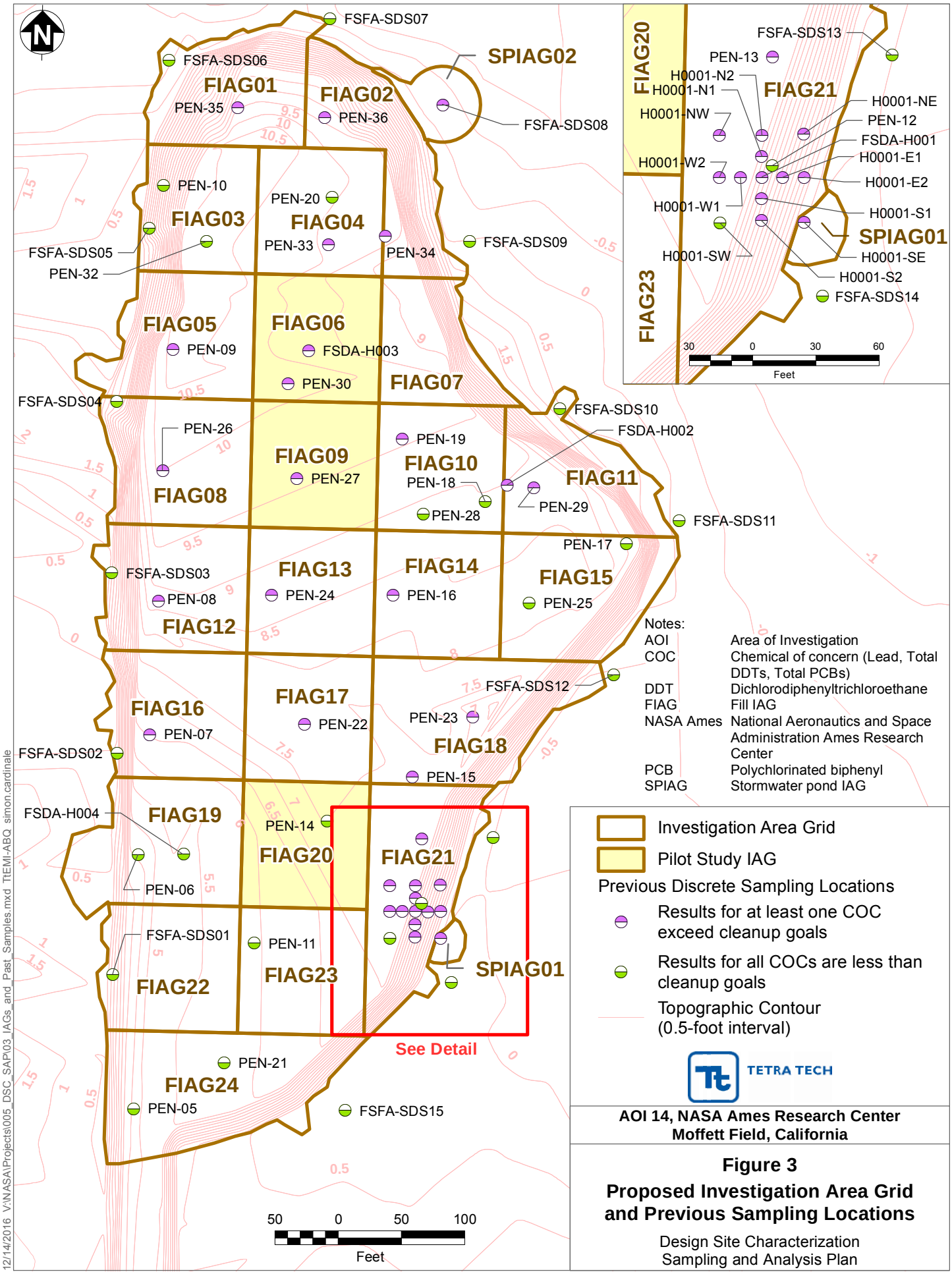
AOI 14, NASA Ames Research Center
Moffett Field, California

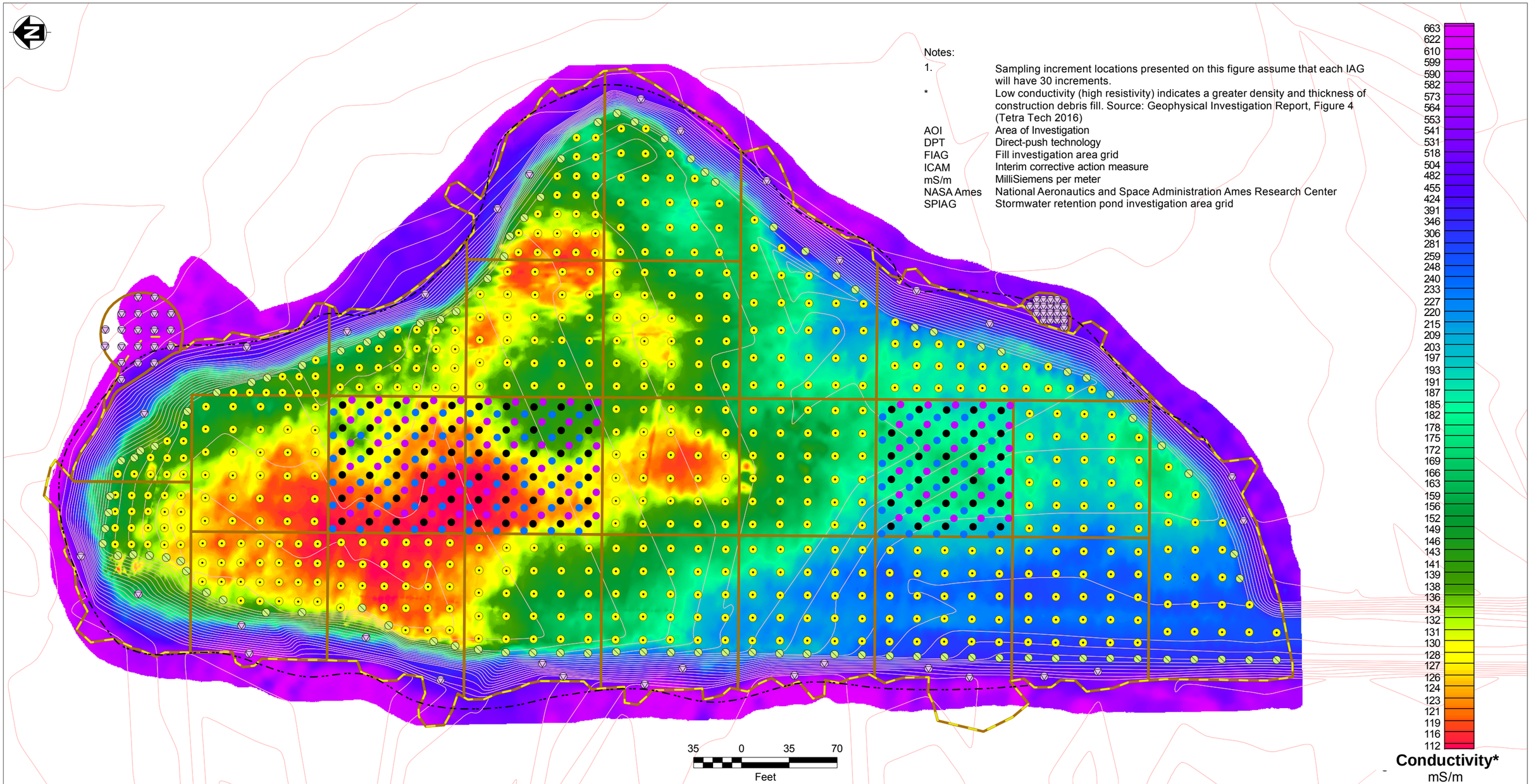
Figure 2

AOI 14 Site Features

Design Site Characterization
Sampling and Analysis Plan

12/20/2016 V:\NASA\Projects\005_DSC_SAP\02_Site_Map.mxd TtEMI-ABQ simon.cardinale


FIAG01
FIAG02
FIAG03
FIAG04
FIAG05
FIAG06
FIAG07
FIAG08
FIAG09
FIAG10
FIAG11
FIAG12
FIAG13
FIAG14
FIAG15
FIAG16
FIAG17
FIAG18
FIAG19
FIAG20
FIAG21
FIAG22
FIAG23
FIAG24
SPIAG01
SPIAG02
FSFA-SDS01
FSFA-SDS02
FSFA-SDS03
FSFA-SDS04
FSFA-SDS05
FSFA-SDS06
FSFA-SDS07
FSFA-SDS08
FSFA-SDS09
FSFA-SDS10
FSFA-SDS11
FSFA-SDS12
FSFA-SDS13
FSFA-SDS14
FSFA-SDS15
FSDA-H001
FSDA-H002
FSDA-H003
FSDA-H004
PEN-05
PEN-06
PEN-07
PEN-08
PEN-09
PEN-10
PEN-11
PEN-12
PEN-13
PEN-14
PEN-15
PEN-16
PEN-17
PEN-18
PEN-19
PEN-20
PEN-21
PEN-22
PEN-23
PEN-24
PEN-25
PEN-26
PEN-27
PEN-28
PEN-29
PEN-30
PEN-32
PEN-33
PEN-34
PEN-35
PEN-36
H0001-N1
H0001-N2
H0001-NW
H0001-W2
H0001-W1
H0001-SW
H0001-NE
H0001-E1
H0001-E2
H0001-S1
H0001-SE
H0001-S2
See Detail
Feet
Notes:
AOI Area of Investigation
COC Chemical of concern (Lead, Total DDTs, Total PCBs)
DDT Dichlorodiphenyltrichloroethane
FIAG Fill IAG
NASA Ames National Aeronautics and Space Administration Ames Research Center
PCB Polychlorinated biphenyl
SPIAG Stormwater pond IAG
Investigation Area Grid
Pilot Study IAG
Previous Discrete Sampling Locations
Results for at least one COC exceed cleanup goals
Results for all COCs are less than cleanup goals
Topographic Contour (0.5-foot interval)
TETRA TECH
AOI 14, NASA Ames Research Center
Moffett Field, California
Figure 3
Proposed Investigation Area Grid and Previous Sampling Locations
Design Site Characterization Sampling and Analysis Plan
12/14/2016 V:\NASA\Projects\005_DSC_SAP\03_IAGs_and_Past_Samples.mxd TtEMI-ABQ simon.cardinale



DPT vertical borings (Advanced from surface to bottom of fill)

DPT angle-hole borings (Advanced at 30 degree angle from surface to bottom of fill)

Hand auger boring (Advanced from surface to between 2 and 4 feet below fill surface in side slope or from surface to 1 foot below fill surface at toe of slope)

Pilot Study Sampling Increment Location

- Replicate 1
- Replicate 2
- Replicate 3

ICAM Silt Fence

Topographic Contour (0.5-foot interval)

Investigation Area Grid

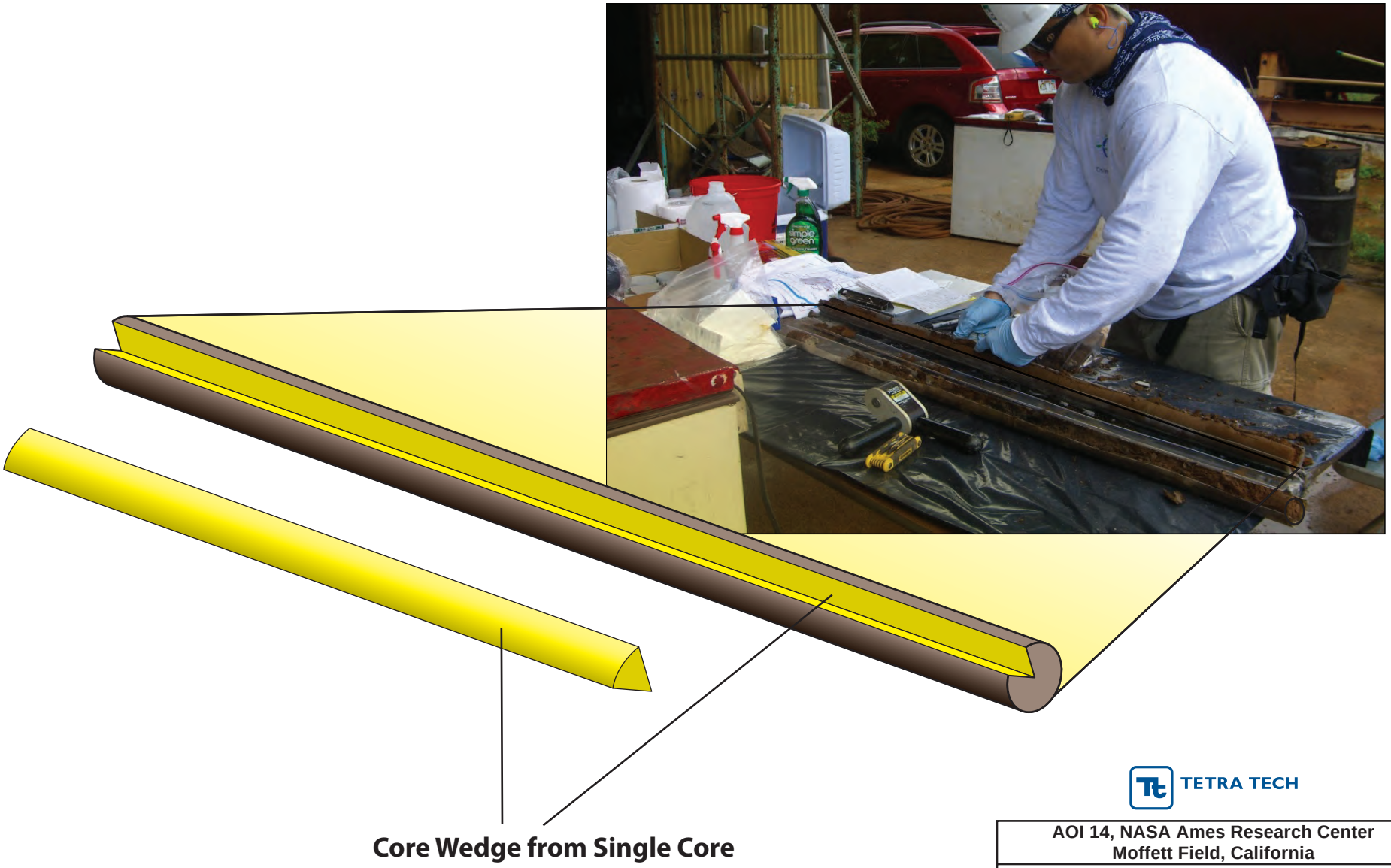
Apparent artificial fill boundary inferred from geophysical survey

TETRA TECH

AOI 14, NASA Ames Research Center
Moffett Field, California

Figure 4
Proposed Sampling Locations and Geophysical Survey Results

Design Site Characterization
Sampling and Analysis Plan

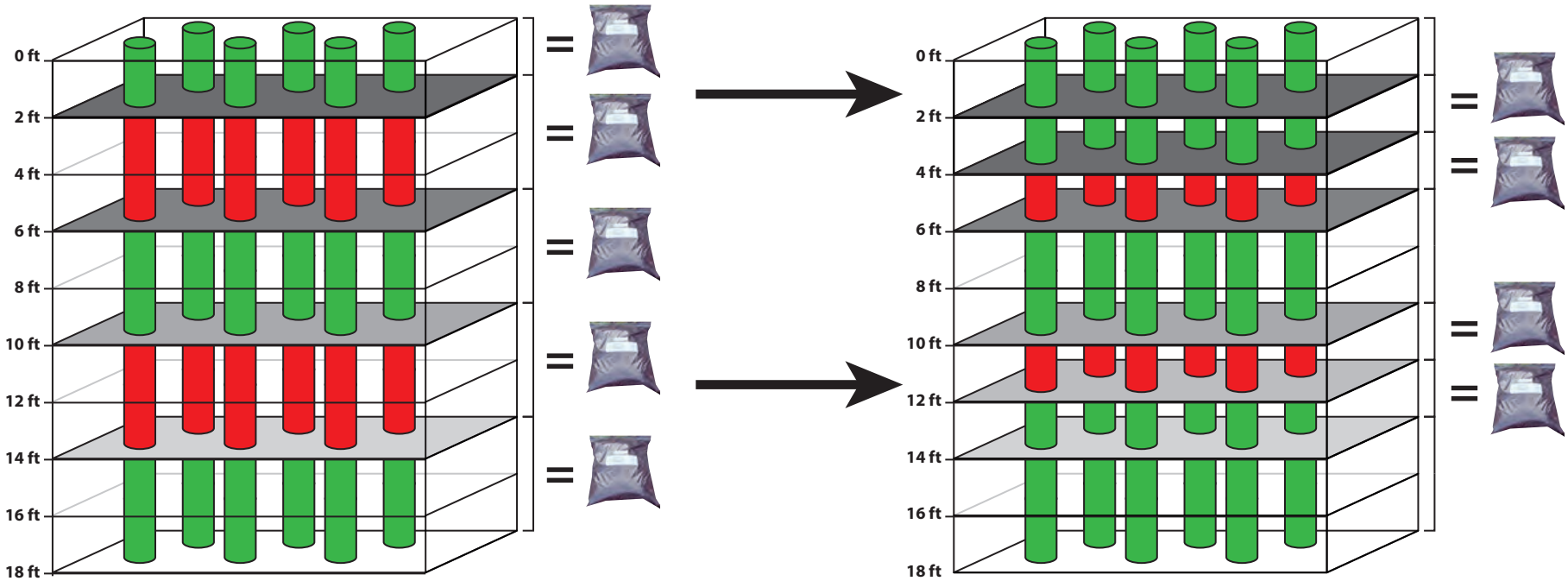


TETRA TECH

AOI 14, NASA Ames Research Center
Moffett Field, California

Figure 5
Core Wedge and
Collection of a Core Wedge

Design Site Characterization
Sampling and Analysis Plan



Results from 2-6 feet bgs and 10-14 feet bgs DUs exceed cleanup goal for at least one COC; therefore, corresponding 2-foot subsurface DUs will be analyzed

Results from 0-2 feet bgs, 6-10 feet bgs, and 14-18 feet bgs DUs do not exceed cleanup goals for any COCs; therefore, no further DU analysis will be conducted

Results from 4-6 feet bgs and 10-12 feet bgs DUs exceed cleanup goal

Conclusion

Soil from 4-6 feet bgs and 10-12 feet bgs DUs will be excavated and disposed of off site. Soil from other DUs may be used on site for backfill or grading purposes.

Legend:

= DU ISM Sample Result < Cleanup Goals for all COCs

= DU ISM Sample Result > Cleanup Goals for at least one COC

Acronyms

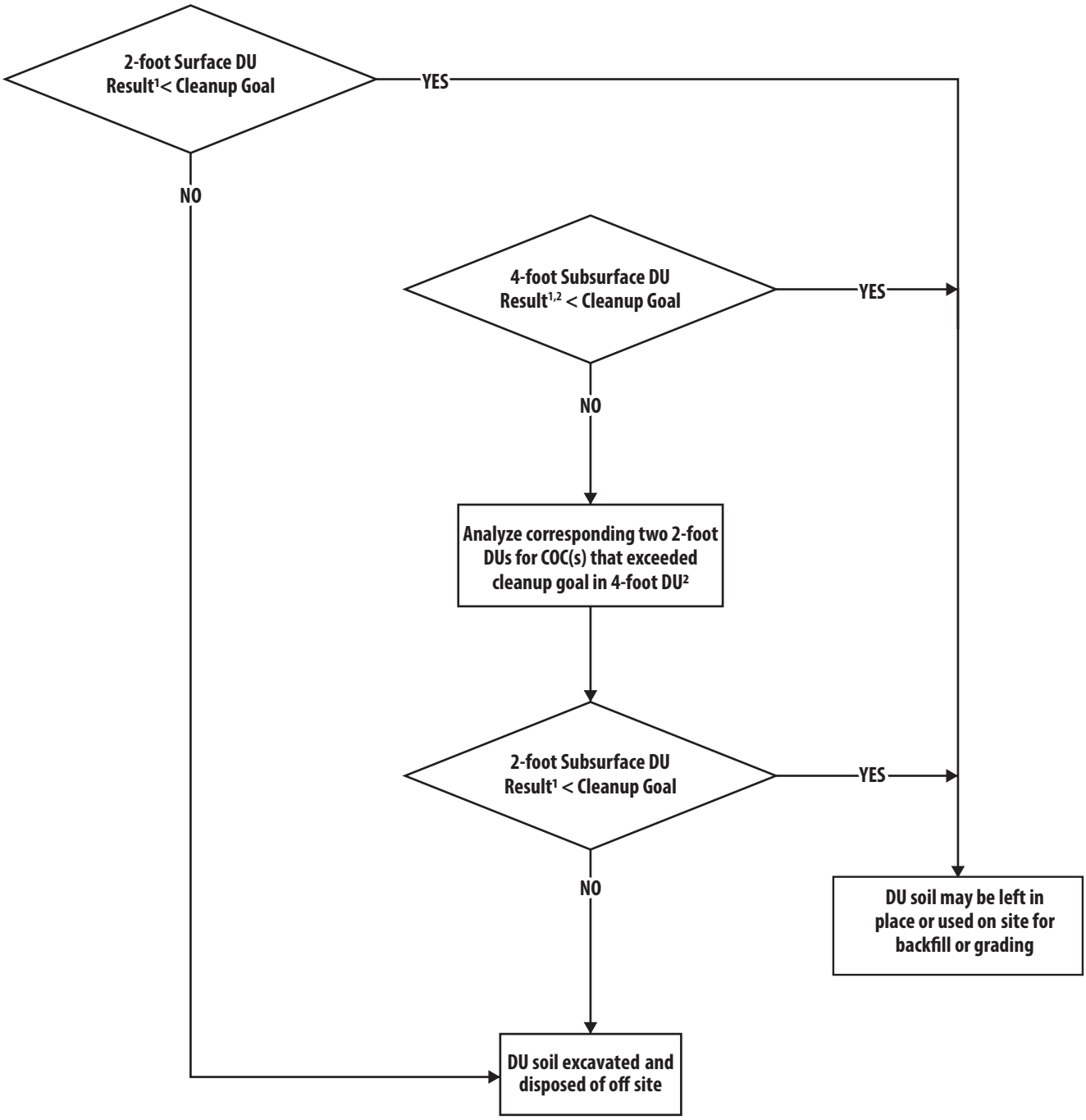
AOI Area of investigation
bgs Below ground surface
COC Contaminant of concern
DU Decision unit
IAG Investigation area grid
ISM Incremental sampling methodology

TETRA TECH

AOI 14, NASA Ames Research Center
Moffett Field, California

Figure 6
Example Scenario for Full-Scale Investigation

Design Site Characterization Sampling and Analysis Plan



Notes:

COC Contaminant of concern
DU Decision unit
95UCL 95th percentile upper confidence limit on the mean

[1] 95UCL concentration for each COC will be compared to cleanup goals

[2] Results for each COC will be considered independently. If the result for one COC in a 4-foot DU exceeds the cleanup goal, but the concentrations of the other COCs do not exceed cleanup goals, then the 4-foot DU would be split in half, and further analysis of the resulting two 2-foot DUs is required for the COC that exceeded the cleanup goal. No further analysis of the COCs that did not exceed the cleanup goal is required.

TETRA TECH

AOI 14, NASA Ames Research Center
Moffett Field, California

Figure 7
Decision Logic for Evaluation of DU Results

Design Site Characterization
Sampling and Analysis Plan

TABLE

Table 1. AOI 14 Pilot Study Triplicate Soil Sampling Data and Percent Relative Standard Deviation, Template

Final SAP/QAPP, AOI 14 Design Site Characterization

Analyte	Point ID	DU ID	Depth (feet bgs)	Field Replicate 1 (mg/kg)	Field Replicate 2 (mg/kg)	Field Replicate 3 (mg/kg)	RSD
Lead	FIAG06	FDU06A	0-2				
Lead	FIAG06	FDU06B	2-6				
Lead	FIAG06	FDU06C	6-10				
Lead	FIAG06	FDU06D	10-14				
Lead	FIAG06	FDU06E	14-18				
Lead	FIAG06	FDU06F	2-4				
Lead	FIAG06	FDU06G	4-6				
Lead	FIAG06	FDU06H	6-8				
Lead	FIAG06	FDU06I	8-10				
Lead	FIAG06	FDU06J	10-12				
Lead	FIAG06	FDU06K	12-14				
Lead	FIAG06	FDU06L	14-16				
Lead	FIAG06	FDU06M	16-18				
Lead	FIAG09	FDU09A	0-2				
Lead	FIAG09	FDU09B	2-6				
Lead	FIAG09	FDU09C	6-10				
Lead	FIAG09	FDU09D	10-14				
Lead	FIAG09	FDU09E	14-18				
Lead	FIAG09	FDU09F	2-4				
Lead	FIAG09	FDU09G	4-6				
Lead	FIAG09	FDU09H	6-8				
Lead	FIAG09	FDU09I	8-10				
Lead	FIAG09	FDU09J	10-12				
Lead	FIAG09	FDU09K	12-14				
Lead	FIAG09	FDU09L	14-16				
Lead	FIAG09	FDU09M	16-18				
Lead	FIAG20	FDU20A	0-2				
Lead	FIAG20	FDU20B	2-6				
Lead	FIAG20	FDU20C	6-10				
Lead	FIAG20	FDU20D	10-14				
Lead	FIAG20	FDU20E	14-18				
Lead	FIAG20	FDU20F	2-4				
Lead	FIAG20	FDU20G	4-6				
Lead	FIAG20	FDU20H	6-8				
Lead	FIAG20	FDU20I	8-10				
Lead	FIAG20	FDU20J	10-12				
Lead	FIAG20	FDU20K	12-14				
Lead	FIAG20	FDU20L	14-16				
Lead	FIAG20	FDU20M	16-18				
Total DDTs	FIAG06	FDU06A	0-2				
Total DDTs	FIAG06	FDU06B	2-6				
Total DDTs	FIAG06	FDU06C	6-10				
Total DDTs	FIAG06	FDU06D	10-14				

Table 1. AOI 14 Pilot Study Triplicate Soil Sampling Data and Percent Relative Standard Deviation, Template

Final SAP/QAPP, AOI 14 Design Site Characterization

Analyte	Point ID	DU ID	Depth (feet bgs)	Field Replicate 1 (mg/kg)	Field Replicate 2 (mg/kg)	Field Replicate 3 (mg/kg)	RSD
Total DDTs	FIAG06	FDU06E	14-18				
Total DDTs	FIAG06	FDU06F	2-4				
Total DDTs	FIAG06	FDU06G	4-6				
Total DDTs	FIAG06	FDU06H	6-8				
Total DDTs	FIAG06	FDU06I	8-10				
Total DDTs	FIAG06	FDU06J	10-12				
Total DDTs	FIAG06	FDU06K	12-14				
Total DDTs	FIAG06	FDU06L	14-16				
Total DDTs	FIAG06	FDU06M	16-18				
Total DDTs	FIAG09	FDU09A	0-2				
Total DDTs	FIAG09	FDU09B	2-6				
Total DDTs	FIAG09	FDU09C	6-10				
Total DDTs	FIAG09	FDU09D	10-14				
Total DDTs	FIAG09	FDU09E	14-18				
Total DDTs	FIAG09	FDU09F	2-4				
Total DDTs	FIAG09	FDU09G	4-6				
Total DDTs	FIAG09	FDU09H	6-8				
Total DDTs	FIAG09	FDU09I	8-10				
Total DDTs	FIAG09	FDU09J	10-12				
Total DDTs	FIAG09	FDU09K	12-14				
Total DDTs	FIAG09	FDU09L	14-16				
Total DDTs	FIAG09	FDU09M	16-18				
Total DDTs	FIAG20	FDU20A	0-2				
Total DDTs	FIAG20	FDU20B	2-6				
Total DDTs	FIAG20	FDU20C	6-10				
Total DDTs	FIAG20	FDU20D	10-14				
Total DDTs	FIAG20	FDU20E	14-18				
Total DDTs	FIAG20	FDU20F	2-4				
Total DDTs	FIAG20	FDU20G	4-6				
Total DDTs	FIAG20	FDU20H	6-8				
Total DDTs	FIAG20	FDU20I	8-10				
Total DDTs	FIAG20	FDU20J	10-12				
Total DDTs	FIAG20	FDU20K	12-14				
Total DDTs	FIAG20	FDU20L	14-16				
Total DDTs	FIAG20	FDU20M	16-18				
Total PCBs	FIAG06	FDU06A	0-2				
Total PCBs	FIAG06	FDU06B	2-6				
Total PCBs	FIAG06	FDU06C	6-10				
Total PCBs	FIAG06	FDU06D	10-14				
Total PCBs	FIAG06	FDU06E	14-18				
Total PCBs	FIAG06	FDU06F	2-4				
Total PCBs	FIAG06	FDU06G	4-6				
Total PCBs	FIAG06	FDU06H	6-8				

Table 1. AOI 14 Pilot Study Triplicate Soil Sampling Data and Percent Relative Standard Deviation, Template

Final SAP/QAPP, AOI 14 Design Site Characterization

Analyte	Point ID	DU ID	Depth (feet bgs)	Field Replicate 1 (mg/kg)	Field Replicate 2 (mg/kg)	Field Replicate 3 (mg/kg)	RSD
Total PCBs	FIAG06	FDU06I	8-10				
Total PCBs	FIAG06	FDU06J	10-12				
Total PCBs	FIAG06	FDU06K	12-14				
Total PCBs	FIAG06	FDU06L	14-16				
Total PCBs	FIAG06	FDU06M	16-18				
Total PCBs	FIAG09	FDU09A	0-2				
Total PCBs	FIAG09	FDU09B	2-6				
Total PCBs	FIAG09	FDU09C	6-10				
Total PCBs	FIAG09	FDU09D	10-14				
Total PCBs	FIAG09	FDU09E	14-18				
Total PCBs	FIAG09	FDU09F	2-4				
Total PCBs	FIAG09	FDU09G	4-6				
Total PCBs	FIAG09	FDU09H	6-8				
Total PCBs	FIAG09	FDU09I	8-10				
Total PCBs	FIAG09	FDU09J	10-12				
Total PCBs	FIAG09	FDU09K	12-14				
Total PCBs	FIAG09	FDU09L	14-16				
Total PCBs	FIAG09	FDU09M	16-18				
Total PCBs	FIAG20	FDU20A	0-2				
Total PCBs	FIAG20	FDU20B	2-6				
Total PCBs	FIAG20	FDU20C	6-10				
Total PCBs	FIAG20	FDU20D	10-14				
Total PCBs	FIAG20	FDU20E	14-18				
Total PCBs	FIAG20	FDU20F	2-4				
Total PCBs	FIAG20	FDU20G	4-6				
Total PCBs	FIAG20	FDU20H	6-8				
Total PCBs	FIAG20	FDU20I	8-10				
Total PCBs	FIAG20	FDU20J	10-12				
Total PCBs	FIAG20	FDU20K	12-14				
Total PCBs	FIAG20	FDU20L	14-16				
Total PCBs	FIAG20	FDU20M	16-18				

Notes:

RSD	Relative standard deviation as a percentage	IAG	Area of investigation
DDT	Dichlorodiphenyltrichloroethane	ID	Identification
DU	Decision unit	mg/kg	Milligram per kilogram
ft bgs	Feet below ground surface	PCB	Polychlorinated biphenyl

APPENDIX A
RESPONSE TO COMMENTS FROM U.S. ENVIRONMENTAL PROTECTION AGENCY AND CALIFORNIA DEPARTMENT OF FISH AND GAME – OFFICE OF SPILL PREVENTION AND RESPONSE

From: Fong, YvonneW
To: Finch, Kimberly (ARC-JQ); Mezquita, Marlon; Wells, Elizabeth@Waterboards; Stralka, Daniel
Cc: Bricknell, Kevin; Brodersen, Jason; MacMillan, Diane; Aragon, Dayna; Tisdale, Rob; Chesnutt, John
Subject: RE: NASA Ames AOI 14 SAP Followup - Proposed Resolution
Date: Friday, June 2, 2017 1:58:19 PM

Hello Kim,

Thank you for your last email summarizing the issues NASA, EPA and the Water Board have been discussing in relation to the use of an Incremental Sampling Methodology (ISM) approach to the investigation and cleanup of AOI 14 at NASA Ames Research Center, as well as the supplemental information you provided on April 26, 2017. As summarized in your email of April 19, 2017, we have been grappling with (1) defining appropriate decisions units (DUs) vertically and horizontally, (2) determining whether to apply a 95% Upper Confidence Limit (UCL) on calculated mean contaminant concentrations, and (3) establishing the representativeness and usefulness of post-excavation confirmation sampling.

In previous discussions, we reached agreement on changing the direction of the Pilot Study from the collection of ISM samples from three Investigation Area Grids (IAGs) with 20, 30 and 40 increments in triplicate to 30 increments in triplicate at each of the three selected IAGs. This will allow NASA to determine the intra- and inter-IAG variability across the site.

With regard to the vertical DUs, EPA concurs with the establishment of a shallower surface DU interval of either 6-inches (preferred) or 2-feet along with 4-foot deep DU intervals throughout the remainder of the fill material. Based on historical discrete sampling data showing PCB exceedances most frequently detected in surface soil (0 to 6-inches) with the majority of the known PCB mass present in the 2 to 4 foot interval, this should create DUs that account for the expected vertical variability in contaminant concentrations based on a conceptual site model of AOI 14 as a heterogeneous landfill.

While historic data provides a basis for defining the vertical DUs as described above, the establishment of the 100-foot by 100-foot IAGs described in the Removal Action Work Plan (RAWP) is not based on either the conceptual site model or historical sampling data. The horizontal limits of the IAGs are based on the needs of heavy-construction equipment operations (as stated in Worksheet 11b, Step 4 of the SAP/QAPP) rather than site-specific heterogeneity. Assuming approximately 10-20 cubic yards in a small-large dump truck, the soil in a 4-foot deep 100x100 foot IAG represents roughly 75-150 truckloads. Although NASA intends to collect 30 increments within this volume, EPA considers it necessary to apply a 95%UCL to the calculated mean for each IAG. This will account for horizontal variability in the soil and provide for national consistency with decision making at other cleanup sites.

With the shallower vertical DUs, ISM data throughout the volume of the fill material and application of the 95% UCL for each IAG, NASA could forgo applying the 95%UCL to the site-wide average (SWA) concentration. In addition, given NASA's plans to regrade the site, collection and analysis of post-excavation confirmation samples would not be required.

The approach outlined above is a site-specific determination for the AOI 14 removal action. EPA supports NASA's efforts to achieve unlimited use/unrestricted exposure at the site and apply innovative technologies such as ISM. EPA and the Water Board intend to submit additional specific comments on the RAWP but are eager to move the cleanup of AO1 14 forward.

Thank you,
Yvonne

YF seal signature

From: Finch, Kimberly (ARC-JQ) [mailto:kimberly.s.finch@nasa.gov]
Sent: Wednesday, April 19, 2017 2:35 PM
To: Fong, YvonneW <Fong.YvonneW@epa.gov>; Mezquita, Marlon <Mezquita.Marlon@epa.gov>; Wells, Elizabeth@Waterboards <Elizabeth.Wells@waterboards.ca.gov>; Stralka, Daniel <Stralka.Daniel@epa.gov>
Cc: Bricknell, Kevin <Kevin.Bricknell@tetratech.com>; Brodersen, Jason <Jason.Brodersen@tetratech.com>; MacMillan, Diane <Diane.MacMillan@tetratech.com>; Aragon, Dayna <Dayna.Aragon@tetratech.com>; Tisdale, Rob <rob.tisdale@tetratech.com>
Subject: NASA Ames AOI 14 SAP Followup

Hello everyone,

Wanted to follow up our recent discussions with additional information and clarification to address the main items brought up by EPA on the Draft SAP:

1. Sample Intervals: NASA concurs:

· 4-foot decision unit (DU) intervals will be established within each investigation area grid (IAG) (with option to decrease further to 2 feet). The sample collection approach in the Draft SAP already addresses collection of samples from these intervals. Reference to possible larger-interval samples will be removed from the Final SAP.

2. Need for a 0-6" interval DU: NASA does not concur:

· The existing soil horizon from 0-6 inches ('surface soil') at the site does not contain a higher likelihood of contamination than the other, deeper horizons based on

a. Analysis of existing soil data and
b. Site history and disposition of contaminants. Heterogeneous fill was placed and likely spread throughout the northern portion of the FSFA. Further, there are no known surface spills or releases to suggest contaminants may be concentrated in surface soil.

· The 4-foot interval (with option to decrease further to 2 feet) will provide adequate characterization of each DU, especially considering that 30 *wedge* sample increments will be collected in each DU.

· Existing surface soil in most areas will likely be redistributed and not remain on the surface after excavation and final grading.

· The site cleanup goals are applicable throughout the entire depth/volume of fill to address potential erosion into the adjacent storm water pond. There is no distinction between 'surface' or deeper soil characterization.

3. 95UCL applied to each DU: NASA does not concur:

· Fundamental to the ISM approach, collection of *30 wedge* sample increments per IAG/DU will provide superior characterization of soil contaminant levels than results from discrete sampling.

· Triplicate samples will be collected within 3 IAGs (to represent at least 10% of all samples) to calculate a coefficient of variation (CV) to demonstrate acceptable confidence.

· Applying the 95UCL to each DU incorporates laboratory error directly into sample result decision-making. While this is a true variability, applying this variability is not practiced in CA or EPA Region 9 decisions, other than adding data qualifiers or outright rejection. This results in application of variance beyond standard practice and we believe is not technically supported.

· The 95UCL calculation identifies variance within the central mean theory for the entire area sampled. Calculation of a traditional 95UCL of the mean within a site single data set does not identify variance within the central mean theory for the entire area – it only calculates the variance from within that single data set. Again,

this approach results in application of variance beyond standard practice and we believe is not technically supported.

· The 95UCL was not calculated or applied for Navy IR Site 25; the reported concentrations for discrete samples (1 sample collected every 10,000 sf of area!) were directly compared to the site cleanup goals.

· Similar to the approach for Navy Site 25, site-wide average concentrations will be calculated and compared to the lower Navy IR Site 25 site-wide average remediation goals. Additional soil may be excavated to meet the Navy IR Site 25 site-wide average remediation goals to apply the most conservative approach to address potential future erosion into the storm water pond.

4. 95UCL applied Site-Wide Average: NASA does not concur:

· In addition to the explanations for items 1-3 above, it should be noted that the Navy IR Site 25 site-wide average remediation goals are conservative in that they are protective of the most sensitive ecological receptors in the storm water pond. These cleanup goals are lower than the goals that would be applied to address the potential receptors and exposure pathways on AOI 14. Application of these goals to AOI 14 addresses potential erosion of soil from AOI 14 into the adjacent storm water pond at concentrations that would increase the site-wide average concentration within Navy IR Site 25 to levels that may pose a risk to aquatic receptors. This pathway will be controlled by (1) removal of contamination in AOI 14 soils above the do-not-exceed cleanup goals (protective of receptors in Site 25), (2) the slope of the remaining peninsula area, which will decrease erosion of the soil, and (3) vegetation on the side slopes of the remaining peninsula area, which will also decrease erosion of soil from AOI 14 into Site 25.

· The 95UCL was not calculated or applied for Navy IR Site 25 to the site-wide average concentration.

5. Confirmation DU following excavation(s): NASA does not concur based on the explanations provided in items 1-4 above.

· In addition to the explanations provided above, the primary consideration is that the site cleanup goals are applicable throughout the entire depth/volume of fill to address potential erosion into the adjacent storm water pond. There will be no distinction between 'surface' or deeper soil characterization. The entire DU volume will be considered the same concentration.

I will follow up regarding the next steps to working through these items.

Thanks,
Kim

Kimberly Finch, P.E.
Restoration Program Manager
Environmental Management Division
NASA Ames Research Center, MS 204-15
Moffett Field, CA 94035-0001
650.604.1294

EPA comments, dated July 10, 2017, on draft SAP/QAPP, submitted December 2017

GENERAL COMMENTS

1. EPA summarized the proposed resolution of issues related to the use of an ISM approach at AOI 14 in an email dated June 2, 2017 and attached below. Please revise the SAP/QAPP for consistency with earlier discussions.

Response: The sampling and analysis plan/quality assurance project plan (SAP/QAPP) has been revised for consistency with the earlier discussions documented in the June 2, 2017 email.

2. It is the understanding of the regulatory agencies that a meeting or conference call will be held following the completion of the pilot study to discuss the results, particularly the relative standard deviation, prior to initiation of the full-scale design site characterization program. The regulatory agencies reserve the right to provide additional comments on the proposed sampling program following discussion of the pilot study results with NASA.

Response: A meeting or conference call will be held with the regulatory agencies once the pilot study field investigation is complete. The results of the pilot study and analysis of relative standard deviation (RSD) of triplicate sample results for each contaminant of concern (COC) in all decision units (DU) within three investigation area grids (IAG) will be presented and discussed.

3. Worksheets #11a and b discuss the application of the relative standard deviation (RSD) where "If the calculated RSDs are greater than 35 percent, the RSDs will be applied to the decision unit (DU) results to assess if cleanup decisions can be effectively determined" and "If the calculated RSD is less than 35 percent, the contaminant of concern (COC) concentrations of the DU will be compared directly to the cleanup goals."

> While the Parties have agreed to vertical DUs no greater than 2-feet in depth, the horizontal boundaries of the DUs are not based on site-specific information.
>
> Therefore, a conservative risk-based decision making approach should include a confidence interval around the estimated mean through use the 95% upper confidence limit (UCL). The proposed decision making approach should be revised to include a "safety margin" to protect the decision from sample data that underestimates true site conditions.
>
> EPA considers it necessary to apply a 95%UCL to the calculated mean for each investigation area grid (IAG). This will account for horizontal variability in the soil and provide for national consistency with decision making at other cleanup sites.

Response:

a. Worksheets #11a and #11b have been updated to discuss the application of a confidence interval that will be applied to each DU incremental sampling methodology (ISM) sample result. Text has been included in the introduction and Worksheet #11a to introduce and describe the revised approach. Text in Worksheets #10, #11b, #14, #17 has also been added to maintain consistency with the revised approach.

   As a result of discussions with U.S. Environmental Protection Agency (EPA) and the San Francisco Bay Regional Water Quality Control Board (Regional Water Board), the National Aeronautics and Space Administration (NASA) has established the following vertical DUs for the full-scale investigation:

   - One shallow 2-foot depth interval (0 to 2 feet below ground surface [bgs]).
   - 4-foot depth intervals throughout the remaining depth of the fill material
   - If any of the calculated 95UCLs of a 4-foot DU exceeds any of the COC cleanup goals, the 4-foot DU would be split into two 2-foot DUs. New Figure 6 and revised Figure 7 illustrate this approach.

   In the pilot study, 2-foot and 4-foot DU results will be used to calculate the RSD that then will be used to calculate the 95%UCL at all DUs sampled at AOI 14 (see Worksheet #11a).

b. EPA has noted that application of a 95%UCL to the calculated mean provides for national consistency with decision making at other cleanup sites. Based on application of RSD for ISM by multiple federal and state agencies, there does not appear to be a national consistency, precedent, or guidance requiring the calculation of 95%UCL during collection of ISM samples. Use of DU results without the application of a 95%UCL has been implemented in many states and EPA regions throughout the U.S. The comment regarding national consistency likely refers to collection of discrete samples. However, NASA agrees to implement this approach at AOI 14 in the interest of moving the project forward.

4. As the pilot study includes samples from three IAGs as well as two steps-outs from each individual sample location, the language of the SAP/QAPP is sometimes confusing when referring to “triplicates” or “replicates.” Please ensure the SAP/QAPP consistently uses these terms. Alternatively, revise the SAP/QAPP to use distinct terms for the various groups of samples.

Response: The language has been updated throughout to clarify the differences between triplicates and replicate samples. Triplicates are now clarified to be “a set of three field replicates” throughout the document.

SPECIFIC COMMENTS

1. Introduction, page 11: In the third paragraph, clarify if the 65,000-cubic yard estimate of fill includes both ferrous and non-ferrous fill.

Response: The estimate of fill includes both ferrous and non-ferrous material. The last sentence of the third paragraph has been modified to clarify that the 65,000-cubic yards includes both ferrous and non-ferrous material.

2. Introduction, page 12: In the second paragraph, clarify that the cleanup goals based on wetland receptors represent cleanup goals protective of the most sensitive receptors.

Response: The second sentence in the paragraph has been revised to state "These *cleanup* goals *are* protective of *the most sensitive* wetland receptors at Navy IR Site 25."

3. Introduction, page 12, and Worksheet #10, page 30: Add that in addition to comparing residual concentrations to the cleanup goals, the residual site-wide average concentrations at AOI 14 will be calculated and compared to the Navy's Site 25 site-wide average remediation goals to ensure that residual concentrations are protective of wetland receptors at the stormwater pond. While this is discussed later in the Draft SAP/QAPP (Worksheet #11b), the regulatory agencies suggest it be presented when the cleanup goals are introduced.

Response: The following text was added immediately following the in-text tables of cleanup goals in the introduction and in Worksheet #10:

> "*In addition to comparing calculated 95UCL concentrations for each DU with the established cleanup goals above, the residual site-wide average concentrations at AOI 14 will be calculated on a volumetric basis and compared with the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors in the stormwater pond (Tetra Tech 2015). The Navy IR Site 25 site-wide average remediation goals are 33 mg/kg for lead, 0.016 mg/kg for total DDT, and 0.20 mg/kg for total PCBs.*"

4. Introduction, page 12: In the last paragraph, revise the fourth sentence as follows – "During the wet season, <u>rainfall and</u> rising water levels in the stormwater retention pond can inundate ~~the sides of~~ AOI 14 and carry soil into the surrounding SP." In addition, in the last sentence on the page, clarify why soil gas is not a medium of concern.

Response: During a major storm event, only the side slopes of AOI 14 would be inundated as the water level does not flood the surface of the FSFA. Therefore, the sentence has been revised as follows (modified text in italics):

> "During the wet season, rising water levels in the stormwater retention pond can inundate soil *along the perimeter* of AOI 14 and carry soil into the surrounding SP, *and rain may carry soil from the surface of AOI 14 into the surrounding SP*."

The following sentence, which was included in the Draft SAP/QAPP, justifies why soil gas is not an issue. No changes to the text have been made as a result of the second portion of the comment.

> *"None of the contaminants detected in soil at AOI 14 are volatile and groundwater exists below the bay mud in the vicinity of AOI 14; therefore, soil gas is not a medium of concern for AOI 14."*

5. Introduction, page 14: In the second paragraph, explain how soil collected using the two alternative methods described will be incorporated into the ISM samples and clarify if the laboratory SOPs include procedures for incorporating supplemental soil samples with soil obtained through the primary DPT soil boring.

Response: Soil from the hand-augered or angle-hole borings will be considered increments within a DU just like soil collected from the direct push technology (DPT) borings. Soil from each individual "increment" will have approximately equivalent soil volumes. Soil from all sampling increments will be incorporated into the ISM sample in the field, and therefore, the laboratory will not need to composite the soil increments. The last sentence of paragraph 2 has been revised to:

> "*From each increment location* collected using these *additional* methods, *a volume of soil equivalent to the soil volumes from each of the other increments* will be incorporated into the ISM samples at the appropriate depth horizons."

6. Introduction, page 14: The third paragraph states that hand auguring on side slopes and at the toe of the slope will be representative of the remaining 5% of the total soil volume. Explain how this determination was made.

Response: The determination was made based on a volumetric analysis of the soil volume of the side slopes versus the total volume in the rest of the IAG. The sentence has been modified to:

> "Hand augering on side slopes and at the toe of slope is intended to capture representative samples from the remaining 5 percent of the total soil volume of apparent artificial fill in the FSFA that comprises the side slope and toe of slope areas, *based on a volumetric analysis of soil within the side slopes compared with the volume of the rest of the IAG*."

7. Worksheets #5 and 9: Derrick Williamson will not be reviewing the SAP/QAPP, please delete his name from these Worksheets

Response: Mr. Williamson's name has been deleted from Worksheet #5. His name was not deleted from Worksheet #9, as that worksheet is a record of the scoping meeting from October 2016, which Mr. Williamson attended.

8. Worksheet #11a, page 34: The first full sentence on the page states that borings will form an approximate gridded pattern. For each IAG in the pilot study, state the approximate distance between borings in the sampling grid.

Response: The approximate distance between borings in each sampling grid in the pilot study and full-scale investigation is 20 feet. Sentences in the first paragraph of Step 5 in Worksheet #11a have been modified as follows:

> "Borings will be approximately evenly spaced within the IAG, forming an approximate gridded pattern, *resulting in borings approximately 20 feet apart*."
>
> "Triplicate samples (three field replicates) will be collected in an overlapping array by stepping out two times within a few feet from the original boring locations, *resulting in borings approximately 18 to 20 feet apart within the pilot study IAGs*."

In addition, the first sentence in the second paragraph of Step 5 in Worksheet #11b, and the same sentence in the Design Site Characterization section of the Introduction (fourth paragraph), have been updated with the distance between borings.

9. Worksheet #11a, page 35: The second bullet on the page states that "RSDs of triplicate results for lead, total DDTs, and total PCBs from the 20-, 30-, and 40- increment samples (will be reviewed) relative to the other triplicates. Clarify the two uses of "triplicates" in this bullet. See General Comment #4 above.

Response: The bullet is no longer applicable, as it has been deleted based on the revised sampling approach.

10. Worksheet #11a, page 37: Bullet number 3 states that implementation of evaluation of the 20-, 30-, and 40-increments will be "concurrent." This appears to contradict the last four bullets on page 35, which describe a sequential evaluation of the 20-, 30-, and 40-increment samples. Correct the apparent inconsistency and revise the text to reflect earlier discussions as summarized in the attached email dated June 2, 2017.

Response: NASA and regulatory agencies has agreed to change the pilot study from collection of ISM samples in three IAGs in triplicate from 20-, 30-, and 40-increments to 30 increments. Text describing collection of 20-, 30-, and 40-increments has been removed from the document.

11. Worksheet #11b, pages 39-40: In the final bullet on the page, revise the text regarding the Navy IR Site 25 site-wide average remediation goals to refer to these values as the remediation

goals for AOI 14. In addition, the last sentence of the bullet states that the residual volumetric average concentrations will be "calculated using the results of the additional site characterization." Clarify that this "additional site characterization" is the result of the ISM in this SAP/QAPP or describe the additional characterization that will occur.

Response: The referenced text is consistent with the Action Memorandum regarding the calculation of the residual volumetric site-wide average concentration and the application of Navy IR Site 25 site-wide average remediation goals. Table 1 of the Action Memorandum lists the cleanup goals for AOI 14. Section 2.1.4 of the Action Memorandum further states that, in addition to these cleanup goals, the residual site-wide average concentrations at AOI 14 will be calculated and compared with the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations at AOI 14 are protective of wetland receptors at Navy IR Site 25.

The last sentence of the bullet has been modified to (modified text in italics):

> "The residual volumetric average concentrations of lead, total DDT, and total PCBs will be calculated using the results of *this design site characterization investigation* prior to establishing the final removal action excavation plan."

12. Worksheet #11b, page 40: The lateral spatial boundary of the stormwater pond IAGs are defined in terms of discrete sample results that exceeded the cleanup goals; however, FSFA-SDS08 as depicted in Figure 3 appears to be significantly beyond "5 feet from the toe of the FSFA." Clarify the description/location of this sample.

Response: The phrase "collected 5 feet from the toe of the FSFA" will be struck from the text as the balance of the text describes the location of this discrete sample location. The balance of the text in this section (bullet describing lateral spatial boundaries of SP IAGs in Worksheet #11b Step 5) describes the relationship of the SP IAG boundaries to the previous discrete sample locations.

13. Worksheet #11b, page 41: The first full paragraph on the page describes the collection of triplicate ISM samples from three IAGs as a quality control (QC) measure. Include a description of how the three IAGs selected for QC will be selected or refer to Worksheet #17, which states that the pilot study IAGs will be the QC IAGs.

Response: The text has been deleted. Worksheet #11a (pilot study Project Quality Objectives) describes how the triplicate QC samples will be collected and evaluated in the pilot study. The following text, moved from Worksheet #11a Step 3, has been added to the bullet describing lateral spatial boundaries of Fill IAGs in Worksheet #11a Step 5 describes the rationale for selection of the three pilot study IAGs, as follows:

> "Lateral: The lateral extent of the pilot study will consist of three IAGs (IAG06, IAG09, IAG20) intentionally selected based on previously collected discrete data for COCs (see

Figure 3); only IAGs located on the interior of the FSFA were considered based on input provided by the regulatory agencies at the scoping meeting on October 27, 2016 (see Worksheet #9). IAG06 was selected as a pilot study IAG based on concentrations minimally exceeding cleanup goals for PCBs and DDTs (based on results from locations PEN-30 and FSDA-H003), IAG09 was selected based on concentrations of total PCBs and total DDTs exceeding cleanup goals (based on results from location PEN-27), and IAG20 was selected based on low concentrations of all COCs (based on results from location PEN-14). Three IAGs were selected to represent approximately 10 percent of the total IAGs."

14. Worksheet #11b, pages 42 - 43: The sample analysis decision logic does not explain what determinations will be made in the case where the initial or surface/ shallowest DU exceeds the cleanup goals but only some of the (deeper) secondary and final DUs exceed the cleanup goals. Revise the sample analysis decision logic to explain whether all soil in shallower DUs that meet the cleanup goals will also be disposed of offsite with soil from deeper secondary and final DUs that exceed the cleanup goals or whether the soil from shallower DUs will be excavated and stockpiled for possible reuse onsite for backfilling and grading purposes.

Response: Soil from shallower DUs that have results less than the cleanup goals will be stockpiled on-site and will be used as backfill during the final grading of the site, after all soil from DUs with results that exceed the cleanup goals has been removed. The following text has been added for clarification, and for consistency with the approach described in the response to general comment 3:

"1. If all *calculated 95UCL* COC concentrations in the *2-foot or 4-foot* ISM Fill DU*s* are less than cleanup goals, *then* all soil within the DU may remain in place or be *stockpiled and then* reused onsite for backfill or grading purposes.

15. Worksheet #11b, page 43: Revise bullet 6 to read "If any of the COC concentrations in final ISM Fill DUs exceed cleanup goals, all soil within the final ISM Fill DU will be removed and disposed of offsite."

Response: The bullet has been deleted as a result of other changes; however, the portion of the text that the commenter requested to be changed (addition of "any of the") before "COC" has been added to the bullets in Step 5 that still exist. In addition, "COC concentration" has been changed to "calculated 95UCL COC concentration" throughout to clarify the value that will be compare with the cleanup goals.

16. Worksheets #11a and b and Figure 7: Please identify the formula for calculating the RSD. Clarify if it uses the "N" or the "N-1" term.

Response: The formulas for calculating the RSD and the standard deviations (which is used within the RSD equation) are below. The "N-1" term will be used in the calculation for the standard deviation, which will in turn be incorporated into the calculation of the RSD. The "N-1" term is appropriate when the data set is a sample of the entire population, which is the

case at AOI 14. The standard deviation (SD) and RSD will be calculated as depicted in Equations 1 and 2:

Equation 1: $$SD_{triplicates} = \sqrt{\frac{\sum(x - x_{avg})^2}{n-1}}$$

Equation 2: $$RSD(\%)_{triplicates} = \frac{SD_{triplicates}}{x_{avg}} \times 100\%$$

Where:

- "*n*-1" = data set is a sample of the entire population
- *SD* = standard deviation of a set of triplicate results
- *x* = each result in the triplicate dataset
- x_{avg} = mean of all results in the dataset
- *n* = the number of replicates.

State of California
Department of Fish and Wildlife

M e m o r a n d u m

Date: August 29, 2017

To: Kimberly Finch, P.E., Restoration Program Manager
Environmental Management Division
National Aeronautics and Space Administration
Ames Research Center, MS 2014-15
Moffett Field, CA 94035-0001

From: "Allen" C.L. Tsao, Associate Toxicologist
Tami Nakahara, Senior Environmental Scientist (Specialist)
California Department of Fish and Wildlife
Office of Spill Prevention and Response
1700 K Street, Suite 250
Sacramento, CA 95811

Subject: **CDFW-OSPR Comments on the Redline strike-out of the Final Sampling and Analysis Plan (Field Sampling Plan/Quality Assurance Project Plan) Design and Site Characterization for Area of Investigation 14, National Aeronautics And Space Administration, Ames Research Center, Moffett Field, CA.**

The California Department of Fish and Wildlife, Office of Spill Prevention and Response (CDFW-OSPR), appreciates the opportunity to review the subject document. Due to contract constraints, staff at CDFW-OSPR were unable to provide comments on the Draft version of the document in a timely manner. Thus, the comments here are on the redline strike-out version of the Final Sampling and Analysis Plan, Design and Site Characterization, received on August 3, 2017.

The comments that follow are provided as part of our role as a natural resource Trustee for the State of California's fish and wildlife, and their habitats. The CDFW is the State's Trustee for fish and wildlife resources pursuant to Fish and Game Code Section 711.7. The CDFW is also designated as a Trustee for natural resources pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 107 (f)(2)(B).

Background

The National Aeronautics And Space Administration, Ames Research Center (NASA ARC) is located on the 2,200-acre former Naval Air Station (NAS) Moffett Field in Santa Clara County, about 10 miles north of the city of San Jose. Area of Investigation 14 (A01-14) is located in the northern portion of NAS Moffett Field and consists of three peninsulas [Former Soil Fill Area (FSFA),

Building N217 Fill Area, and Building N217A Fill Area] that extend into the Stormwater Retention Pond, at Navy Installation Restoration (IR) Site 25. Potential soil contaminants at A01-14 include heavy metals, polychlorinated biphenyls (PCBs) as Aroclors (total PCBs), and dichlorodiphenyltrichloroethane (DDT) and its metabolites (total DDT). A non-tidal wetland, providing potential habitat for the federally and State endangered salt marsh harvest mouse (SMHM), California Clapper Rail (renamed Ridgway's Rail), and California Least Tern, and the State threatened California Black Rail, is located adjacent to A01-14. All four species are also State Fully Protected Species. Other than collection for scientific research purposes for the recovery of the species, Fully Protected Species may not be "taken" or possessed at any time. CDFW is not authorized to issue a permit for the "take" of such Fully Protected Species, including trapping. The habitats at A01-14 consist of disturbed grassland, shrubs, ruderal, and coastal salt marsh vegetation, which may be utilized by these species.

CDFW-OSPR has been involved with the Navy's remedial activities at IR Site 25 adjacent to A01-14 and provided comments on various CERCLA documents as requested by the San Francisco Regional Water Quality Control Board. The following highlight the CERCLA documents reviewed thus far on A01-14, followed by the reference to our comment memoranda:

- A01-14 Engineering Evaluation/Cost Analysis (EE/CA) Request for Applicable or Relevant and Appropriate Requirements (Nakahara, 2014)
- Draft A01-14 EE/CA (Tsao and Nakahara, 2015)
- Draft Final A01-14 EE/CA (Tsao, 2015)
- Draft A01-14 Action Memorandum (Nakahara and Tsao, 2016)
- Draft Protected Species Mitigation and Habitat Restoration Plan for A01-14 (Appendix H of the Draft Remedial Action Work Plan [RAWP]) (Nakahara, 2017)
- Biological Assessment, Non-Time Critical Removal Action (NTCRA) for A01-14 (Appendix G of the Draft RAWP) (Nakahara, 2017).

General Comments

1. Since the NASA intends this NTCRA to be the final action and that the analytical results of the project will be used to evaluate the adequacy of the NTCRA with respect to the lower and appropriately more protective site-wide average remediation goal established for the adjacent Site 25 Record of Decision (Navy, 2009), CDFW-OSPR recommends the detection limits or the project action limits be at or below the site-wide remedial goal (See Specific Comments #16 and #19 below).

   Response: The comment is currently addressed in Worksheet #15 which shows that the detection limits for lead, pesticides, and PCBs are below the Navy Site 25 site-wide remediation goals.

2. For clarity, please replace the term "cleanup goal' with "removal action goal' globally throughout the document. The NTCRA removal action goal is not protective of the ecological receptors because the NTCRA removal action goals for lead, total DDT and total PCBs are based on mid-range adverse effects level for listed species (Navy, 2009).

   Response: The use of the term cleanup goal is consistent with the Action Memorandum and all other documents related to the removal action for AOI 14. The cleanup goal is defined in Section 2.1.4 of the Action Memorandum as equal to the do-not-exceed remediation goals identified for Navy IR Site 25. The Navy Site 25 ROD indicates that the remedial goals are protective of ecological receptors, and that the remediation goals are based on bird and mammal receptors (Navy 2009, p20). The specific remediation goals are based on risk-management decisions for total PCBs, and the risk –based concentrations derived from the high toxicity reference values (TRV) for lead and total DDT (Navy 2009, p21). As indicated in the Action Memorandum, if residual site-wide average concentrations of lead, total PCBs or total DDT at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, NASA will perform additional evaluation or removal.

3. As explained in General Comment #2 above, the NTCRA removal action goal is not protective of ecological receptors. Therefore, CDFW-OSPR does not recommend grading backfill be conducted unless the residual soil concentrations also meet the site-wide remediation goal for the adjacent Navy Site 25.

   Response: Section 2.1 of the RAWP indicates that the residual site-wide average concentrations at AOI 14 will be calculated and compared to the Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual soil concentrations are protective of wetland receptors at Navy IR Site 25. The selected cleanup goals are consistent with the remediation goals in IR Site 25 as explained in the response to General Comment #2.

4. CDFW-OSPR believes that it is very difficult to draw inferences on the performance of the remaining 21 Investigation Area Grids (IAGs) by obtaining the relative standard deviation (RSD[1] - also known as Coefficient of Variation) from the triplicates of only 3 pilot study grids. There is significant uncertainty with regards to extrapolating RSDs collected from the pilot study area to the un-sampled areas. There is no assurance that the distribution of contaminant concentrations in the sampled area is the same or similar to that of the un-sampled area. In the absence of data, any purported level of confidence that the RSDs for the pilot study area and the rest of the 26 grid areas will be similar is subjective. It also is contrary to the conceptual site model that describes the wastes at FSFA as highly heterogeneous (See Specific Comments #10, #11, #13, #14, and #17 below).

   Response: The selection of three IAGs and corresponding decision units represents 10 percent of the total IAGs and decision units. The use of 10 percent quality assurance samples is standard practice in environmental sampling and supported by U.S. EPA.

Specific Comments

1. *Page 11, Section Site Background and Previous Investigations; and page 38, SAP Worksheet #11b — Project Quality Objectives/Systematic Planning Process Statements for the Full-Scale Investigation.* The text states:

   > *The objective of the NTCRA is to prevent exposure of human receptors and terrestrial ecological receptors to surface and subsurface soil and to prevent erosion of soil that exceed cleanup goals from the FSFA into the SP* [stormwater pond] *to protect wetland ecological receptors.*

   Please revise the text to state, *"The objective of the NTCRA is to prevent exposure of human receptors and terrestrial and wetland ecological receptors to surface and subsurface soil..."* A01-14 provides wetland habitat along its base where pickleweed grows for State and Federal special status species such as the salt marsh harvest mouse (SMHM), Ridgway's Rail, and California Black Rail. Uplands at A01-14 within 50 feet of the salt marsh also provide habitat for these special status species.

   Response: NASA concurs and will revise the text as noted.

2. *Page 12, Section Contaminants of Concern and Conceptual Site Model.* The text states:

   > *The FSFA currently provides terrestrial habitat suitable for ecological receptors such as terrestrial plants, soil invertebrates, amphibians and reptiles, birds, and mammals that may be exposed to contaminated soil.*

   Please revise the text to state, *"The FSFA currently provides terrestrial habitat suitable for ecological receptors such as terrestrial plants, soil invertebrates, amphibians and reptiles, and terrestrial and wetland birds and mammals that may be exposed to contaminated soil'.* Please see Specific Comment 1.

   Response: NASA concurs and will revise the text as noted and with the clarification as underlined in the text below:
   "The FSFA <u>surface</u> currently provides terrestrial habitat suitable for ecological receptors such as terrestrial plants, soil invertebrates, amphibians, ~~and~~ reptiles, and <u>terrestrial</u> birds and mammals, <u>and wetland habitat for birds and mammals along its base where pickleweed grows,</u> that may be exposed to contaminated soil."

3. *Page 13, Section Contaminants of Concern and Conceptual Site Model; and page 38, SAP Worksheet #11b — Project Quality Objectives/Systematic Planning Process Statements for the Full-Scale Investigation.* The text states:

   > *During the wet season, rising water levels in the stormwater retention pond can inundate soil along the perimeter of AOI 14 and carry soil into the surrounding SP, and rain may carry soil from the surface of AOI 14 into the surrounding SP. This pathway is currently controlled by the ICAM* [Interim Corrective Action Measure] *silt fence...*

   During 2015, bay water overtopped the U.S. Fish and Wildlife Service levee, flooded the stormwater retention pond, and submerged portions of the silt fence. Above normal rainfall levels during the winter of 2016-2017 may have also

inundated portions of the silt fence. Please include a discussion as to whether these flooding events affected the exposure pathway controlled by the ICAM silt fence.

Response: Since 2013 when the silt barrier fencing was installed, NASA has conducted quarterly site inspections and annual sediment sampling from the SP bottom surrounding AOI 14. During the 2015 levee breach, water levels in the SP rose above the top of the silt fencing in some areas. Sediment sampling conducted in September 2016 did not indicate erosion of contaminants from AOI 14 into the SP. Water levels in the SP similarly rose above the top of the fencing through a gradual rise in water levels over the course of the 2016-2017 wet season. NASA continues to maintain the silt barrier fencing, which functions by settling soil/sediment that may be entrained in water behind the fencing. The AOI 14 peninsula, including side slopes, is heavily vegetated, which also limits potential erosion.

4. *Page 14, Section Corrective Actions to Date.* The text discusses the ICAM silt fence and annual sediment sampling to monitor concentrations of contaminants in the SP adjacent to the FSFA. Please include a discussion as to whether flooding of the silt fence in 2015 and 2016/2017 affected the concentrations of contaminants in the SP. Please see Specific Comment 3.

   Response: See the response to Specific Comment 3.

5. *Page 18, Worksheet #2. SAP Identifying Information.* The text states:

   > *The California Department of Fish and Wildlife provides input on State species concerns.*

The CDFW provides recommendations on biological avoidance, minimization, and mitigation measures for all special status species, including California threatened, endangered, fully protected species and State Species of Special Concern during the implementation of the work. In addition, CDFW provides recommendations on the Multi-incremental Sampling Design and Approach because this effort directly affects how exposures to species are evaluated. Finally, CDFW provides input so that the implementation of the project and the contaminants that may impact fish and wildlife are in compliance with State natural resource regulations. We also provide input on the protectiveness of the removal and remedial cleanup goals because the NTCRA removal and remedial goals are derived for listed species that are protected resources of the State of California. Therefore, please modify the quote above to state that the California Department of Fish and Wildlife provides recommendations to NASA on appropriate remedial cleanup values and biological measures to protect special-status species.

Response: The text will be modified to be state that “the California Department of Fish and Wildlife provides recommendations to NASA on appropriate remedial cleanup values and biological measures to protect special-status species.”

6. *Page 19, Worksheet #3. Distribution List.* Please add CDFW-OSPR reviewers in the distribution list.

   Response: CDFW-OSPR personnel will be added to the distribution list.

7. *Page 21. Worksheet #5. Project Organizational Chart.* Please add CDFW-OSPR in the project organizational chart. NASA has accepted several Fish and Game codes in the Final Action Memorandum for A01-14; therefore, CDFW-OSPR should be placed with direct lines of authority with NASA, the responsible party under CERCLA.

   Response: CDFW will be added into the project organization chart with the authority indicated in the Action Memorandum. The Action Memorandum accepts Fish and Game codes as relevant and appropriate, and as such NASA will work with CDFW to develop appropriate avoidance actions; however, NASA is responsible for determining which avoidance actions to implement. The organization chart will reflect CDFW as providing input on developing appropriate avoidance actions, such as described above in the response to Specific Comment #5.

8. *Page 32, Worksheet #11a. Project Quality Objectives/Systematic Planning Process Statements for the Pilot Study.* The text states:

> *ISM* [incremental sampling methodology] *sample results for lead, total DDTs, and total PCBs from up to 13 DUs* [Decision Units] *within each of the three pilot study IAGs, collected in triplicate (set of three field replicates) at each IAG.*

There will be three ISM results from the triplicate ISM samples from the pilot study. Please clarify how non-detect results for the chemicals of ecological concern will be incorporated into the 95 Upper Confidence Limit (95 UCL) calculation.

Response: The text will be revised to indicate that if one or two results for a triplicate are non-detect for a given analyte, then we will use the nonparametric Kaplan-Meier (KM) product limit method to estimate the concentration, SD, and RSD for that triplicate.

However, if all three results are non-detect for a triplicate, then the calculation of the SD, RSD, and 95 UCL will not be calculated. In these cases, it will be assumed that the triplicate meets goals for the RSD. The DU mean will be estimated as the average of the non-detects, and the result for that DU will still be retained as a non-detect result in the estimates of the site-wide average concentration. The DU mean will be compared to the cleanup goal in these cases. The text will be revised to include the proposed method of treating non-detect values in cases where all three results are non-detect.

The KM approach employs a well-studied method that has been used in the field of causal analysis for more than 50 years (Kaplan, E.L., and P. Meier. 1958. "Nonparametric Estimator from Incomplete Observations." Journal of the American Statistical Association. Volume 53. Pages 457-481.). The KM estimator is an empirical, nonparametric,

maximum likelihood procedure that can be applied to data with multiple reporting or detection limits.

9. *Page 33, Worksheet #11a. Project Quality Objectives/Systematic Planning Process Statements for the Pilot Study.*
   a. Please clarify how non-detect samples will be treated in the calculation of the RSDs.

      Response: See response to Comment number 8.

   b. There will be a total of at least 5 vertical DUs. With 3 pilot study areas, this totals at least 15 DUs, each with a set of replicates and associated RSDs for each DU. CDFW-OSPR recommends that the decision logic for selecting which RSD will be applied to the remaining 22 grids-DUs be completed in the subject document rather than leaving taking input from the regulatory agencies after RSD values are calculated for the 3 pilot study areas.

      Response: The total number of vertical 2-foot DUs within each grid may be up to nine (0-2, 2-4, 4-6, 6-8, 8-10, 10-12, 12-14, 14,-16, 16-18 feet bgs), in addition to the 4-foot DUs (2-6, 6-10, 10-14, 14-18 feet bgs), depending on the total depth of the IAG. In the southern end of the site, the depth to the bottom of fill is shallow and there may be only four 2-foot vertical DUs (0-2, 2-4, 4-6, 6-8 feet bgs), in addition to the 4-foot DU (2-6 feet bgs). The preferred methodology to apply the RSD strategy following receipt of the data is to take input from the regulatory agencies. This approach allows for iterative review of the results and the most effective means of applying the RSD results rather than predetermining the application of the RSD results.

10. *Page 35, Worksheet #11a. Project Quality Objectives/Systematic Planning Process Statements for the Pilot Study.* The text states:

    > *Based on the results of the pilot study, an appropriate RSD will be applied to all 24 Fill IAGs and two SP IAGs* [stormwater pond investigation area grids] *in order to calculate a 95UCL for each DU result. The appropriate RSD will be determined based on evaluation of the RSD dataset for each* COC [contaminant of concern] *(the average RSD for each analyte during the pilot study may be selected for example).*

    a. The Interstate Technology & Regulatory Council (ITRC) guidance warns that in determining the true mean of a DU, the opportunity for making errors is greatest when the DU is relatively heterogeneous and the replicates, by chance, give similar results (ITRC, 2012). Using the approach described in the subject document, the error may be further compounded by taking the "average" of the RSDs from the pilot study grids, thereby artificially compressing the RSDs, and making the subsequent RSDs uniform across the DU.

       Response: The strategy involves a review of all RSD results and selection of appropriate RSD values with concurrence from EPA and the Regional Water Board.

b. Moreover, there is no assurance that the distribution of contaminant concentrations in the pilot study area is the same or similar to the rest of the grids. The net effect of this approach would result in a 95 UCL that is neither intrinsically conservative nor permissive. This approach is *ad hoc* with no clear statistical underpinning, and therefore difficult to meaningfully interpret.

   Response: The strategy is consistent with industry-standard incremental sampling methodology techniques and several state's guidance, including the State of Hawaii. The State of Hawaii Department of Health guidance is considered the most representative and current guidance document applicable to this project since neither California nor EPA Region 9 have published guidance regarding incremental sampling.

c. In order to resolve Specific Comment #10a and #10b above, CDFW-OSPR recommends triplicates be taken for all IAGs, including the two SP IAGs. Initially, NASA can analyze one of the three ISM data. If the ISM result is significantly lower than the site-wide average, no action is needed. If ISM result is significantly higher than the site-wide average and exceeds the NTCRA removal goal, remove the DU. Finally, if the ISM value is borderline to the Site 25 site-wide average remedial goal, analyze the remaining replicates to generate a 95 UCL for the DU.

   Response: The proposed strategy is based on 10 percent quality control samples, including field replicates. Use of 10 percent quality control samples is very common in all soil sampling programs and is a commonly-used and accepted quality control metric by EPA and CalEPA.

d. The RSD generated from the three pilot study areas should be applied to the pilot study area as is. CDFW-OSPR does not recommend running an average across all the RSDs and applying it across all 26 grid areas.

   Response: The pilot study will generate several RSD results, therefore there is not necessarily a single or "as is" RSD value to be applied, which is the basis for conducting a review meeting to evaluate all of the RSD results. The document does not propose use of the average as the recommended strategy, it only provides it as an example of a possible result following review of the pilot study results.

11. *Page 35, SAP Worksheet #11a.* The text states:

    The RSD provides a quantitative evaluation of the ability of the increments to represent the contaminant heterogeneity and thereby measures the confidence of the reproducibility and accuracy of chemical analytical results for each DU.

    a. CDFW-OSPR agrees that the relative standard deviation, RSD can serve as an indicator of precision or reproducibility of the result. However, the RSD does not provide an indication on how accurate the ISM result is to the true mean (p. 69, 80, 152, 160, and 180; ITRC, 2012). Please remove the word *"accuracy'* from the text above.

Response: The collection of replicate data is the only mechanism to help evaluate accuracy of the true mean – however according to EPA guidance (EPA 2005, 2015), the term accuracy is used specifically to evaluate the measured sample concentrations with an established laboratory concentration, and therefore it will be removed from the text accordingly.

b. Because there is uncertainty in estimating the true mean concentration at a site, CDFW-OSPR supports the calculation of the 95 UCL on the mean to ensure that the true mean is captured from ISM sampling methodology (ITRC, 2012; DTSC EcoNote 2, 1999). In order to calculate the 95 UCL, the ITRC developed a formula to calculate a 95 UCL on the mean, based on a minimum of 3 replicate ISM samples (also called triplicates). The 95 UCL on the mean from the triplicate is specific to that DU. For this project, NASA proposes to use the 3 pilot IAGs (which have various depth DUs) and sample 3 replicates for each of the DUs within the pilot IAGs. The idea is to apply the sample standard deviation from the 3 IAGs to all of the 26 grid areas. However, this approach is problematic because the 95 UCL formula is intended for the triplicates specific to the DU.

   Response: NASA concurs that the ITRC guidance applies the 95UCL calculation to DUs for which triplicate samples are collected. 95UCLs are also applied to DUs without triplicate results assuming the heterogeneity of the DUs are consistent with each other, which is the case for AOI 14. Based on several discussions with EPA and Regional Water Board, NASA will apply 95UCLs to all DUs based on the results of the RSDs in the pilot study in order to add an acceptable margin of error to each DU.

   As stated in response to Specific Comment 10.d, the data from the pilot study will provide numerous RSD values as a basis for the other grid areas, therefore it is not a case of applying a singular RSD result to the other DUs. The application of the RSD from 10 percent of the IAGs has been determined to be appropriate for this project and is based on industry-standard for quality control, multiple guidance documents and comprehensive discussions and review by EPA and Regional Water Board.

c. The subject document states that one of the ways that the RSDs may be applied without taking triplicates in the remaining 24 grid areas is to categorize the RSDs from the 3 pilot study areas by how high the RSD-associated DU exceeds the NTCRA removal action goal. There is no scientific support for making this assumption, and it goes against the idea that the site is highly heterogeneous in contaminant distribution (please see Specific Comment #10).

   Response: The text does not state "categorize the RSDs from the 3 pilot study areas by how high the RSD-associated DU exceeds the cleanup goal." The relationship between the RSD and concentrations near the cleanup goals is one of the variables that will be evaluated to identify DUs that require excavation.

12. *Page 36, SAP Worksheet #11 a.* Please include CDFW-OSPR when it conducts meetings with the U.S. Environmental Protection Agency and the Regional Water Quality Control Board to discuss the pilot study results and determine the methodology for applying the RSDs to FSFA. Please rectify this globally in the subject document.

    Response: NASA will inform CDFW-OSPER of meetings to be held with EPA and the Regional Water Board to discuss the pilot study results.

13. *Page 37, SAP Worksheet #11a.* The text states that the performance and acceptance criteria are the outcome of the triplicate RSD analysis conducted during the pilot study. Please clarify this statement. There will be 12 subsurface RSDs for each analyte (4 subsurface x 3 pilot study areas). The RSDs cannot be accepted unquestioned. For example, if the RSD for a particular DU from a pilot study area is 70%, a corrective measure should be considered to increase the accuracy of the ISM result (such as increasing the number of increments). CDFW-OSPR recommends the subject document clearly specify the level of acceptable RSD for the pilot study areas and what corrective measure it will provide to achieve a desired RSD level.

    Response: There will be approximately 39 subsurface RSDs for each analyte (39 RSDs/Pilot Study = 13 DUs/IAG x 3 replicates/DU x 3 IAGs/pilot study) as indicated on SAP Worksheet #11a, is Step 3. The current strategy is based on a result of many communications and discussions between NASA, EPA, and Regional Water Board, and incorporates input from several incremental sampling guidance documents, including ITRC. Concerns identified in this and other CDFW comments have been identified by EPA and the strategy in this document reflects accepted approaches to the concerns.

    The RSD results will be used to evaluate performance and acceptance criteria; those criteria cannot be evaluated prior to review of the RSD results. The document neither implies nor states that RSDs will be accepted unquestioned – that is the intent of the pilot study results review meeting: to review and discuss the appropriate application of pilot study results to all the AOI 14 DUs. Within the provided example, if an RSD is 70%, then an associated 95UCL based on the 70% RSD will address the margin of error associated with the elevated RSD; additional increments are not necessary. Additional increments are potentially appropriate when RSD values exceed performance criteria and no margin of error is applied; however, that is not the case for this project.

14. *Page 46, SAP Worksheet #12.* The text states that 10 percent of samples will be analyzed in triplicates (i.e. the 3 pilot study areas) to help evaluate the confidence associated with each ISM sample. However, as stated in Specific Comment #13 above, there is no cut-off of the RSD value from the pilot study that would result in a corrective measure. CDFW-OSPR recommends the subject document specify a performance criteria (not just accepting any field RSDs) in order to evaluate the confidence level of the pilot study areas.

Response: Please see response to Specific Comment 13 regarding evaluation and application of RSDs.

15. *Page 54, SAP Worksheet #15— 15b Pesticides.* Table 15b lists 21 micrograms/kilogram as the Project Action Limit (PAL) for each of the DDTs and its metabolites. Please note that the sum of all the DDTs and its metabolites has to be at or below 16 micrograms/kilogram to meet the site-wide average concentration. CDFW-OSPR recommends the PAL be at least 5 micrograms/kilogram or lower (16 micrograms/kilogram divided by three).

    Response: Table 15b will be corrected to show that the sum of 4,4'-DDD , 4,4'-DDE and 4,4'-DDT must be less than the PAL.

16. *Page 55, SAP Worksheet #15 —15c PCBs.* Table 15c lists 0.20 mg/kg as the PAL for each of the Aroclors. Please note that the sum of all the Aroclors has to be at or below 0.210 mg/kg to meet the removal action goal, not the individual Aroclors. CDFW-OSPR recommends the PAL be lowered to 0.025 mg/kg (0.210 mg/kg divided by the eight Aroclors).

    Response: Table 15C will be corrected to show that the sum of the eight Aroclors must be less than the PAL.

17. *Page 59, Worksheet #17. Sampling Design and Rationale.* The text states:

    > *Triplicate samples collected in the pilot study IAGs will be used to meet* QC [Quality Control] *requirements in the full-scale study; therefore, one ISM sample will be collected from each depth interval (DU) in the remaining 21 Fill IAGs.*

    There is no scientific basis that triplicates from the pilot study area can be used to meet the QC requirements for the remainder of the grid areas. Please see Specific Comments #11 b, #11 c, #13, and #14).

    Response: As stated in response to Specific Comment 13, the current strategy is based on a result of many communications and discussions between NASA, EPA, and Regional Water Board and incorporates input from several incremental sampling guidance documents, including ITRC. The use of a percentage of samples to evaluate QA goals is standard practice in EPA and state programs. As an example, sampling programs do not require all laboratory samples to be evaluated for QA performance such as MS/MSD or laboratory duplicate results; instead, most frequently 10 percent of the samples are evaluated for QA performance standards and those results are used as overall evaluation of performance goals. The strategy for this project not only provides an evaluation of performance standards, but the results are actually applied to all data through the application of the 95UCLs. In traditional sampling programs, QA results are rarely applied to actual sample results, they are solely used as a pass/fail evaluation of those performance goals. As a result, the AOI 14 investigation provides additional margin of error beyond traditional discrete investigations.

18. *Page 54, Worksheet #15.*

a. The Project Quantitation Limit (PQL) for the individual congeners of DDT (i.e., 4,4'-DDD, 4,4'-DDT, and 4, 4'-DDD) are all at 10.5 micrograms/kilogram. Although this limit is below the site-wide average goal of 16 micrograms/kilogram for Total DDT, it is typically recommended that the PQL be five times lower than the remedial cleanup goal.

   Response: Table 15b in Worksheet #15 shows that the Laboratory's specific Limit of Quantification (LOQ) is more than 5 times lower than the PAL (project action level which includes the Site 25 site-wide average cleanup goal).

b. The PQL for the individual congeners of Aroclor are all at 0.105 mg/kg (except for Aroclor-1221). It is typically recommended that the PQL be five times lower than the remedial cleanup goal.

   Response: Table 15c in Worksheet #15 shows that the Laboratory's specific Limit of Quantification (LOQ) is more than 5 times lower than the PAL (project action level which includes the cleanup goal).

CDFW-OSPR appreciates the opportunity to review the subject document. If you have any questions regarding this review or require further details, please contact Allen Tsao regarding contaminants at (916) 323-4731 or by email at Allen.Tsao@wildlife.ca.gov or Tami Nakahara regarding biological issues at (916) 324-8452 (Tami.Nakahara@wildlife.ca.gov).

Peer-Reviewer: Regina Donohoe Ph.D., Staff Toxicologist

Reference List

DTSC (Department of Toxic Substances Control). 1999. EcoNote 2: Calculation of a range of intakes for vertebrate receptors in a Phase I Predictive Assessment for use with EPA Region IX BTAG Toxicity Reference Doses (TRVs) to obtain a range of hazard quotients. Sacramento, CA. June 9.

ITRC (Interstate Technology & Regulatory Council). 2012. Incremental Sampling Methodology. ISM-1. Washington, D.C. Interstate Technology & Regulatory Council, Incremental Sampling Methodology Team.

Nakahara, T. 2014. Memorandum to Kimberly Finch, P.E. Restoration Program Manager, National Aeronautics and Space Administration, Ames Research Center. RE: National Aeronautics and Space Administration Ames Research Center Area of Investigation 14 Engineering Evaluation/Cost Analysis Request for Applicable or Relevant and Appropriate Requirements for Moffett Field, California. CDFW-OSPR, Sacramento, CA. November 18.

Nakahara, T. 2017. Memorandum to Kimberly Finch, P.E. Restoration Program Manager, National Aeronautics and Space Administration, Ames Research Center. Combined review of Draft Protected Species Mitigation and Habitat Restoration Plan, Area of Investigation 14, National Aeronautics and Space Administration Ames Research Center, Moffett Field, California and the Biological Assessment, Area of Investigation 14, Non-Time Critical Removal Action National Aeronautics and Space Administration Ames Research Center, Moffett Field, CA. July 17.

Nakahara, T. and C.L. Tsao. 2016. Memorandum to Kimberly Finch, P.E. Restoration Program Manager, National Aeronautics and Space Administration, Ames Research Center. RE: Review of Draft Area of Investigation 14 Action Memorandum, National Aeronautics and Space Administration Ames Research Center, Moffett Field, California. CDFW-OSPR, Sacramento, CA. May 13.

Tsao, C.L. 2015. Email to Kimberly Finch, Restoration Program Manager, NASA ARC. RE: Comments on the Final EE/CA for NASA Ames A01-14 from the California Department of Fish and Wildlife, Office of Spill Prevention and Response. CDFW-OSPR, Sacramento, CA. October 2.

Tsao, C.L. and T. Nakahara. 2015. Memorandum to Kimberly Finch, Restoration Program Manager, NASA ARC. RE: Review of Draft Area of Investigation 14 Engineering Evaluation/Cost Analysis, National Aeronautics and Space Administration Ames Research Center, Moffett Field, California. CDFW-OSPR, Sacramento, CA. May 15.

US Department of the Navy (Navy). 2009. Final Record of Decision, Site 25. Former Naval Air Station Moffett Field, CA. November.

cc: Elizabeth Wells, PE, Remedial Project Manager (sent via electronic mail to: Elizabeth.Wells@waterboards.ca.gov)
Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Yvonne Fong, Remedial Project Manager (sent via electronic mail to: Fong.YvonneW@epa.gov)

Ned Black, Ph.D., Superfund Ecologist/Microbiologist (sent via email to: Black.Ned@epa.gov)
United States Environmental Protection Agency, Region 9
75 Hawthorne St. (SFD-8-1)
San Francisco, CA 94105

Tom Maurer, Ph.D., Environmental Contaminants Division (sent via email to: Thomas_Maurer@fws.gov)
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Kim Squires, Section 7 Coordinator (sent via email to: Kim_Squires@fws.gov)
Anne Mankowski, Section 7 (sent via email to: Anne_Mankowski@fws.gov)
U.S. Fish and Wildlife Service
Bay Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

Annee Ferranti, Senior Environmental Scientist (Supervisor) (sent via email to: Annee.Ferranti@wildlife.ca.gov)
California Department of Fish and Wildlife, Region 3 (Bay Delta Region)
7329 Silverado Trail
Napa, CA 94558

Melisa Amato, Refuge Manager (sent via email to: Melisa_Amato@fws.gov)
Don Edwards San Francisco Bay National Wildlife Refuge
U. S. Fish and Wildlife Service
9500 Thornton Ave
Newark, CA 94560

Brian Faulkner, Ph.D., Senior Toxicologist (sent via email to: Brian.Faulkner@dtsc.ca.gov)
Department of Toxic Substances Control
Human and Ecological Risk Office
Ecological Risk Assessment Section
8800 Cal Center Drive
Sacramento, CA 95826

Marlon Mezquita, Chemical Engineer, PE (sent via email to: Mezquita.Marlon@epa.gov)
U.S. EPA Region 9, EMD3-2
75 Hawthorne Street
San Francisco, CA 94105

Mark Malinowski, PG (sent via email to: Mark.Malinowski@dtsc.ca.gov)
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, 95826

Don Chuck, Chief, Environmental Management Division (sent via email to: Donald.M.Chuck@nasa.gov)
Environmental Management Division
NASA Ames Research Center
Moffett Field, CA 94035-0001

Bill Berry (sent via email: wmeberry@comcast.net)
RAB Community Co-Chair

Responses to California Department of Fish and Wildlife Comments Received on December 14, 2017

General Comments

1. **Grading of stockpiled soil should not be conducted unless all of the Chemical of Ecological Concern (COEC) concentrations in the stockpiled soil also meet the site-wide average remedial goals (from Navy IR 25 Record of Decision).** NASA has decided to set its removal action goal for AOI-14 to be the same as the do-not-exceed remediation goals at the adjacent Navy Installation Restoration Site 25 (IR 25). But NASA incorrectly claims that the do-not-exceed goal, by itself, is protective of ecological receptors. Under the Navy's IR 25 Record of Decision, the do-not-exceed and the site-wide average remediation goals both have to be met in order to be considered protective. The do-not-exceed remedial goals are based on mid-range effects levels (i.e., receptors would have already been affected at these levels). It is for this reason that CDFW-OSPR re-iterates our recommendation that the stockpiled soil should not be re-graded across the site unless the residual soil concentrations also meet the site-wide remediation goals.

   Additionally, CDFW-OSPR also does not recommend that the stockpiled soil that have contaminant level in between the removal action and the site-wide average remediation goal from IR 25 be placed offsite (off-AOI-14) where potential exposure pathways for ecological receptors may exist (e.g., indirect exposure of ecological receptors to contaminants in stockpiled soil via food-chain exposure).

   Response:
   As documented in the Action Memorandum, NASA is using a combination of the numeric cleanup goals and the Navy Site 25 site-wide (area-weighted) average remediation goals to evaluate the soil at the FSFA. The numeric cleanup goals (set equal to the Navy Site 25 do-not-exceed remediation goals) are protective of terrestrial ecological receptors on the FSFA. The numeric cleanup goals and the Navy site-wide average remediation goals are applied in series to be protective of wetland receptors in the adjacent stormwater retention pond. The Action Memorandum states:

   "To ensure that residual concentrations are protective of wetland receptors at Navy IR Site 25 (Tetra Tech 2015), the residual site-wide average concentrations at AOI 14 will be calculated and compared to the Navy IR Site 25 site-wide (area-weighted) average remediation goals. The Navy IR Site 25 site-wide average remediation goals are 33 milligrams per kilogram (mg/kg) for lead, 0.016 mg/kg for total DDT, and 0.200 mg/kg for total PCBs. If residual site-wide average concentrations of lead, total PCBs, and total DDT at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14."

   The application of the site-wide (area-weighted) average remediation goal at AOI 14 is described in Section 2.1 of the Removal Action Work Plan:
   "The residual site-wide average concentration at AOI 14 will be calculated using the results of the additional site characterization described in Section 3.2. Volumetric average concentrations

of lead, total DDT, and total PCBs remaining in soil at the site after the removal action will be compared to the Navy IR Site 25 site-wide average remediation goals. If residual site-wide average concentrations of lead, total DDT, or total PCBs at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14 as part of this NTCRA."

The results of the ISM sampling will be compared to the cleanup goals for AOI 14. Decision units with contaminant concentrations that exceed the cleanup goals will be identified for excavation and off-site disposal. The volumetric average concentration of site contaminants will be calculated using data from the remaining decision units (those with contaminant concentrations below the cleanup goals). This calculated volumetric average concentration will be compared to the Navy Site 25 site-wide average remediation goal. If necessary, additional decision units will be identified for excavation and off-site disposal and the residual volumetric average concentration will be recalculated. This cycle will continue until the residual site-wide volumetric average concentrations of lead, total DDT, and total PCBs are below the Navy Site 25 site-wide average remediation goal. All of these calculations will be completed before excavation begins so soil can be properly segregated as it is removed. The decision units identified for excavation and off-site disposal (based on the cleanup goals or to achieve the residual site-wide average remediation goal) will be excavated and directly loaded onto trucks if possible. Decision units that will not be excavated will remain in place or may be graded to provide the required slope and habitat described in the RAWP.

After the removal action is complete, all soil with concentrations of lead, total DDT, and total PCBs that exceed the cleanup goals will be disposed of off-site and the volumetric site-wide average concentrations of lead, total DDT, and total PCBs remaining at AOI 14 will be less than the Navy Site 25 site-wide (area-weighted) remediation goal.

2. **A performance or acceptance criteria for the relative standard deviations (RSDs) should be made explicitly in the Sampling and Analysis Plan (SAP).** The performance or acceptance criteria for the RSDs for each of the Decision Units (DUs, most were approximately 100 ft x 100 ft in size) were specified at 35% in the previous version of the SAP. The numeric performance or acceptance criteria are now removed from the most recent version of the SAP. The absence of such criteria does not appear to meet the stated project quality objective. There is also no corrective measure if the RSD of a DU was to exceed performance or acceptance criteria (e.g., increase number of increments). It is rather unprecedented and highly unusual not to have performance or acceptance criteria in a SAP. CDFW-OSPR cannot endorse a SAP that does not have a performance or acceptance criteria clearly specified. CDFW-OSPR recommends that a performance or acceptance criteria or a cut-off value for RSDs be specified (such as 35%) above which would trigger a corrective measure (e.g., increase the number of increments).

Response: The measurement performance criteria for each set of triplicate samples identified in Worksheet #12 has not been modified since the Draft version of the SAP (December 2016), and is specified as less than or equal to 35%. As indicated in Worksheet #11a, Step 5, "an RSD of 35

percent indicates good precision for estimates of the average (ITRC 2012) and reliable data for decision making (Hawai'i Department of Health [DOH] 2016). …The greater the RSD, the less confidence there is that the mean contaminant concentration estimated for any individual DU is representative of the true mean for the DU (Hawai'i DOH 2016)." In the agreed-upon approach with the EPA and Regional Water Board, the RSDs for 13 DUs in each of 3 IAGs (a total of 39 sets of triplicate samples) will be calculated and evaluated in the pilot study, and an RSD will be selected based on the results during a joint meeting with NASA and the regulatory agencies. Although a corrective action is not specified if an RSD for a triplicate sample set exceeds 35%, NASA and the regulatory agencies will take all calculated RSDs into account when selecting the RSD during the agency meeting.

3. **Decision Process on how RSDs from three pilot DUs would be used is absent.** There is no decision process described detailing how the RSDs generated from three pilot study DUs will be applied to the remaining 23 DUs. This decision process should be determined *a priori* and not after receiving the results. Although the document provides a description of a process that uses the average of RSDs, in the response to comment NASA states that it does not propose to use the average as the recommended strategy. Rather the document only provides the "averaging of RSDs" as an example of a possible result. Simply stated, there is no clear process that describes how the RSDs will be applied. CDFW does not believe that it is adequate to rely upon an agency discussion after the RSD values are generated. The lack of such decision process constitutes a gap in the decision-making process. CDFW-OSPR recommends this document clearly specify a decision process on how RSD results from the three pilot DUs will be selected for other 23 DUs.

   Response: Per agreement with the EPA and Water Board, and as described in Worksheet #11, RSDs will be calculated for each of the triplicate sets, and the RSD dataset will be statistically evaluated as a whole. NASA will provide the methods and results of the statistical evaluation for agency review prior to the agency meeting, and NASA will work with the agencies at the meeting to agree on the RSD selected to apply to the results. The statistical evaluation approach will depend on the results of the RSD calculations. Some of the statistical evaluations that NASA may employ are: 1) comparison of RSDs across each pilot study IAG using IAG T-test or Wilcoxon-Mann-Whitney (if datasets are similar); 2) analysis of variance across depths and IAGs (if datasets do not have a clear trend); 3) calculation of the average RSD; and 4) statistical tests on subgroups of the data, such as depth intervals).

4. **There is no statistical valid methodology for using the RSDs from three DUs and applying it to the remaining 23 DUs.** With regard to the selection of three DUs out of the total of 26 DUs to generate RSDs, NASA's statement that "the use of 10 percent quality assurance samples is standard practice in environmental sampling" is a mis-application of the 10% QA rule. The idea that the variability of each of the 26 DUs can be represented by taking triplicates from 3 DUs is contrary to the conceptual site model that describes the wastes at FSFA as highly heterogeneous. In other words, the representativeness of three DUs for the remaining 23 DUs has not been addressed by the redline strikeout version of the SAP. To use a RSD generated from one DU to calculate a 95 UCL for another

is not statistically defensible. CDFW-OSPR maintains our recommendation that triplicate samples be taken for all 26 DUs so that a 95 UCL on the mean for each DU can be generated and compared against the removal action goal (and the lower, site-wide average remediation goals).

Recommended response: Collection of 10 percent triplicate samples at each IAG is common practice within ISM projects throughout the U.S. NASA will rely on the pilot study triplicate data to calculate a confidence interval that will be applied to each of the single DU results in the full-scale study. As indicated in Worksheet #11a, Step 4, the pilot study IAGs were selected based on previously collected discrete data for COCs: IAG06 was selected as a pilot study IAG based on concentrations minimally exceeding cleanup goals for PCBs and DDTs, IAG09 was selected based on concentrations of total PCBs and total DDTs exceeding cleanup goals, and IAG20 was selected based on low concentrations of all COCs. In addition, the number of IAGs (three) were selected to represent approximately 10 percent of the total IAGs.

From: Tsao, Allen@Wildlife [Allen.Tsao@wildlife.ca.gov]
Sent: Thursday, December 14, 2017 2:04 PM
To: Finch, Kimberly (ARC-JQ)
Cc: Wells, Elizabeth@Waterboards; Fong.YvonneW@epa.gov; Black.Ned@epa.gov; thomas_maurer@fws.gov; Squires, Kim@fws.gov; Anne_Mankowski@fws.gov; Ferranti, Annee@Wildlife; Mezquita.Marlon@epa.gov; Chuck, Donald M. (ARC-JQ); Joab, Bruce@Wildlife; Anderson, Michael@Wildlife; Cho, Gail@Wildlife; wmeberry@comcast.net; LaBonty, Tami@Wildlife
Subject: NASA: SAP and Site Characterization for AOI-14

12/14/17

Hi Kim,

The California Department of Fish and Wildlife, Office of Spill Prevention and Response (CDFW-OSPR), appreciates NASA providing a response to our comments (dated August 29, 2017) on the redline strike out version of the Final Sampling and Analysis Plan Design and Site Characterization for AOI-14. We have the following comments to NASA's responses received on November 21, 2017. Please include the following comments in your administrative record. If you have any questions or would like to discuss this further, please let us know.

RE: Outstanding comments and concerns regarding the grading of fill material above the site-wide average and the application of the multi-incremental sampling approach.

General Comments

1. **Grading of stockpiled soil should not be conducted unless all of the Chemical of Ecological Concern (COEC) concentrations in the stockpiled soil also meet the site-wide average remedial goals (from Navy IR 25 Record of Decision).** NASA has decided to set its removal action goal for AOI-14 to be the same as the do-not-exceed remediation goals at the adjacent Navy Installation Restoration Site 25 (IR 25). But NASA incorrectly claims that the do-not-exceed goal, by itself, is protective of ecological receptors. Under the Navy's IR 25 Record of Decision, the do-not-exceed and the site-wide average remediation goals both have to be met in order to be considered protective. The do-not-exceed remedial goals are based on mid-range effects levels (i.e., receptors would have already been affected at these levels). It is for this reason that CDFW-OSPR re-iterates our recommendation that

the stockpiled soil should not be re-graded across the site unless the residual soil concentrations also meet the site-wide remediation goals.

Additionally, CDFW-OSPR also does not recommend that the stockpiled soil that have contaminant level in between the removal action and the site-wide average remediation goal from IR 25 be placed offsite (off-AOI-14) where potential exposure pathways for ecological receptors may exist (e.g., indirect exposure of ecological receptors to contaminants in stockpiled soil via food-chain exposure).

2. **A performance or acceptance criteria for the relative standard deviations (RSDs) should be made explicitly in the Sampling and Analysis Plan (SAP).** The performance or acceptance criteria for the RSDs for each of the Decision Units (DUs, most were approximately 100 ft x 100 ft in size) were specified at 35% in the previous version of the SAP. The numeric performance or acceptance criteria are now removed from the most recent version of the SAP. The absence of such criteria does not appear to meet the stated project quality objective. There is also no corrective measure if the RSD of a DU was to exceed performance or acceptance criteria (e.g., increase number of increments). It is rather unprecedented and highly unusual not to have performance or acceptance criteria in a SAP. CDFW-OSPR cannot endorse a SAP that does not have a performance or acceptance criteria clearly specified. CDFW-OSPR recommends that a performance or acceptance criteria or a cut-off value for RSDs be specified (such as 35%) above which would trigger a corrective measure (e.g., increase the number of increments).

3. **Decision Process on how RSDs from three pilot DUs would be used is absent.** There is no decision process described detailing how the RSDs generated from three pilot study DUs will be applied to the remaining 23 DUs. This decision process should be determined *a priori* and not after receiving the results. Although the document provides a description of a process that uses the average of RSDs, in the response to comment NASA states that it does not propose to use the average as the recommended strategy. Rather the document only provides the "averaging of RSDs" as an example of a possible result. Simply stated, there is no clear process that describes how the RSDs will be applied. CDFW does not believe that it is adequate to rely upon an agency discussion after the RSD values are generated. The lack of such decision process constitutes a gap in the decision-making process. CDFW-OSPR recommends this document clearly specify a decision process on how RSD results from the three pilot DUs will be selected for other 23 DUs.

4. **There is no statistical valid methodology for using the RSDs from three DUs and applying it to the remaining 23 DUs.** With regard to the selection of three DUs out of the total of 26 DUs to generate RSDs, NASA's statement that "the use of 10 percent quality assurance samples is standard practice in environmental sampling" is a mis-application of the 10% QA rule. The idea that the variability of each of the 26 DUs can be represented by taking triplicates from 3 DUs is contrary to the conceptual site model that describes the wastes at FSFA as highly heterogeneous. In other words, the representativeness of three DUs for the remaining 23 DUs has not been addressed by the redline strikeout version of the SAP. To use a RSD generated from one DU to calculate a 95 UCL for another

is not statistically defensible. CDFW-OSPR maintains our recommendation that triplicate samples be taken for all 26 DUs so that a 95 UCL on the mean for each DU can be generated and compared against the removal action goal (and the lower, site-wide average remediation goals).

Sincerely,
Allen Tsao

Associate Toxicologist
California Dept of Fish and Wildlife
Office of Spill Prevention and Response
1700 K Street, Suite 250
Sacramento, CA 95811
Allen.Tsao@wildlife.ca.gov
916-323-4731

ATTACHMENT 1
STANDARD OPERATING PROCEDURES

(Provided on CD)

TETRA TECH FIELD SOPS

BC LABORATORY SOPS

SGS LABORATORY SOPS

TETRA TECH FIELD SOPS

SOP NO. 002-3	General Equipment Decontamination
SOP NO. 005-2	Soil Sampling
SOP NO. 019-7	Packaging and Shipping Samples
SOP NO. 024-2	Recording Notes in Field Logbooks
SOP NO. 203-0	Laboratory Analytical Data Verification – Minimum Requirements

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 3

Last Reviewed: June 2009

Quality Assurance Approved	6-19-09 Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap, obtained in powder detergent form and dissolved in water

Liquinox: Nonphosphate soap, obtained in liquid form for mixing with water

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992a. "Guide to Management of Investigation-Derived Wastes." Office of Solid Waste and Emergency Response. Washington D.C. EPA 9345.3-03FS. January.

EPA. 1992b. "RCRA Ground-Water Monitoring: Draft Technical Guidance." Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). http://www.ert.org/mainContent.asp?section=Products&subsection=List

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles
- Alconox or Liquinox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Isopropanol (pesticide grade)
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, general sampling equipment, and groundwater sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums (refer to Section 3.0).

Personnel decontamination procedures will be as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

4. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.

5. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.

6. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.

7. Remove disposable gloves and place them in plastic bag for disposal.

8. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on site before drilling operations begin, between borings, and at completion of the project. Decontamination may be conducted on a temporary decontamination pad constructed at satellite locations within the site area in support of temporary work areas. The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Decontamination pads may be constructed of concrete, wood, or plastic sheeting, depending on the site-specific needs and plans. Wash waters and contaminated soil generated during decontamination activities should be considered contaminated and thus, should be collected and containerized for proper disposal.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned and placed on polyethylene sheeting on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

The drilling auger, bits, drill pipe, any portion of drill rig that is over the borehole, temporary casing, surface casing, and other equipment used in or near the borehole should be decontaminated by the drilling subcontractor as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Remove loose soil using shovels, scrapers, wire brush, etc.
4. Steam clean or pressure wash to remove all visible dirt.
5. If equipment has directly or indirectly contacted contaminated media and is known or suspected of being contaminated with oil, grease, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.
6. To the extent possible, allow components to air dry.
7. Wrap or cover equipment in clear plastic until it is time to be used.
8. All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING DOWNHOLE EQUIPMENT DECONTAMINATION

All soil sampling downhole equipment should be decontaminated before use and after each sample as follows:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Prior to sampling, scrub the split-barrel sampler and sampling tools in a wash bucket or tub using a stiff, long bristle brush and Liquinox or Alconox solution.

4. After sampling, steam clean the sampling equipment over the rinsate tub and allow to air dry.

5. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.

6. Containerize all water and rinsate; disposable single-use sampling equipment should also be containerized.

7. Decontaminate all equipment placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. Wipe the tape and probe with a disposable Alconox- or Liquinox-impregnated cloth or paper towel.
4. If immiscible layers are encountered, the interface probe may require steam cleaning or washing with pesticide-grade isopropanol.
5. Rinse with deionized water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of personal protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (isopropanol, methanol, or hexane) rinse, if applicable, or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (isopropanol, methanol, or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

2.6 GROUNDWATER SAMPLING EQUIPMENT

The following procedures are to be employed for the decontamination of equipment used for groundwater sampling. Decontamination is not necessary when using disposable (single-use) pump tubing or bailers. Bailer and downhole pumps and tubing decontamination procedures are described in the following sections.

2.6.1 Bailers

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Evacuate any purge water in the bailer.

4. Scrub using soap and water and/or steam clean the outside of the bailer.

5. Insert the bailer into a clean container of soapy water. Thoroughly rinse the interior of the bailer with the soapy water. If possible, scrub the inside of the bailer with a scrub brush.

6. Remove the bailer from the container of soapy water.

7. Rinse the interior and exterior of the bailer using tap water.

8. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol.

9. Rinse the bailer interior and exterior with deionized water to rinse off the tap water and solvent residue, as applicable.

10. Drain residual deionized water to the extent possible.

11. Allow components to air dry.

12. Wrap the bailer in aluminum foil or a clean plastic bag for storage.

13. Containerize the decontamination wash waters for proper disposal.

2.6.2 Downhole Pumps and Tubing

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of personal protection as was used for sampling.

3. Evacuate any purge water in the pump and tubing.

4. Scrub using soap and water and/or steam clean the outside of the pump and, if applicable, the pump tubing.

5. Insert the pump and tubing into a clean container of soapy water. Pump/run a sufficient amount of soapy water to flush out any residual well water. After the pump and tubing are flushed, circulate soapy water through the pump and tubing to ensure that the internal components are thoroughly flushed.

6. Remove the pump and tubing from the container.

7. Rinse external pump components using tap water.

8. Insert the pump and tubing into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).

9. If groundwater contains or is suspected to contain oil, grease, PAH, PCB, or other hard to remove organic materials, rinse the pump and tubing with pesticide-grade isopropanol.

10. Rinse the pump and tubing with deionized water to flush out the tap water and solvent residue, as applicable.

11. Drain residual deionized water to the extent possible.

12. Allow components to air dry.

13. For submersible bladder pumps, disassemble the pump and wash the internal components with soap and water, rinse with tap water, isopropanol (if necessary), and deionized water, and allow to air dry.

14. Wrap pump and tubing in aluminum foil or a clean plastic bag for storage.

15. Containerize the decontamination wash waters for proper disposal.

3.0 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) can include disposable single-use PPE and sampling equipment, soil cuttings, and decontamination wash waters and sediments. Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage will be provided in project-specific documents, or separate direction will be provided by the project manager. The following guidelines are provided for general use:

1. Assume that all IDW generated from decontamination activities contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

2. Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.

3. Label IDW storage containers with the facility name and address, date, contents, company generating the waste, and an emergency contact name and phone number.

4. Temporarily store the IDW in a protected area that provides access to the containers and allows for spill/leak monitoring, sampling of containers, and removal following determination of the disposal method.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

SOIL SAMPLING

SOP NO. 005

REVISION NO. 2

Last Reviewed: June 2009

Quality Assurance Approved	6-19-09 Date

1.0 BACKGROUND

Soil sampling is conducted for three main reasons: for laboratory chemical analysis, laboratory physical analysis, or visual classification and field screening. These three sampling objectives can be achieved separately or in combination with each other. Sampling locations are typically chosen to provide chemical, physical, or visual information in both the horizontal and vertical directions. A sampling and analysis plan is used to outline sampling methods and provide preliminary rationale for sampling locations. Sampling locations may be adjusted in the field based on the screening methods being used and the physical features of the area.

1.1 PURPOSE

Soil sampling is conducted to determine the chemical, physical, and visual characteristics of surface and subsurface soils.

1.2 SCOPE

This standard operating procedure (SOP) describes procedures for soil sampling in different areas using various implements. It includes procedures for test pit, surface soil, and subsurface soil sampling, and describes ten soil sampling devices.

1.3 DEFINITIONS

Hand auger: Instrument attached to the bottom of a length of pipe that has a crossarm or "T" handle at the top. The auger can be closed-spiral or open-spiral.

Bucket auger: A type of auger that consists of a cylindrical bucket 10 to 72 inches in diameter with teeth arranged at the bottom.

Core sampler: Thin-wall cylindrical metal tube with diameter of 0.5 to 3 inches, a tapered nosepiece, a "T" handle to facilitate sampler deployment and retrieval, and a check valve (flutter valve) in the headpiece.

EnCore™ sampler: A disposable volumetric sampling device. It comes in sample sizes of 5 and 25 grams. It is a hermetically sealed, single-use soil sampler made from a high-tech, inert polymer. EnCore™ samplers are used to collect soil samples with zero headspace, as required for volatile organic compound analysis. Each sample is collected using a reuseable "T" handle.

Spatulas or Spoons: Stainless steel or disposable instruments for collecting loose unconsolidated material.

Trier: Tube cut in half lengthwise with a sharpened tip that allows for collection of sticky solids or loosening of cohesive soils.

Trowel: Metal or disposable tool with a scooped blade 4 to 8 inches long and 2 to 3 inches wide with a handle.

Split-Spoon (or Split-Barrel) Sampler: Thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to drill rods.

Thin-Wall Tube Sampler: Steel tube (1 to 3 millimeters thick) with a tapered bottom edge for cutting. The upper end is fastened to a check valve that is attached to drill rods.

Volatile Organics Analysis (VOA) Plunger: Disposable, plastic, single-use soil sample collection device for volatile organic compound sample collection.

1.4 REFERENCES

U.S. Environmental Protection Agency. (EPA) 1984. "Soil Sampling Quality Assurance Users Guide." EPA 600/4-84-043.

EPA. 1980. "Samplers and Sampling Procedures for Hazardous Waste Streams." EPA 600/2-80-018. January.

EPA 1983. "Preparation of Soil Sampling Protocol: Techniques and Strategies." EPA 600/4-83-020.

EPA. 1987. "A Compendium of Superfund Field Operations Methods." OSWER Directive 9355.0-14 (EPA/540/P-87/001).

EPA. 1991. "Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells." March. EPA/600/4-89/034.

EPA. 1994. "Soil Sampling." Environmental Response Team SOP #2012 (Rev. #0.0, 11/16/94). http://www.ert.org/mainContent.asp?section=Products&subsection=List

EPA. 1996. SW-846, Method 5035, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples. December. http://www.epa.gov/epawaste/hazard/testmethods/sw846/pdfs/5035.pdf

1.5 REQUIREMENTS AND RESOURCES

Soil sampling requires the use of one or more of the following types of equipment:

- Spoons and spatulas
- Trowel
- Shovel or spade
- Trier
- Core sampler
- EnCore™ sampler
- VOA Plunger
- Hand auger
- Bucket auger
- Split-spoon
- Thin-wall tube

In addition, the following equipment is also needed for various methods:

- Sample containers, labels, and chain-of-custody forms
- Logbook
- Tape for measuring recovery
- Soil classification information
- Wax or caps for sealing ends of thin-wall tube
- "T" Handles
- Plastic sheeting
- Decontamination equipment
- Drilling equipment
- Backhoe
- Health and safety equipment

2.0 SOIL SAMPLING PROCEDURES

This SOP presents procedures for conducting test pit, surface soil, and subsurface soil sampling. The site sampling plan will specify which of the following procedures will be used.

Soil samples for chemical analysis should be collected in the following order: (1) volatile organics, (2) semivolatile organics, and (3) metals. Once the chemical samples have been containerized, samples for physical analyses can be containerized. Typical physical analyses conducted include (1) grain size distribution, (2) moisture content, (3) saturated permeability, (4) unsaturated permeability, and (5) Atterberg limits. Additionally, visual descriptions of samples, using the Unified Soil Classification System (USCS), should be recorded. Field tests such as head space analyses can also be conducted.

Soil samples for chemical analyses can be collected either as grab samples or composite samples. A grab sample is collected from a discrete location or depth. A composite sample consists of soil combined from more than one discrete location. Typically, composite samples consist of soil obtained from several locations and homogenized in a stainless steel or Teflon® pan, tray, or baggie. Refer to the site-specific Quality Assurance Project Plan (QAPP) for methodology for composite sample collection. Samples for volatile organics analysis should not be composited.

All soil samples collected should be packaged and shipped to the laboratories in accordance with SOP 019. All nondedicated or nondisposable equipment used for soil sampling should be decontaminated between sampling locations in accordance with SOP 002.

2.1 SOIL SAMPLE COLLECTION PROCEDURES

Soil samples can be collected as discrete samples for volatile organic compound (VOC) analysis using specialized equipment for preservation in the laboratory or in the field. Soil samples collected for non-VOC analysis can be collected as either grab or composite samples using standard equipment.

2.1.1 Procedure for Preserving and Collecting Soil Samples for VOC analysis

Samples collected for VOC analysis using traditional methods, such as collection in a jar with no preservation, are shown to yield nonrepresentative samples due to loss of VOCs. To prevent such losses,

preservation with methanol or sodium bisulfite may be used to minimize volatilization and biodegradation. This preservation may be performed in the laboratory or in the field, depending on the sample collection methodology used. The specific sampling methodology will be specified in the project-specific QAPP or work plan.

Soil samples to be preserved in the laboratory are collected using SW-846 Method 5035. For samples preserved in the field, laboratories may perform low-level analysis (sodium bisulfate preservation) or high- to medium-level analyses (methanol preservation), depending on the project-specific QAPP.

The following procedures outline the necessary steps for collecting soil samples to be preserved at the laboratory, and for collecting soil samples to be preserved in the field with methanol or sodium bisulfate.

2.1.1.1 Soil Samples to be Preserved at the Laboratory

Soil samples collected for VOC analysis that are to be preserved at the laboratory shall be obtained using a hand-operated, hermetically sealed sample vial such as an EnCore™ sampler. Each sample shall be obtained using a reusable sampling handle ("T" handle) that can be provided with the EnCore™ sampler when requested and purchased. Collect the soil sample in the following manner for each EnCore™ sampler.

The EnCore™ sampler is loaded into the "T" handle with the plunger fully depressed. Press the "T" handle into the soil to be sampled. The plunger will be forced upward as the cavity fills with soil. When the sampler is full, using the "T" handle, rotate the plunger and lock it into place. If the plunger does not lock, then it is not filled with soil. Soft soil may require several plunges or forcing soil against a hard surface such as a decontaminated sample trowel to ensure headspace has been eliminated. Remove soil from the outside of the sampler so a tight seal can be made between the sample cap and the O-ring. With soil slightly piled above the rim of the sampler, force the cap on until the catches hook the side of the sampler. Remove any surface soil from outside of the sampler and place in the foil bag provided with the sampler. Label the bag with sample location information. Typically, collect three EnCore™ samplers per sample location. Decontaminate the "T" handle between sample locations.

Using the EnCore™ sampler eliminates the need for field preservation and the shipping restrictions associated with preservatives. A complete set of instructions is included with each EnCore™ sampler.

After the EnCore™ samples are collected, they should be placed on ice immediately and delivered to the laboratory within 48 hours. The samples must be preserved by the laboratory within 48 hours of collection.

2.1.1.2 Soil Samples to be Preserved in the Field

Soil samples preserved in the field may be prepared for analysis using both the low-level (sodium bisulfate preservation) and high- to medium-level (methanol preservation) methods. If samples effervesce when placed in preservative, it is necessary to collect a sample unpreserved, in deionized water. In addition, an unpreserved sample for determination of moisture content must also be collected when collecting soil samples to be preserved in the field.

Methanol Preservation (High to Medium Level). Bottles may be pre-spiked with methanol in the laboratory or prepared in the field. Soil samples to be preserved in the field with methanol shall utilize 40- to 60-milliliter (mL) glass vials with septum-lined lids. Each sample bottle shall be filled with 25 mL of demonstrated analyte-free purge-and-trap grade 3 methanol. The preferred method for adding methanol to the sample bottle is by removing the lid and using a pipette or scaled syringe to add the methanol directly to the bottle.

Soil shall be collected with the use of a decontaminated (or disposable), small-diameter coring device such as a disposable VOA plunger. The outside diameter of the coring device must be smaller than the inside of the sample bottle neck. To collect the sample, pull the plunger back to the required location, insert it into the soil to be sampled, push the coring device into the soil, extrude the soil sample into the methanol-preserved sample bottle, and cap the bottle tightly. Swirl the sample (do not shake) in the methanol to break up the soil such that all of the soil is covered with methanol. Place the sample on ice immediately.

Sodium Bisulfate Preservation (Low Level). Bottles may be prepared in the laboratory or in the field with sodium bisulfate solution. Samples to be field-preserved using sodium bisulfate are collected using the same procedures described for methanol preservation.

2.1.2 Procedure for Collecting Soil Samples for Non-VOC Analyses

Samples collected for non-VOC analyses may be collected as either grab or composite samples as follows. Using a sampling device, transfer a portion of soil to be sampled to a stainless steel bowl, disposable inert plastic tray, or baggie. Remove roots, vegetation, sticks, and stones larger than the size of pea gravel. Thoroughly mix the soil to obtain as uniform a texture and color as practicable. Transfer the mixed soil to the appropriate sample containers and close the containers. Place the sample containers immediately on ice.

2.2 TEST PIT AND TRENCH SOIL SAMPLING

Test pit and trench soil sampling is conducted when a complete soil profile is required or as a means of locating visually detectable contamination. This type of sampling provides a detailed description of the soil profile and allows for multiple samples to be collected from specific soil horizons. Prior to conducting any test pit or trench excavation with a backhoe, the sampling team should ensure that the sampling area is clear of utility lines, subsurface pipes, and poles.

A test pit or trench is excavated by incrementally removing soil material with a backhoe bucket. The excavated soil is placed on plastic sheeting well away from the edge of the test pit. A test pit should not be excavated to depths greater than 4 feet unless its walls are properly sloped or stabilized. No personnel shall enter any test pit or trench excavation over 4 feet deep; such action would constitute confined space entry and must conform with Occupational Safety and Health Administration (OSHA) regulations at Title 29 of the *Code of Federal Regulations* § 1910.

Personnel entering the test pit may be exposed to toxic or explosive gases and oxygen deficient environments. Air monitoring is required before entering the test pit, and the use of appropriate respiratory gear and protective clothing is mandatory. At least two persons must be present at the test pit before sampling personnel may enter the excavation and begin soil sampling. Refer to project-specific Health and Safety Plans for required safety procedures for excavations.

Soil samples can also be obtained directly from the backhoe bucket or from the excavated material after it has been removed and deposited on plastic sheeting. The sampling personnel shall direct the backhoe excavator to obtain material from the selected depth and location within the excavation. The backhoe

operator shall set the backhoe bucket on the ground in a designated location, at a sufficient distance from the excavation to allow the sampler safe access to the bucket. The backhoe operator shall disengage the controls and signal to the sampler that it is safe to approach the bucket. The soil sample shall then be collected from the center of the backhoe bucket to reduce the potential for cross-contamination of the sample.

Test pits are not practical for sampling at depths greater than 15 feet. If soil samples are required from depths greater than 15 feet, samples should be obtained using test borings instead of test pits. Test pits are also usually limited to a few feet below the water table. In some cases, a pumping system may be required to control the water level within the pits.

Access to open test pits should be restricted by the use of flagging, tape, or fencing. If a fence is used, it should be erected at least 6 feet from the perimeter of the test pit. The test pit should be backfilled as soon as possible after sampling is completed.

Various equipment may be used to collect soil samples from the walls or bottom of a test pit. A hand auger, bucket auger, or core sampler can be used to obtain samples from various depths. A trier, trowel, EnCore™ sampler, VOA plunger, or spoon can be used to obtain samples from the walls or pit bottom surface.

2.3 SURFACE SOIL SAMPLING

The surface soil sampling equipment presented in this SOP is best suited for sampling to depths of 0 to 6 feet below ground surface (bgs). The sample depth, sample analyses, soil type, and soil moisture will also dictate the most suitable sampling equipment. Prior to sample collection, the sampling locations should be cleared of any surface debris such as twigs, rocks, and litter. The following table presents various surface soil sampling equipment and their effective depth ranges, operating means (manual or power), and sample types collected (disturbed or undisturbed).

Sampling Equipment	Effective Depth Range (feet bgs)	Operating Means	Sample Type
Hand Auger	0 to 6	Manual	Disturbed
Bucket Auger	0 to 4	Power	Disturbed
Core Sampler	0 to 4	Manual or Power	Undisturbed
EnCore™ Sampler	Not Applicable	Manual	Disturbed
Spoon/Spatula	0 to 0.5	Manual	Disturbed
Trowel	0 to 1	Manual	Disturbed
VOA Plunger	Not Applicable	Manual	Disturbed

The procedures for using these various types of sampling equipment are discussed below.

2.3.1 Hand Auger

A hand auger equipped with extensions and a "T" handle is used to obtain samples from depths of up to 6 feet bgs. If necessary, a shovel may be used to excavate the topsoil to reach the desired subsoil level. If topsoil is removed, its thickness should be recorded. Samples obtained using a hand auger are disturbed in their collection; determining the exact depth at which samples are obtained is difficult.

The hand auger is screwed into the soil at an angle of 45 to 90 degrees from horizontal. When the entire auger blade has penetrated soil, the auger is removed from the soil by lifting it straight up without turning it, if possible. If the desired sampling depth has not been reached, the soil is removed from the auger and deposited onto plastic sheeting. This procedure is repeated until the desired depth is reached and the soil sample is obtained. The auger is then removed from the boring and the soil sample is collected directly from the auger into an appropriate sample container.

2.3.2 Bucket Auger

A bucket auger, equipped similarly as the hand auger, is used to obtain disturbed samples from depths of up to 4 feet bgs. A bucket auger should be used when sampling stony or dense soil that prohibits the use of a hand-operated core or screw auger. A bucket auger with closed blades is used in soil that cannot generally be penetrated or retrieved by a core sampler.

The bucket auger is rotated while downward pressure is exerted until the bucket is full. The bucket is then removed from the boring, the collected soil is placed on plastic sheeting, and this procedure is repeated until the appropriate depth is reached and a sample is obtained. The bucket is then removed from the boring and the soil sample is transferred from the bucket to an appropriate sample container.

2.3.3 Core Sampler

A hand-operated core sampler (Figure 1), similarly equipped as the hand auger, is used to obtain samples from depths of up to 4 feet bgs in uncompacted soil. The core sampler is capable of retrieving undisturbed soil samples and is appropriate when low concentrations of metals or organics are of concern. The core sampler should be constructed of stainless steel. A polypropylene core sampler is generally not suitable for sampling dense soils or sampling at greater depths.

The core sampler is pressed into the soil at an angle of 45 to 90 degrees from horizontal and is rotated when the desired depth is reached. The core is then removed, and the sample is placed into an appropriate sample container.

2.3.4 Shovel

A shovel may be used to obtain large quantities of soil that are not readily obtained with a trowel. A shovel is used when soil samples from depths of up to 6 feet bgs are to be collected by hand excavation; a tiling spade (sharpshooter) is recommended for excavation and sampling. A standard steel shovel may be used for excavation; either a stainless steel or polypropylene shovel may be used for sampling. Soil excavated from above the desired sampling depth should be stockpiled on plastic sheeting. Soil samples should be collected from the shovel and placed into the sample container using a stainless-steel scoop, plastic spoon, or other appropriate tool.

2.3.5 Trier

A trier (Figure 2) is used to sample soil from depths up to 1 foot bgs. A trier should be made of stainless steel or polypropylene. A chrome-plated steel trier may be suitable when samples are to be analyzed for organics and heavy metal content is not a concern.

Samples are obtained by inserting the trier into soil at an angle of up to 45 degrees from horizontal. The trier is rotated to cut a core and is then pulled from the soil being sampled. The sample is then transferred to an appropriate sample container.

2.3.6 Trowel

A trowel is used to obtain surface soil samples that do not require excavation beyond a depth of 1 foot. A trowel may also be used to collect soil subsamples from profiles exposed in test pits. Use of a trowel is practical when sample volumes of approximately 1 pint (0.5 liter) or less are to be obtained. Excess soil should be placed on plastic sheeting until sampling is completed. A trowel should be made of stainless steel or galvanized steel. It can be purchased from a hardware or garden store. Soil samples to be analyzed for organics should be collected using a stainless steel trowel. Samples may be placed directly from the trowel into sample containers.

2.4 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling is accomplished in conjunction with borehole drilling, for soil sampling from depths greater than approximately 6 feet bgs. Subsurface soil sampling is frequently coupled with exploratory boreholes or monitoring well installation.

Subsurface soil sampling may be conducted using a drilling rig, power auger, or direct-push technology (DPT). Selection of sampling equipment depends upon geologic conditions and the scope of the sampling program. Two types of samplers used with machine-driven augers—the split-spoon sampler and the thin-wall tube sampler—are discussed below. All sampling tools should be cleaned before and after each use in accordance with SOP No. 002 (General Equipment Decontamination). Both the split-spoon sampler and the thin-wall tube sampler can be used to collect undisturbed samples from

unconsolidated soils. The procedures for using the split-spoon and thin-wall tube samplers are presented below.

2.4.1 Split-Spoon Sampler

Split-spoon samplers are available in a variety of types and sizes. Site conditions and project needs, such as large sample volume for multiple analyses, determine the specific type of split-spoon sampler to be used. Figure 3 shows a generic split-spoon sampler.

The split-spoon sampler is advanced into the undisturbed soil beneath the bottom of the casing or borehole using a weighted hammer and a drill rod. The relationship between hammer weight, hammer drop, and number of blows required to advance the split-spoon sampler in 6-inch increments indicates the density or consistency of the subsurface soil. After the split-spoon sampler has been driven to its intended depth, it should be removed carefully to avoid loss of sample material. In noncohesive or saturated soil, a catcher or basket should be used to help retain the sample.

After the split-spoon sampler is removed from the casing, it is detached from the drill rod and opened. If VOA samples are to be collected, EnCore™ samplers or VOA plungers should be filled with soil taken directly from the split-spoon sampler. Samples for other specific chemical analyses should be taken as soon as the VOA sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample (except for the top several inches of possibly disturbed material) is retained for analysis or disposal.

2.4.2 Thin-Wall Tube Sampler

A thin-wall tube sampler, sometimes called the Shelby tube (Figure 4), is used to collect soil samples for geophysical analysis. Tube samplers are best suited for collecting cohesive soils such as clays and silts. The tube sampler may be pressed or driven into soil inside a hollow-stem auger flight, wash bore casing, or uncased borehole. The tube sampler is pressed into the soil, without rotation, to the desired depth or until refusal. If the tube cannot be advanced by pushing, it may be necessary to drive it into the soil without rotation using a hammer and drill rod. The tube sampler is then rotated to collect the sample from the soil and removed from the borehole.

After removal of the tube sampler from the drilling equipment, the tube sampler should be inspected for adequate sample recovery. The sampling procedure should be repeated until an adequate soil core is obtained (if sample material can be retained by the tube sampler). The soil core obtained should be documented in the logbook. Any disturbed soil is removed from each end of the tube sampler. If chemical analysis is required, VOA samples must be collected immediately after the tube sampler is withdrawn. EnCore™ samplers or VOA plungers should be filled with soil taken directly from the tube sampler. Before use, and during storage and transport, the tube sampler should be capped with a nonreactive material. For physical sampling parameters, the tube is sealed using plastic caps. The top and bottom of the tube sampler should be labeled and the tube sampler should be stored accordingly.

2.4.3 Direct-Push Technology Sampler

Geoprobe systems utilize DPT. In many cases, DPT is less expensive and faster than collecting soil samples with a standard drilling rig. In addition, the use of DPT causes minimal disturbance to the ground surface and generates little to no soil cuttings. DPT uses acetate or clear polyvinyl chloride (PVC) sleeves for collecting soil samples. Use of the Geoprobe system is described in SOP No. 054.

Upon retrieval of the sampling rod from the ground, the sample sleeve is extruded from the sampling rod. The sleeve is sliced lengthwise twice, to open the sleeve. Soil samples can be collected directly from the opened sleeve. If VOA samples are to be collected, EnCore™ samplers or VOA plungers should be filled with soil taken directly from the opened DPT sampler. Samples for other specific chemical analyses should be taken after the VOA sample has been collected. The remainder of the recovered soil can then be used for visual classification of the sample and containerized for physical analysis. The entire sample is retained for analysis or disposal.

FIGURE 1

HAND-OPERATED CORE SAMPLER

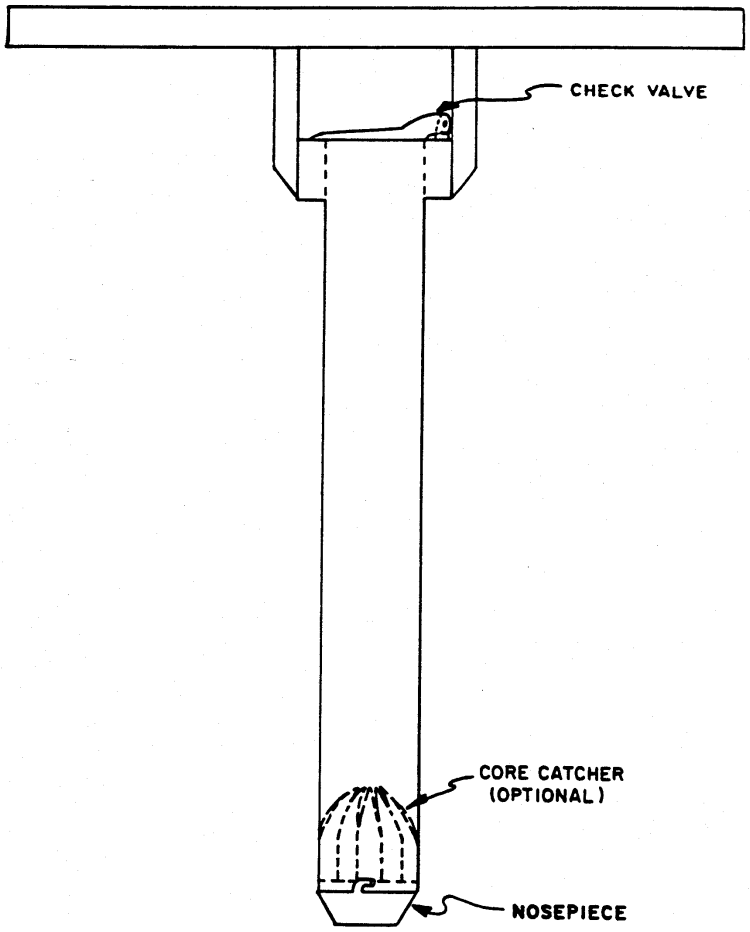


FIGURE 2

TRIER

TRIER

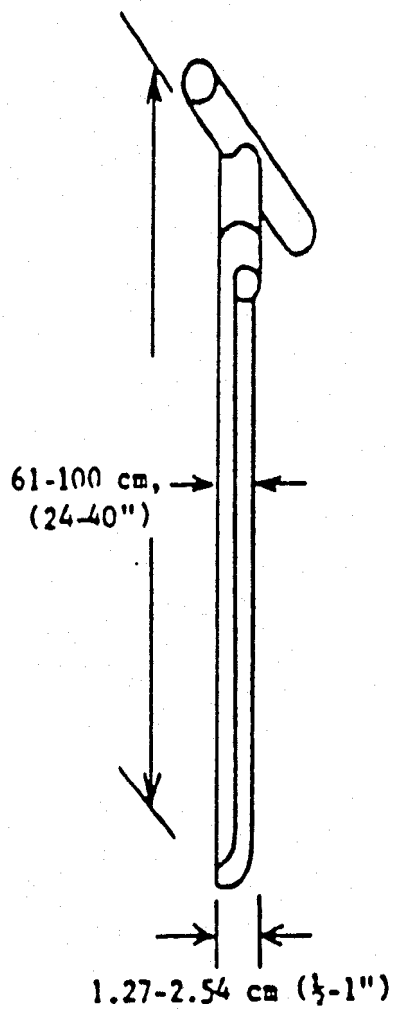


FIGURE 3

GENERIC SPLIT-SPOON SAMPLER

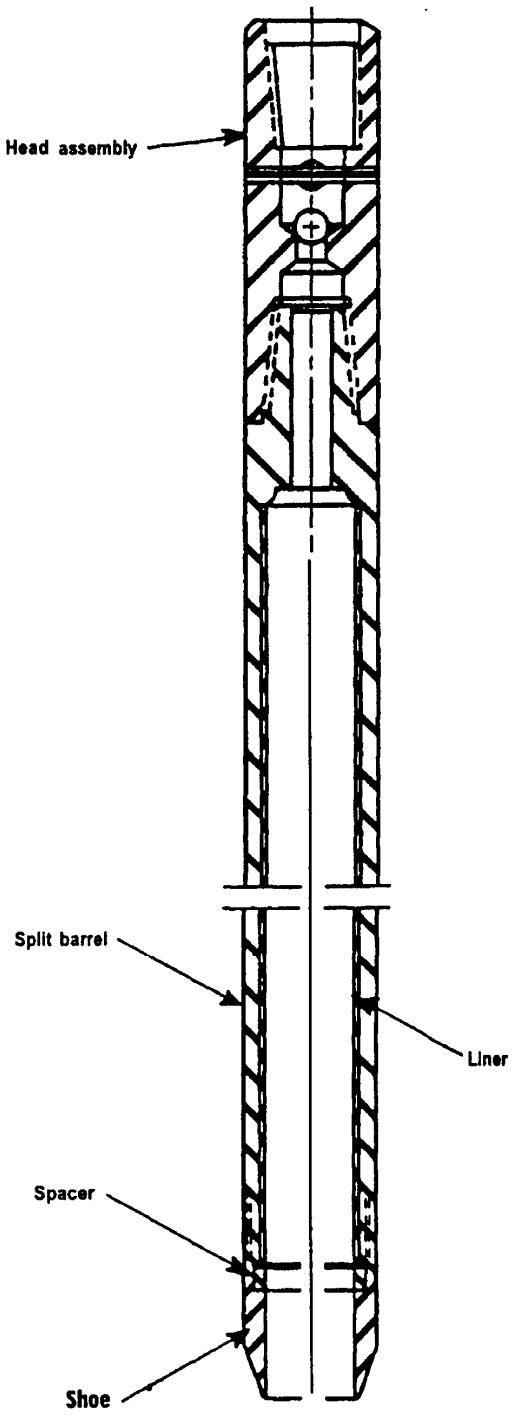
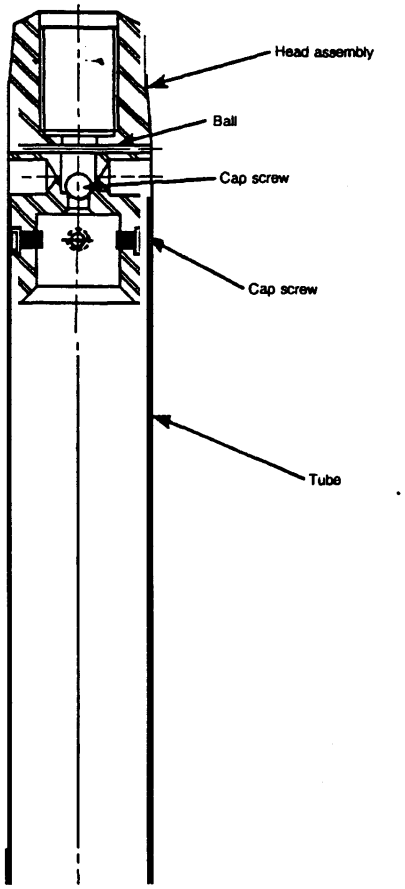


FIGURE 4

THIN-WALL TUBE SAMPLER



SOP APPROVAL FORM

TETRA TECH, INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

PACKAGING AND SHIPPING SAMPLES

SOP NO. 019

REVISION NO. 7

Last Reviewed: November 2014

Carla J Banks

Quality Assurance Approved	November 24, 2014 Date

1.0 BACKGROUND

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. This standard operating procedure (SOP) describes procedures for packaging and shipping samples. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples.

1.1 PURPOSE

This SOP establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) "Contract Laboratory Program Guidance for Field Samplers." Procedures described in this SOP should be followed for all routine sample packaging and shipping. If procedures are to be modified for particular contract- or laboratory-specific requirements, modified procedures should be clearly described in site-specific plans such as work plans, field sampling plans (FSPs), or quality assurance project plans (QAPPs). Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already in the appropriate sample jars and that the sample jars are labeled.

This SOP does not cover the packaging and shipment of Dangerous Goods or Hazardous Materials. The shipment of Dangerous Goods (by air) and Hazardous Materials (by ground) requires specialized training. If you have NOT received this training in the last two years, you are NOT qualified to package or ship these materials and may be personally liable for any damages or fines. Contact one of Tetra Tech's shipping experts for assistance. Instructions to access the training course, shipping experts and health and safety (H&S) contacts, and general information on packaging and shipping hazardous substances and dangerous goods can be obtained by checking the links provided in Section 1.4 (References).

1.2 SCOPE

This SOP applies to packaging and shipping of environmental and nonhazardous samples. This SOP does not address shipping dangerous goods or hazardous materials.

1.3 DEFINITIONS

Airbill: An airbill is a shipping form (such as a FedEx shipping form) acquired from the commercial shipper and is used to document shipment of the samples from the sampler to the designated analytical laboratory (see Figure 1).

Custody-of-Custody form: A chain-of-custody form is used to document the transfer of custody of samples from the field to the designated analytical laboratory (see Figure 2). The chain-of-custody form is critical to the chain-of-custody process and is used to identify the samples in each shipping container to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis (see Figure 3).

Custody seal: A custody seal is a tape-like seal and is used to indicate that samples are intact and have not been disturbed during shipping or transport after the samples have been released from the sampler to the shipper (see Figure 4). The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping (see Figure 5).

Environmental samples: Environmental samples include drinking water, most groundwater and surface water, soil, sediment, treated municipal and industrial wastewater effluent, indoor and ambient air, nonhazardous bulk materials, soil gas, dust, asbestos, and biological specimens. Environmental samples typically contain low concentrations of contaminants and, when handled, require only limited precautionary procedures.

Field Blank: A field blank is any blank sample that is packaged and shipped from the field. Each field blank is assigned its own unique sample number. Field blanks include trip blanks, rinse blanks, and equipment blanks, all intended to assess potential cross-contamination. For example, a trip blank checks for contamination during sample handling, storage, and shipment from the field to the laboratory.

Nonhazardous samples: Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the International Air Travel Association's (IATA's) "Dangerous Goods Regulations" (DGR) or U.S. Department of Transportation's (U.S. DOT's) "Hazardous Materials Regulations" (HMR) defined in Title 49 Code of Federal Regulations (CFR).

The following definitions are provided to further distinguish environmental and nonhazardous samples from dangerous good and hazardous samples:

Dangerous goods: Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 2014).

Hazardous samples: Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

Hazardous substance: A hazardous substance is any material, including its mixtures and solutions, that is listed in 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in Table 1 to Appendix A of 49 CFR 172.101.

1.4 REFERENCES

General Awareness, H&S contacts, and course training information" click here. (Tetra Tech, Inc., EMI Operating Unit. Intranet) Available on-line at: https://int.tetratech.com/sites/EMI/hs/Pages/Dangerous-Goods-Shipping.aspx

International Air Transport Association (IATA). 2014. "Dangerous Goods Regulations. 2014." For sale at: http://www.iata.org/publications/Pages/standards-manuals.aspx. Updated annually, with new edition available late in year.

U.S. Environmental Protection Agency (EPA). 40 CFR, 763 Subpart F, Asbestos Hazards Emergency Response Act (AHERA).

EPA. 2011. "Contract Laboratory Program Guidance for Field Samplers." EPA 540-R-09-03. Available on-line at: http://www.epa.gov/oerrpage/superfund/programs/clp/download/sampler/CLPSamp-01-2011.pdf. January.

1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping samples require the following:

- Coolers (insulated ice chest) or other shipping containers appropriate to sample type
- Ice
- Bubble wrap or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Large plastic garbage bags for lining the cooler
- Temperature blank sample bottle filled with distilled water can be included in the cooler if appropriate to sample type

- Trip blank samples used to check for volatile contamination during sample handling in the field and shipment from field to laboratory should be included in the cooler if volatile organic compounds are requested for analysis. Also see Field Blank under definitions.

2.0 PROCEDURES

The following procedures apply to packaging and shipping nonhazardous and environmental samples.

2.1 PACKAGING SAMPLES

After they have been appropriately containerized and labeled, environmental samples should be packaged as described in this section. This section covers procedures for packing samples for delivery by commercial carrier (air or ground) and hand delivery of environmental samples (by employee or courier), as well as shipping asbestos and air quality samples. Note that these instructions are general; samplers also should be aware of client-specific requirements concerning the placement of custody seals or other packaging provisions.

2.1.1 Packaging Samples for Delivery by Commercial Carrier (Air or Ground)

Samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

Preparing the sample:

1. Allow a small amount of headspace in all bottles, or as instructed by the laboratory (except volatile organic compound [VOC] containers with a septum seal) to compensate for any changes in pressure and temperature during transfer.
2. Be sure the lids on all bottles are tight (will not leak). Lids maybe taped or sealed with custody seals as added protection or as required.
3. Place sample containers in resealable plastic bags.

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
3. Wrap the sample containers in bubble wrap or line the cooler (bottom and sides) with a cushioning material to prevent breakage of bottles or jars during shipment.
4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C ($\pm$ 2 °C). Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.

5. For volatile organic analysis (VOA) samples only, include one trip blank for VOA analysis per shipment matrix in each cooler.
6. Fill all remaining space between the bottles or jars with bubble wrap.
7. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).
8. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,” and so forth.
9. Place the chain-of-custody forms (see Figure 2) into a resealable plastic bag, and tape the bag to the inner side of the cooler lid (see Figure 3). If you are shipping more than one cooler, copy the chain-of-custody form so that there is one copy of all forms in each cooler. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler. Tape any instructions for returning the cooler to the inside of the lid.
10. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once.
11. Place two signed custody seals (see Figure 4) on opposite sides of the cooler, ensuring that each one covers the cooler lid and side of the cooler (see Figure 5; note that in contrast to the figure, the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in Figure 5). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal.
12. Shipping containers must be marked "THIS END UP.” Arrow labels, which indicate the proper upward position of the container, may also be affixed to the container (see Figures 3 and 5). A label containing the name, phone number, and address of the shipper should be placed on the outside of the container (Federal Express [FedEx] label) (see Figure 1).
13. Ship samples overnight using a commercial carrier such as FedEx.

2.1.2 Hand Delivery of Environmental Samples (by Employee or Courier)

Samples hand-delivered to the laboratory should be packed for shipment using the following procedures:

Preparing the sample:

1. Bottles can be filled completely with sample (required for VOC containers with a septum seal).
2. Be sure the lids on all bottles are tight (will not leak).

Preparing the cooler:

1. Secure and tape the drain plug of the cooler with fiber or duct tape.
2. Wrap the sample containers in bubble wrap and/or line the cooler (bottom and sides).
3. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. If required, include one temperature blank (a sample bottle filled with distilled water) per cooler.
4. For VOA samples only, include one trip blank for VOA analysis per shipment matrix in each cooler.
5. If more than one cooler is being shipped, mark each cooler as “1 of 2,” “2 of 2,”and so forth.

6. Place chain-of-custody form (see Figure 2) in a resealable plastic bag and tape to the inside of the cooler lid, close the lid, seal with custody seals, and transfer the cooler to the courier (see Figure 3). Alternatively, when samples will be delivered directly to the laboratory, close the cooler and hand-deliver it with the chain-of-custody form. The samples listed on the chain-of-custody form must match exactly with the contents of the cooler.
7. Include any instructions for returning the cooler to the inside of the lid.
8. Place two signed custody seals (see Figure 4) on opposite sides of the cooler, ensuring that each one covers the cooler lid and side of the cooler (see Figure 5, note that the seals should be placed on the opposite sides of the cooler and offset from each other, rather than directly across from each other as shown in Figure 5). Place clear plastic tape over the custody seals so that the cooler cannot be opened without breaking the seal.
9. Shipping containers must be marked "THIS END UP," and arrow labels, which indicate the proper upward position of the container should be affixed to the container (see Figures 3 and 5).

2.1.3 Shipping Asbestos Samples

Asbestos samples shipped by commercial carriers should be packed for shipment using the following procedures and in compliance with all carrier requirements:

1.` Place each asbestos sample in a small resealable plastic bag. Place the bags of asbestos samples in a large resealable plastic bag.
2. Select a rigid shipping container (FedEx box) and pack the cassettes upright in a noncontaminating, nonfibrous medium such as a bubble pack to prevent excessive movement during shipping.
3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.
4. Affix custody seals to the top of the cassettes or outer sample bag so that the bags cannot be opened without breaking the seal.
5. Insert the chain-of-custody form in the box. Include a shipping bill and a detailed listing of samples shipped, their descriptions and all identifying numbers or marks, sampling data, shipper's name, and contact information.
6. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container will be rejected.
7. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.
8. Hand-carry samples to the laboratory in an upright position if possible; otherwise, choose that mode of transportation least likely to jar the samples in transit.
9. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain-of-custody and sample tracking procedures. This information will also help the laboratory schedule timely analysis for the samples when they are received.

2.1.4 Shipping Air Samples

Packaging and shipping requirements for air samples vary depending on the media used to collect the samples and the analyses required. Sampling media typically include Summa canisters and Tedlar bags for whole air samples, filters for metals and particulate matter, and sorbent tubes for organic contaminants. This section of the SOP provides general guidelines for packaging and shipping air samples collected using these media. The project FSP or QAPP should also be reviewed for any additional project-specific requirements or instructions.

Summa Canister Samples

1. Close the canister valve by tightening the knob clockwise or flipping the toggle switch. Replace the brass cap on the canister inlet.
2. If a flow controller was used to collect the air sample over a specified time interval, the flow controller should be removed before replacing the brass cap.
3. Fill out the sample tag on the canister with the sample number and the date and time of collection. Include the identification number of the flow controller on the sample tag if one was used. Make sure the information on the sample tag matches the chain-of-custody form.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final Summa canister vacuum readings; Summa canister identification number; and flow controller identification number.
5. Package the Summa canister (and flow controller) in its original shipping box with the original packaging material. Tape the box shut and apply custody seals if required. Note: Summa canisters should never be packaged with ice.
6. Summa canister shipments typically include several canisters, and may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes.
7. Ship the samples by a method that will meet the holding time. Summa canister samples should be analyzed within 30 days of sample collection.

Tedlar Bag Samples

1. Close the Tedlar bag by tightening the valve clockwise.
2. Fill out the label on the bag with the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form.
4. Package the Tedlar bag in a shipping box with appropriate packing material. Multiple bags can be packaged in the same box. Tape the box shut and apply custody seals if required. Note: Tedlar bag samples should not be cooled or packaged with ice.
5. Tedlar bag shipments may include more than one shipping box. The chain-of-custody form for the shipment should be sealed within one of the shipping boxes.

6. Ship the samples using priority overnight delivery. Tedlar bag samples should be analyzed within 3 days of sample collection.

Filter Cassette Samples

1. Disconnect the filter cassette from the air sampling pump and replace the plastic caps on the inlet and outlet openings.
2. Attach a label to the sample that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
4. Package the filter cassettes in a shipping box (such as a FedEx box). Use an appropriate packing material (such as bubble wrap) to separate the samples and prevent damage.
5. Place the chain-of-custody form within the box, seal the box, and apply custody seals if required. Filter cassette samples typically do not need to be cooled, but check the FSP or QAPP for project-specific requirements.
6. Ship the samples by a method that will meet the holding time.

Sorbent Tube Samples

1. Disconnect the sample tube from the air sampling pump and seal both ends of the tube with plastic caps.
2. Complete a sample label that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. If the tube is small and the label cannot be attached to the tube, the tube can be placed in a small sealable plastic bag and the label can be attached to the bag or placed inside the bag with the tube.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Packaging requirements for the sample tubes will depend on the analysis required, and the sampler should check the FSP or QAPP for project-specific requirements (for example, tubes may need to be wrapped in aluminum foil to prevent exposure to light). Packaging containers and methods include (1) shipping boxes (as described under filter cassette samples), (2) small sample coolers filled with double-bagged ice, and (3) small sample coolers filled with blue ice.
6. Place the chain-of-custody form within the box or container, seal the box or container, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time.

Polyurethane Foam (PUF) Tube Samples

1. Disconnect the PUF tube from the air sampling pump and wrap the tube in aluminum foil.
2. Attach a label to the wrapped sample tube that includes the sample number and the date and time of sample collection. Make sure the information on the label matches the chain-of-custody form.
3. Wrap the PUF tube in bubble wrap and place the tube in a glass shipping jar.
4. Complete the chain-of-custody form. In addition to the information normally included, the form should include the following data: sample start and stop dates and times; initial and final air flow rates (or average flow rate); volume of air sampled; and sampling pump identification number.
5. Package the PUF tube jars in a cooler that is filled with double-bagged ice. Use bubble wrap or other cushioning material to separate the samples and prevent breakage.
6. Place the chain-of-custody form within the cooler, seal the cooler, and apply a custody seal if required.
7. If coolers are used for shipping, tape instructions for returning the cooler to the inside of the lid.
8. Ship the samples by a method that will meet the holding time. Samples collected in PUF tubes typically must be extracted within 7 days of collection.

2.2 SHIPPING DOCUMENTATION FOR SAMPLES

Airbills, chain-of-custody forms, and custody seals must be completed for each shipment of nonhazardous environmental samples. Figures 1, 2, and 4 provide examples of these forms and instructions for completing them.

Field staff collecting samples should also review their field work plans to confirm what documentation must be completed during each sampling event, including client-specific requirements. For example, some EPA programs have a specific requirement to use Scribe software, an environmental data management system, to create sample documentation, electronically input information into Traffic Report or chain-of-custody forms, and enter other data.

- The Scribe software can be accessed from the EPA Environmental Response Team (ERT) at the following address: http://www.ertsupport.org/scribe_home.htm
- The ERT User Manual for Scribe, reference, and training materials can be accessed from the Scribe Support Web site at the following address: http://www.epaosc.org/scribe

Note that some laboratories must routinely return sample shipping coolers within 14 calendar days after the shipment has been received. Therefore, the sampler should also include instructions for returning the cooler with each shipment, when possible. The sampler (not the laboratory) is responsible for paying for return of the cooler and should include shipping airbills bearing the sampler's shipping account number,

as well as a return address to allow for return of the cooler (see Figure 1). Samplers should use the least expensive option possible for returning coolers.

2.3 SHIPMENT DELIVERY AND NOTIFICATION

A member of the field sampling team must contact the laboratory to confirm it accepts deliveries on any given day, especially Saturdays. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required. The sampler needs to know the laboratory's contact name, address, and telephone number and be aware of the laboratory's requirements for receiving samples.

The sampler needs to know the shipping company's name, address, and telephone number (see Figure 1). In addition, samplers should be aware of the sample holding times, shipping company's hours of operation, shipping schedule, and pick-up and drop-off requirements to avoid delays in analytical testing.

Priority Overnight Delivery

Priority overnight delivery is typically the best method for shipment. Delays caused by longer shipment times may cause the sample temperature to rise above the acceptable range of 4° C (± 2 ° C) and technical holding may expire, which in turn may compromise sample integrity and require recollection of samples for analysis. If sample delivery procedures are to be modified for particular contract- or laboratory-specific requirements, the procedures should be clearly described in site-specific plans such as work plans, FSPs, or QAPPs.

Saturday Delivery

If planning to ship samples for Saturday delivery, the laboratory must be contacted in advance to confirm it will accept deliveries on Saturdays or arrange for them to be accepted. In addition, samplers should ensure the laboratory has been notified in advance of the pending shipment and notify any additional parties as required.

2.4 HEALTH AND SAFETYCONSIRATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHA) for the project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment (PPE) necessary to address potential hazards. The hazards specific to project tasks must be identified and

controlled to the extent practicable and communicated to all project personnel via the approved, project-specific Health and Safety Plan (HASP).

3.0 POTENTIAL PROBLEMS

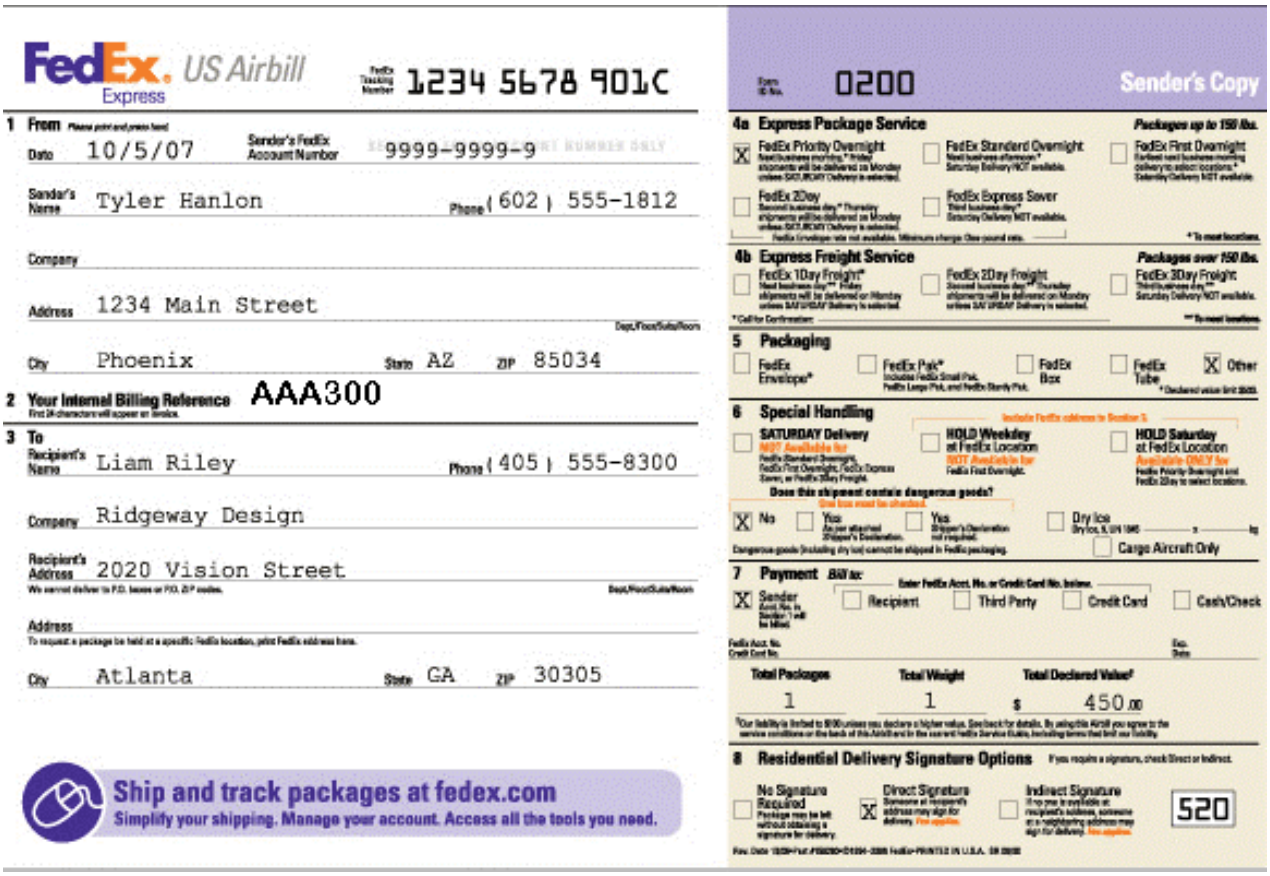
The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package and return the package. Special care should be taken during sample packaging to minimize potential leaks.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment. A good practice is to have labels, forms, and container markings double checked by a member of the field team.
- Bulk samples and air samples delivered to the analytical laboratory in the same container. If samples are combined in this way, they will be rejected. Always ship bulk samples in separate containers from air samples.
- Issues in packing asbestos samples. When asbestos samples are shipped, avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials with asbestos samples because of possible contamination.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice these errors as well and return the package to the shipper. A good practice is to have another field tram member double check this information.
- Missed drop off time or wrong location. Missing the drop off time or having the wrong location identified for drop off will delay delivery to the laboratory and may cause technical holding times to expire. Establish the time requirements in advance of completing the field effort and be sure and provide some contingency time for potential delays such as traffic or checking and redoing paperwork.
- Incorrectly packaging samples for analysis at multiple laboratories. For example, inorganic samples may be shipped to one laboratory for analysis, while organic samples may need to be shipped to another laboratory. All field staff should be aware which samples are to be shipped to which laboratory they package samples for multiple types of analysis.
- Holidays or weather-related delays. Be aware of holidays and weather forecasts that could cause delays in delivery. Delays caused by longer shipping times may cause technical holding times to expire, which in turn may compromise sample integrity or require recollection of samples for analysis.
- Not noting field variances in field log book. Field variances should be noted in the field log book and the project manager notified. Common field variances include:
  - Less sample volume collected than planned. Notify appropriate staff and the laboratory to ensure there is an adequate amount for analysis.

- Sample collected into incorrect jar because of broken or missing bottle-ware. Notify appropriate laboratory staff to ensure there is no confusion regarding the analysis of the sample.

FIGURE 1

EXAMPLE OF A FEDEX US AIRBILL FOR LOW LEVEL ENVIRONMENTAL SAMPLES


FedEx Express US Airbill
1234 5678 901C
0200
Sender's Copy
1 From
Date 10/5/07
Sender's FedEx Account Number 9999-9999-9
Sender's Name Tyler Hanlon
Phone (602) 555-1812
Company
Address 1234 Main Street
City Phoenix
State AZ
ZIP 85034
2 Your Internal Billing Reference AAA300
3 To
Recipient's Name Liam Riley
Phone (405) 555-8300
Company Ridgeway Design
Recipient's Address 2020 Vision Street
Address
City Atlanta
State GA
ZIP 30305
Ship and track packages at fedex.com
Simplify your shipping. Manage your account. Access all the tools you need.
4a Express Package Service
Packages up to 150 lbs.
FedEx Priority Overnight
FedEx Standard Overnight
FedEx First Overnight
FedEx 2Day
FedEx Express Saver
4b Express Freight Service
Packages over 150 lbs.
FedEx 1Day Freight
FedEx 2Day Freight
FedEx 3Day Freight
5 Packaging
FedEx Envelope
FedEx Pak
FedEx Box
FedEx Tube
Other
6 Special Handling
SATURDAY Delivery
HOLD Weekday at FedEx Location
HOLD Saturday at FedEx Location
Does this shipment contain dangerous goods?
No
Yes
Dry Ice
Cargo Aircraft Only
7 Payment Bill to:
Sender
Recipient
Third Party
Credit Card
Cash/Check
Total Packages 1
Total Weight 1
Total Declared Value $ 450.00
8 Residential Delivery Signature Options
No Signature Required
Direct Signature
Indirect Signature
520

Filling Out the FedEx US Airbill

- The sender *must complete* the following fields on the pre-printed airbill:
  - Section 1: Date
  - Section 1: Sender's FedEx Account Number
  - Section 1: Sender's Name, Company, Address, and Phone Number
  - Section 2: Internal Billing Reference (Project Number)
  - Section 3: Recipient's Name, Company, Address, and Phone Number
  - Section 4: Express Package or Freight Services (Priority Overnight)
  - Section 5: Packaging (usually "Other," your own packaging)
  - Section 6: Special Handling (Saturday delivery if prearranged with receiving laboratory; "No" dangerous goods contained in shipment)
  - Section 7: Payment ("Bill to Sender")
  - Section 7: Total Number of Packages
  - Section 7: Total Weight (completed by FedEx employee)
  - Section 8: Delivery Signature Options ("No Signature Required")

FIGURE 2

EXAMPLE OF A CHAIN-OF-CUSTODY FORM (WHITE COPY)

Tetra Tech EM Inc.
Oakland Office
1999 Harrison Street, Suite 500
Oakland, CA 94612
510.302.6300 Phone
510.433.0830 Fax

Chain of Custody Record No. 9814 13G175 Page 1 of 1

Lab PO#: 13OAk27
Lab: EMAX
Project name: Concord DA RWI
TtEMI technical contact: Sara Woolley
Field samplers: Sandy Jack, Rebecca Johnson
Project (CTO) number: 1036A59029
TtEMI project manager: Steve Dellhomme
Field samplers' signatures:

Preservative Added: None, None, None

No./Container Types: 40 ml VOA, 1 liter Amber, 500 ml Poly, Sleeve, Glass Jar 8oz, 250 ml Poly, Encore

Analysis Required: VOA, SVOA, Pest, Metals, TPH Purgeables, TPH Extractables, PCB

	Sample ID	Point ID/Depth	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sleeve	Glass Jar 8oz	250 ml Poly	Encore	VOA	SVOA	Pest	Metals	TPH Purgeables	TPH Extractables	PCB
1	029SRE SS01		7/22/13	1240	Soil						2				X	X	X	X	X	
2	029SRE SS02		7/22/13	1245							2				X	X	X	X	X	
3	029PBC3DSS01		7/24/13	1200							1				X	X	X	X		
4	029C3DSS02			1215							1				X	X	X	X		
5	029C3DSS03			1230							1				X	X	X	X		
6	029C3DSS04			1245							1				X	X	X	X		

	Name (print)	Company Name	Date	Time
Relinquished by:	Rebecca Johnson	TtEMI	7/30/13	1630
Received by:	Cecilia Chavez	EMAX	7/30/13	09:30
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks: Standard TAT
Prioritize: SVOCs, TPH-e on 029C3DSS01 → 04 thermetals
Temp – 20°C

Fed Ex #: 8612 4667 7215

1002

WHITE-Laboratory Copy YELLOW-Sample Tracker PINK-File Copy

Completing a Sample Chain-of-Custody Form

After samples have been collected, they will be maintained under chain-of-custody procedures. These procedures are used to document the transfer of custody of the samples from the field to the designated analytical laboratory. The same chain-of-custody procedures will be used for the transfer of samples from one laboratory to another, if required.

The field sampling personnel will complete a Chain-of-Custody and Request for Analysis (CC/RA) Form (Figure 1, Chain of Custody Record) for each separate container of samples to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. Information contained on the triplicate, carbonless form will include:

1. Project identification (ID) (for example, contract and task order number);
2. Project Contract Task Order (CTO) number;
3. Laboratory Project Order (PO) number;
4. Tetra Tech Technical Contact;
5. Tetra Tech Project Manager
6. Laboratory name;
7. Field sampler names;
8. Field sampler signature;
9. Sample ID;
10. Point ID and Depth (Do **NOT** include this information on the laboratory copy of the chain-of-custody (top white copy);
11. Date and time of sampling;
12. Sample matrix type;
13. Sample preservation method; note “NONE” if no preservatives;
14. Number and types of sample containers and container capacity;
15. Sample hazards (if any);
16. Requested analysis;
17. Requested sample turnaround time or any special remarks;
18. Page __ of __;
19. Method of shipment;
20. Carrier/waybill number (if any);
21. Signature, name, and company of the person relinquishing the samples and the person receiving the samples when custody is transferred;
22. Date and time of sample custody transfer;

23. Condition of samples when they are received by the laboratory.

The sample collector will cross out any blank space on the CC/RA Form below the last sample number listed on the part of the form where samples are listed.

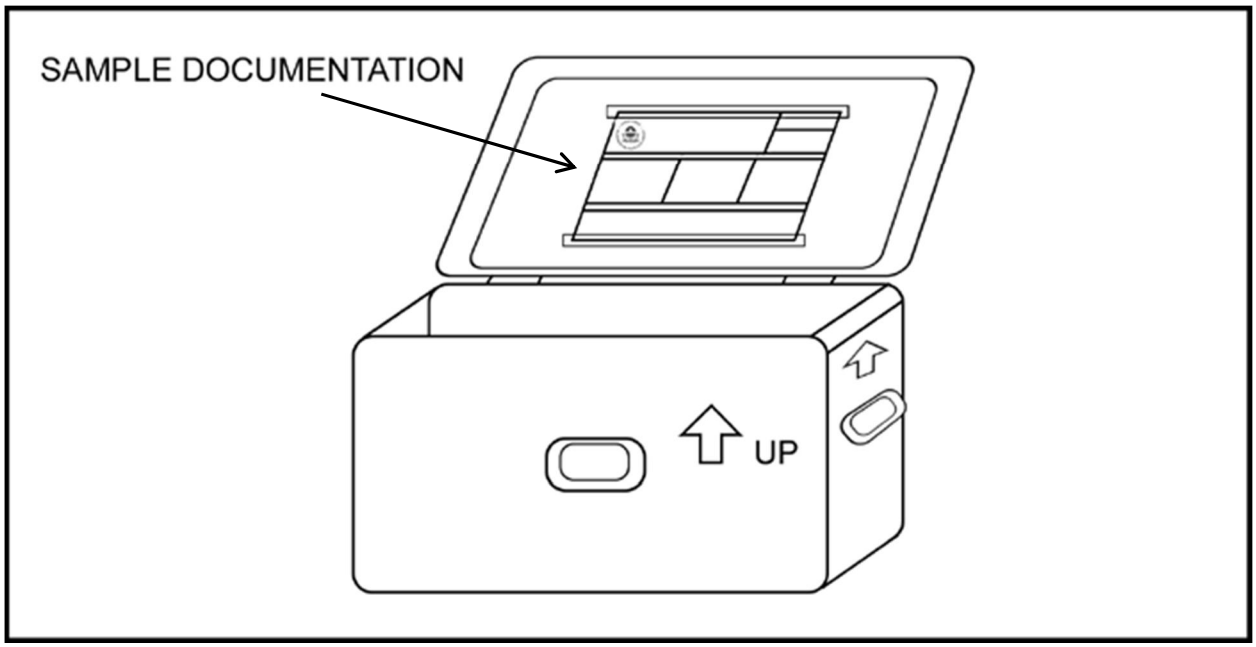
The sampling personnel whose signature appears on the CC/RA Form is responsible for the custody of a sample from time the sample is collected until the custody of the sample is transferred to a designated laboratory, a courier, or to another Tetra Tech employee for transporting a sample to the designated laboratory. A sample is considered to be in custody when the custodian: (1) has direct possession of it; (2) has plain view of it; or (3) has securely locked it in a restricted access area.

Custody is transferred when both parties to the transfer complete the portion of the CC/RA Form under "Relinquished by" and "Received by" or a sample is left at a FedEx facility pending shipment. Signatures, printed names, company names, and date and time of custody transfer are required. When custody is transferred, the Tetra Tech sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the CC/RA Form. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the CC/RA Form. Receipts of Bills of Lading will be retained as part of the permanent documentation in the Tetra Tech project file.

FIGURE 3

EXAMPLE OF A SAMPLE COOLER WITH ATTACHED DOCUMENTATION

Place the necessary paperwork (chain-of-custody form, cooler return instructions, and associated paperwork) in the shipping cooler or acceptable container. All paperwork must be placed in a plastic bag or pouch and then secured to the underside of the shipping container lid.



Source: U.S. Environmental Protection Agency. 2011.

FIGURE 4

EXAMPLE OF A CUSTODY SEAL

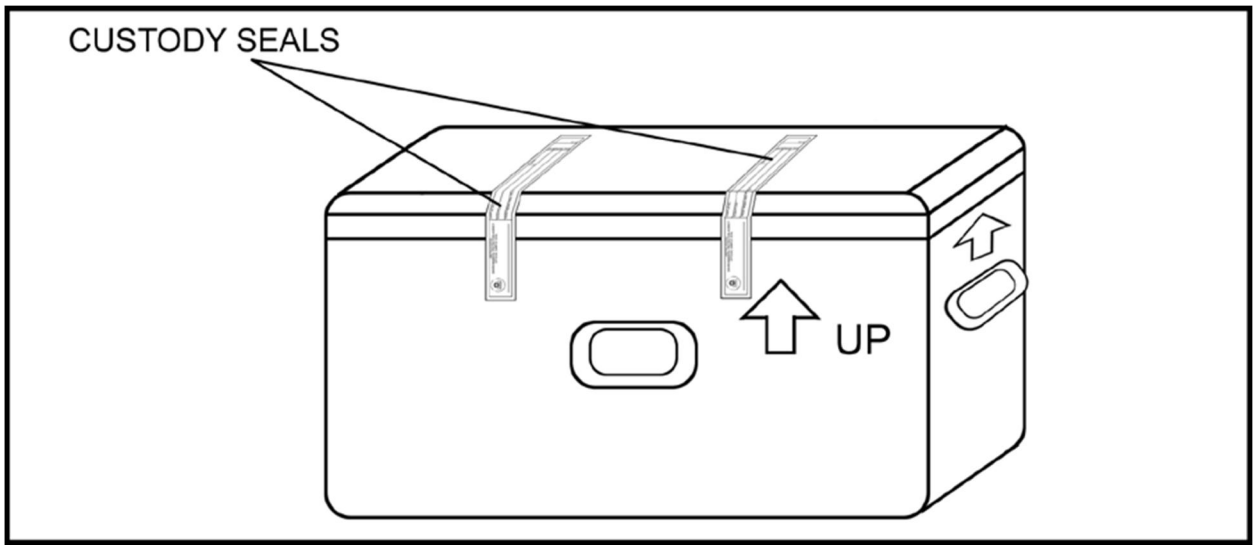
CUSTODY SEAL

Date _____

Signature _____

FIGURE 5

EXAMPLE OF SHIPPING COOLER WITH CUSTODY SEALS



Source: U.S. Environmental Protection Agency. 2011.

Please note that the two seals typically are affixed *to opposite sides of the cooler and offset from each other*, although the offset is not depicted on the EPA figure above.

SOP APPROVAL FORM

TETRA TECH, INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

RECORDING NOTES IN FIELD LOGBOOKS

SOP NO. 024

REVISION NO. 2

Last Reviewed: November 2014

Carla J Burks

Quality Assurance Approved

November 24, 2014

Date

1.0 BACKGROUND

Complete and accurate field documentation is critical to a successful project and the field log book is an important tool to support field documentation needs. The field logbook should include detailed records of all field activities, document interviews with people, and record observations of conditions at a site. Entries should be described in a level of detail to allow personnel to reconstruct, after the fact, activities and events that occurred during their field assignments. Furthermore, entries should be limited to facts. Avoid speculation related to field events and do not record hearsay or unfounded information that may be presented by other parties during field activities. For example, do not record theories regarding the presence or absence of contamination when you are collecting field screening data or speculation regarding the reasons for a property owner's refusal to grant access for sampling.

Field logbooks are considered accountable documents in enforcement proceedings and may be subject to review. Therefore, the entries in the logbook must be accurate and detailed, but should not contain speculative information that could conflict with information presented in subsequent project deliverables and correspondence. Also be aware that the field logbooks for a site may be a primary source of information for depositions and other legal proceedings that may occur months or years after field work is complete and long after our memories have faded. The accuracy, neatness, and completeness of field logbooks are essential for recreating a meaningful account of events.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidance to ensure that field logbook documentation collected during field activities meets all requirements for its later use. Among other things, field logbooks may be used for:

- Identifying, locating, labeling, and tracking samples
- Recording site activities and the whereabouts of field personnel throughout the day
- Documenting any deviations from the project approach, work plans, quality assurance project plans, health and safety plans, sampling plans, and any changes in project personnel
- Recording arrival and departure times for field personnel each morning and evening and weather conditions each day
- Describing photographs taken during the project.

In addition, the data recorded in the field logbook may later assist in the interpretation of analytical results. A complete and accurate logbook also aids in maintaining quality control, because it can verify adherence to project scope and requirements.

1.2 SCOPE

This SOP establishes the general requirements and procedures for documenting site activities in the field logbook.

1.3 DEFINITIONS

None.

1.4 REFERENCES

Compton, R.R. 1985. *Geology in the Field*. John Wiley and Sons. New York, NY.

1.5 REQUIREMENTS AND RESOURCES

The following items are required for field notation:

- Field logbooks
- Ballpoint pens or Sharpies with permanent waterproof ink
- 6-inch ruler (optional)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers, and each page should have preprinted lines, numbered pages, and a single column. They should be approximately $7^1/_2$ by $4^1/_2$ inches or $8^1/_2$ by 11 inches in size. Loose-leaf sheets are not acceptable for use as field notes.* If notes are written on loose paper, they must be transcribed as soon as possible into a bound field logbook by the same person who recorded the notes originally. **Note: Data collection logs and field forms used to record field measurements and data are acceptable as loose-leaf sheets maintained in a three-ring binder with numbered pages.*

Ideally, distribution of logbooks should be controlled by a designated person in each office. This person assigns a document control number to each logbook, and records the assignment of each logbook distributed (name of person, date distributed, and project number). The purpose of this procedure is to ensure the integrity of the logbook before its use in the field, and to document each logbook assigned to a

project. In the event that more than one logbook is assigned to a project, this process will ensure that all logbooks are accounted for at project closeout.

2.0 PROCEDURES

The following subsections provide general guidelines and formatting requirements for field logbooks, and detailed procedures for completing field logbooks.

2.1 GENERAL GUIDELINES

- A separate field logbook must be maintained for each project. If a site consists of multiple subsites (or operable units), designate a separate field logbook for each subsite. Similarly, if multiple activities are occurring simultaneously requiring more than one task leader (well installation, private well sampling, or geophysical survey.), each task leader should maintain a separate field logbook to ensure that each activity is documented in sufficient detail.
- At larger sites, a general field log may be kept at the site trailer or designated field office to track site visitors, document daily safety meetings, and record overall site issues or occurrences.
- Data from multiple subsites may be entered into one logbook that contains only one type of information for special tasks, such as periodic well water-level measurements.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages can be removed from the logbook for any purpose.
- All information must be entered using permanent, waterproof ink. Do not use pens with “wet ink,” because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Be sure that all entries are legible. Use print rather than cursive and keep the logbook pages free of dirt and moisture to the extent possible.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective. Avoid speculation that could conflict with information presented in subsequent project deliverables and correspondence (see Section 1.0 above).
- Use military time, unless otherwise specified by the client.
- Include site sketches, as appropriate.
- Begin a new page for each day’s notes.
- Include the date at the top of each page.
- At the end of a day, draw a single diagonal line through any unused lines on the page, and sign at the bottom of the page. Note and implement any client specific requirements (for example, some U.S. Environmental Protection Agency (EPA) programs require each logbook page to be signed).

- Write notes on every line of the logbook. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page.
- If a line is left blank for some reason, cross out (with a single line) and initial to prevent unauthorized entries.
- Cross out (with a single line) and initial any edits to the logbook entries. Edits should only be made if the initial entry is illegible or erroneous. Do not make corrections for grammar or style.

2.2 LOGBOOK FORMAT

The layout and organization of each field logbook should be consistent and generally follow the format guidelines presented below. Some clients or contracts may have specific formatting guidelines that differ somewhat from this SOP; review client requirements at the start of the project to help ensure any client-specific guidelines are integrated.

2.2.1 Logbook Cover

Write the following information on the front cover of each logbook using a Sharpie or similar type permanent ink marker:

- Logbook document control number (assigned by issuer)
- "Book # of #" (determined by the project manager if there is more than one logbook for the project)
- Contract and task order numbers
- Name of the site and site location (city and state)
- Name of subsite (or operable unit), if applicable
- Type of activity (if logbook is for specific activity, such as well installation or indoor air sampling)
- Beginning and ending dates of activities entered into the logbook

2.2.2 Inside Cover or First Page

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Tetra Tech project manager and site manager and phone numbers
- Tetra Tech office address

- Client contact and phone number
- Site safety officer and phone number
- Emergency contact phone number (911, if applicable, or nearest hospital)
- Subcontractor contacts and phone numbers
- Site property owner or property manager contact information

2.3 ENTERING INFORMATION IN THE LOGBOOK

The following lists provide guidance on the type of information to be included in a typical field logbook. This guidance is general and is not intended to be all-inclusive. Certain projects or clients may specify logbook requirements that are beyond the elements presented in this SOP.

General Daily Entries:

- Document what time field personnel depart the Tetra Tech office and arrive at the hotel or site. If permitted by the client to charge travel time for site work, document what time personnel leave and arrive at the hotel each day. (This information may be needed at remote sites where hotel accommodations are not near the site.)
- Indicate when all subcontractors arrive and depart the site.
- Note weather conditions.
- Include the date at the top of each page.
- Document that a site safety meeting was held and include the basic contents of the meeting.
- List the level of protection to be used for health and safety.
- Summarize the day's planned activities.
- Summarize which activities each field team member will be doing.

Field Activity Entries:

- Refer to field data collection forms for details about field data collection activities (for example time, date, depth of samples, field measurements). If separate field sampling sheets are not used, see section below regarding logbook entries for sampling activities.
- Refer to well purge forms, well construction logs, and other activity-specific forms as applicable rather than including this type of information in the field logbook. These other forms allow the information to be more accessible at a later date.
- List any air monitoring instrumentation used, with readings and locations.
- Refer to instrument field logs for equipment calibration information.
- Summarize pertinent conversations with site visitors (agency representatives, property owners, client contacts, and local citizens).
- Summarize any problems or deviations from the quality assurance project plan (QAPP) or field sampling plan.
- Document the activities and whereabouts of each team member. (As indicated in Section 2.1, multiple logbooks may be required to ensure sufficient detail for contemporaneous activities).
- Indicate when utility clearances are completed, including which companies participated.
- Indicate when verbal access to a property is obtained.
- Include names, addresses, and phone numbers of any pertinent site contacts, property owners, and any other relevant personnel.
- Document when lunch breaks or other work stoppages occur.
- Include approximate scale for all diagrams. If a scale is not available, write “not to scale” on the diagram. Indicate the north direction on all maps and cross-sections, and label features on each diagram.

Sampling Activity Entries: The following information should typically be on a sample collection log and referenced in the log book. If the project does not use sample sheets as a result of project-specific requirements, this information should be included in the logbook.

- Location description
- Names of samplers
- Collection time
- Designation of sample as a grab or composite sample
- Type of sample (water, sediment, soil gas, or other medium)
- On-site measurement data (pH, temperature, and specific conductivity)

- Field observations (odors, colors, weather)
- Preliminary sample description
- Type of preservative used.
- Instrument readings, if applicable

Closing Daily Entries:

- Describe decontamination procedures (personnel and equipment).
- Describe handling and disposition of any investigation-derived wastes.
- Summarize which planned activities were completed and which ones were not.
- Note the times that personnel depart site for the day.
- Summarize any activities conducted after departing the site (paperwork, sample packaging, etc.). This may be required to document billable time incurred after field activities were completed for the day.

Photographic Log Entries:

- For digital photographs, indicate in the text that photographs were taken and the location where the photographs can be found (for example, in the project file).
- Camera and serial #
- Photographer
- Date and time of photograph
- Sequential number of the photograph and the film roll number or disposable camera used (if applicable)
- Direction of photograph
- Description of photograph

2.4 LOGBOOK STORAGE

Custody of logbooks must be maintained at all times. During field activities, field personnel must keep the logbooks in a secure place (locked car, trailer, or field office) when the logbook is not in personal possession. When the field work is over, the logbook should be included in the project file, which should be in a secured file cabinet. The logbook may be referenced in preparing subsequent reports and may also be scanned for inclusion as an appendix to a report. However, it is advisable to obtain direction directly from the client before including the logbook as a report appendix, because its inclusion may not be appropriate in all cases.

2.5 HEALTH AND SAFETY CONSIDERATIONS

In addition to the procedures outlined in this SOP, all field staff must be aware of and follow the health and safety practices that result from the Activity Hazard Analyses (AHAs) for a project. The AHAs include critical safety procedures, required controls, and minimum personal protective equipment (PPE) necessary to address potential hazards. The hazards specific to project tasks must be identified and controlled to the extent practicable and communicated to all project personnel via the approved, project-specific Health and Safety Plan (HASP).

SOP APPROVAL FORM

TETRA TECH EM INC.

LABORATORY ANALYTICAL DATA STANDARD OPERATING PROCEDURE

Laboratory Analytical Data Verification – Minimum Requirements

SOP NO. 203

REVISION NO. 00

Last Reviewed: August 2010

Quality Assurance Approved	August 24, 2010 Date

1.0 BACKGROUND

Data quality assurance (QA) is necessary for every project. It is the total integrated process for assuring reliability and defensibility of decisions based on data—including analytical data. In particular, appropriate level and accurate review of data resulting from chemical and physical analysis are essential to ensure these data are of sufficient quality to support the project's technical requirements.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to ensure laboratory data used by Tetra Tech to make project decisions are of the quality required and provide the level of confidence needed to make the appropriate project decisions. This SOP specifies data verification guidelines for ensuring achievement of a minimum level of project data QA.

1.2 SCOPE

Analytical data generated for Tetra Tech projects must receive the appropriate level of data review. The level of detail and stringency of data verification or data validation depends on the needs of the project and program. This SOP specifies guidance for data verification procedures when program-specific or regulatory requirements are not defined contractually or by program procedures and regulations (for example, Phase II Environmental Site Assessments, emissions monitoring, and compliance reporting data for permit applications).

1.3 DEFINITIONS

This subsection defines key terms used in the text.

Data package – A hard copy or electronic report from an analytical laboratory for a set of chemical and physical analyses performed on a group of samples (sometimes referred to as a Sample Delivery Group [SDG]). The data package should contain sufficient QA documentation to complete data verification and determine data usability.

Data usability – A qualitative decision process whereby a qualified person determines whether the data may be used for the intended purpose. Data should be classified into one of the following two categories: usable or rejected (unusable).

Data verification – The act of determining and documenting whether data conform to specified requirements. The determination may involve processes such as reviewing, inspecting, testing, checking, recalculating, and auditing.

Rejected data – Data that do not conform to some or all requirements considered critical to assuring and confirming the quality of the data. Nonconformances may include: (1) critical quality control (QC) criteria are not met (see Table 1); (2) appropriate methods were not followed or the methods used involved significant deviations that might impact data quality or meaning; and (3) critical documentation is missing or incomplete.

Sample delivery group – A unit (group) of samples received by the laboratory during a field sampling event. A "sample date group" (SDG) is typically comprised of 20 or fewer samples, and is grouped based on the number of samples and not the analytical testing requested. A SDG may be defined based on the number of samples received by the laboratory on a given day or over a period of up to 7 calendar days.

Qualified person – A chemist or other person who received training in or has demonstrated skills and knowledge of laboratory procedures and QC. The qualified person involved in data verification should understand the data generation procedures and know project documentation and data quality requirements.

Usable data – Data conforming to most or all requirements considered critical to assuring and confirming the quality of the data. Conformances important to achieve usability include: (1) critical QC criteria are met (see Table 1); (2) appropriate methods were followed, or only minor deviations to the methods were made that would not impact data quality or meaning; and (3) critical documentation is complete. Professional judgment by a qualified person should be used to determine data usability.

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 2002. Guidance on Environmental Data Verification and Data Validation EPA, QA/G-8. EPA/240/R-02/004. November. On-line address: http://www.epa.gov/quality/qs-docs/g8-final.pdf

EPA. 2005. "USEPA Analytical Services Branch (ASB) National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review." September. On-line address: http://www.epa.gov/superfund/programs/clp/download/dlm/dlm2nfg.pdf

EPA. 2008. "USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review." June. On-line address: http://www.epa.gov/superfund/programs/clp/download/somnfg.pdf

EPA. 2009. "USEPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use." January. On-line address: http://www.epa.gov/superfund/policy/pdfs/EPA-540-R-08-005.pdf.

EPA. 2010. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review." January. On-line address: http://www.epa.gov/superfund/programs/clp/download/ism/ism1nfg.pdf

1.5 REQUIREMENTS AND RESOURCES

The following are required for laboratory data verification as described in this SOP:

- Laboratory data package(s)
- Project-specific information for data use (i.e. work plan, sampling and analysis plan [SAP], quality assurance project plan [QAPP], proposal, or purchase order)
- Qualified person, familiar with laboratory procedures and capable of determining data usability.

Laboratory data package(s) should include the following to allow for data verification:

- Cover letter or case narrative, including the laboratory name and address, that certifies analytical results via signature of the project chemist, QA manager, or laboratory manager
- Signed field chain-of-custody form(s)
- Sample receipt and log-in forms, which include general comments and specify temperature, holding time, bottle breakages, and any nonconformances or discrepancies
- Laboratory log-in summary, including laboratory sample identification (ID), field sample ID, list of analyses performed, and analytical methods employed
- Analytical results
- Applicable analytical batch QC results (for example, method and field blanks, surrogate spikes, matrix spike/matrix spike duplicates [MS/MSD], and laboratory control sample/laboratory control sample duplicates [LCS/LCSD])
- List of laboratory data qualifier definitions.

Time required for laboratory data verification can vary greatly depending on the number of analyses per data package and the number of samples per data package. The following rules of thumb, including producing a record of the type found in Attachment A, may be useful for planning purposes:

- 30 minutes for a SDG with one major analysis (e.g., metals or volatiles)
- 90 minutes to 2 hours for a SDG with a common suite of analyses (e.g., metals, volatiles, semivolatiles, pesticides, polychlorinated biphenyls, and total petroleum hydrocarbons)
- 30 minutes for a SDG with a common suite of wet chemistry analyses (e.g., alkalinity, pH, major anions, total organic carbon, total dissolved solids, and total suspended solids).

The times noted are estimates only. Involving a qualified person in the planning process will help ensure proper budget for data verification.

2.0 PROCEDURES

Step 1 – The project manager identifies a qualified person with an understanding of laboratory data generation and usability to review and verify the data. If the data are released to the client prior to verification, the client should be advised that the data are preliminary pending this review.

Step 2 – The qualified person identifies the project analytical QA/QC needs for documentation and technical specifications as these apply to data content and quality. A work plan, SAP, QAPP, regulatory guidance, laboratory analytical method, client contract, or project scope of work may identify the technical specifications and QA/QC requirements.

Step 3 – The qualified person reviews the data and documents the review findings based on the requirements for data quality needed to achieve project objectives. Serious issues regarding data usability are immediately brought to the project manager's attention for further discussion and resolution. Table 1 describes the elements of data verification.

In all cases, the laboratory chain-of-custody indicating sample IDs, matrices, and analytical methods—and perhaps frequency of collection and submittal of QA/QC samples (i.e., field duplicates, trip blanks, field blanks, equipment rinsate blanks, and MS/MSDs)—should be cross-checked with the SAP or the contracted scope of work.

In each case, professional judgment should be used to determine data usability. Ultimately, the project manager's responsibility is to ensure a qualified person has reviewed the laboratory data package, and has deemed the data usable for the data's intended purpose.

Step 4 – The qualified person reviews and compares the analytical method detection limits (MDL), reporting limits (RL), and practical quantitation limits (PQL) for compliance with project requirements. Explicit definition and clarification of MDLs, RLs, and PQLs should be established prior to field activities.

Step 5 – The qualified person communicates findings. The deliverable from the qualified person includes at least one of the following:

- An e-mail indicating data usability
- A memo summarizing the evaluated results
- A table of data showing data points considered biased or outside acceptance criteria for various data quality indicators by a large enough factor that use of the data might affect environmental decisions.

Some written form of communication should be provided for the project file. An example of a minimum data verification deliverable is included as Attachment A.

3.0 DATA VERIFICATION RESULTS

As described above, potential data verification issues involving the following designations may be encountered during this process:

Rejected data – During verification, the qualified person may reject some or all of the data (consider the data unusable). If laboratory data are rejected due to poor quality, the project manager may ask the laboratory to re-analyze the extracts, or re-digest and/or re-extract the original sample if enough volume remains.

Inadequate data – The qualified person may find the data inadequate for the intended purpose, even if all QC criteria were met—for example, a case in which laboratory reporting limits are not adequate to meet the comparison or screening values established during the project planning process.

Incomplete data packages – The data package provided by the laboratory may not be complete. If the laboratory data package does not include the minimum contents defined in Section 1.5, the laboratory should be notified and required to issue a revised data package.

If encountered, any of the above data designations should be addressed immediately and corrected to minimize effects on future project deliverables. Further discussion with the analytical laboratory may help in the effort to address each of the above designations. The data verifier and the project manager should discuss potential remedies or corrective measures to minimize impact(s) of the above designations on project analytical data and decisions based on those data.

Table 1
Elements of Laboratory Data Verification

Data Report Element	Minimum Required Review	Actions
Chain-of-custody	Review laboratory log-in forms against chain-of-custody forms and the contracted scope of work (SAP) for: accuracy and completeness of documentation, sample quantity and IDs, proper signatures attesting to chain-of-custody, sample condition upon receipt (breakage, temperature, etc.), sample preservation (see below), and analytical method selection.	Discrepancies regarding log-in, chain-of-custody, analytical method selection, or related issues should be immediately addressed. If discrepancies are identified, the laboratory should be contacted immediately and corrective actions implemented. Improper sample handling and preservation should be investigated to determine sample adequacy (see below).
Data package completeness	Review data package to make sure that all requested analytical procedures have occurred and required corresponding data are reported.	Analytical results that lack supporting data and information may be considered invalid and not usable for the purpose intended. Such conditions should be immediately addressed with the project team and laboratory.
Sample preservation, storage, and holding times	Review sample preservation, storage, and holding times in compliance with selected analytical method and matrix.	Analytical results of samples not properly preserved and stored, or digested/extracted or analyzed outside the appropriate holding time, may be considered invalid and not usable for the purpose intended. Such conditions should be immediately addressed with the project team.
Method and field blanks	Review blank data for positive results that may indicate possible field or laboratory contamination.	If blank contamination is found in either the laboratory method blanks or the field QC blanks (i.e., equipment rinsate blanks, source or field blanks, or trip blanks), associated sample results should be reviewed. Detections in the associated environmental samples may be attributed to laboratory or field contamination, and qualifications of the data may be necessary.
Precision and accuracy* (may include surrogate spikes, MS/MSDs, and LCS/LCSDs)	Review QC data summaries for the analytical method used. Use project-required, method-required, or laboratory-provided control limits. Review laboratory-assigned data quality flags and notations, and revise if necessary.	In general, recoveries and relative percent difference values for surrogate spikes, MS/MSDs, and LCS/LCSDs that fall outside of the specified control limits may indicate problems with the laboratory analysis.*

Notes:

* The type and amount of QC information available for review will depend upon the analytical method and level of data package requested.

ID Identification
LCS/LCSD Laboratory control sample/laboratory control sample duplicate
MS/MSD Matrix spike/matrix spike duplicate
QC Quality control
SAP Sampling and analysis plan

ATTACHMENT A
EXAMPLE DATA VERIFICATION REPORT

Prepared by: _____

Date: _____

Site Name/Job Number: _____

Laboratory: _____

Data Package or SDG Number: _____

Sample Designations/Names (ID): _____

Matrices: _____

Analytical Parameters: _____

Data Package Element	Usable	Rejected	NA	Description of Affected Data (note specific samples and analytical parameters affected)
Chain of custody	__	__		
Data package completeness	__	__		
Sample preservation, storage, and holding times				
Method and field blank contamination				
Surrogate spikes				
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)				
Laboratory Control Samples/Laboratory Control Sample Duplicates (LCS/LCSD)				
Other				
Summary				

BC LABORATORY SOPS

BCORG014	Organochlorine Pesticides and PCB's by Gas Chromatography EPA 508 / 608 / 8080 / 8081
BCORG019	Gas Chromatography for Polychlorinated Biphenyls / EPA Method 8082
BCMET013	Determination of Metals and Trace Elements in Waters and Waste Waters by ICP-OES 200.7/6010B
BCPREP014	Splitting and Refrigerating Samples (including Incremental Sampling Methodology Sample Preparation Methods)

BC LABORATORIES, INC.

SOP APPROVAL LOG

EPA 508/608/8080/ 8081 BCORG014

REV #	QA OFFICER SIGNATURE	DATE APPROVED	DEPARTMENT SUPERVISOR SIGNATURE	DATE APPROVED
0				
1				
2				
3				
4				
5	X [illegible]	7/22/03	X [illegible]	7/23/03
6	X S. Guron	8/18/05	X Steve Bennett	~~8/18/05~~ 9/6/05 SPB
7	X Sara Guron	3/1/06	X [illegible]	3-1-06
8	X S. Guron	11/20/07	X [illegible]	11-20-07
9	X S. Guron	1/18/08	X [illegible]	1-21-08
10	X S. Guron	4/19/08	X [illegible]	4-22-08
11	S. Guron	1/10/12	[illegible]	1/10/12
12	X S. Guron	4/9/13	Steve Bennett	4/9/13
13	X S. Guron	1/16/14	[illegible]	1/16/14
14	X S. Guron	1/21/15	[illegible]	1/21/15
15	X S. Guron	1/20/16	[illegible]	1/20/16
16				
17				
18				
19				
20				
21				
22				
23				
24				

BC LABORATORIES, INC.
SOP REVIEWED LOG
SOPs are review on a yearly basis
(No changes were made on the following revisions)
EPA 508/608/8080/8081 **BCORG014**

REV #	QA OFFICER SIGNATURE	DATE REVIEWED	DEPARTMENT SUPERVISOR SIGNATURE	DATE REVIEWED
15	S. Gurson	1/23/17		1/23/17

[S:\WPDOCS\WORDOC\LAB_DOCS]SOP\SOPReviewedL]

BC LABORATORIES, INC.

SOP APPROVAL LOG

EPA METHOD 8082***BCORG019***

REV #	QA OFFICER SIGNATURE	DATE APPROVED	DEPARTMENT SUPERVISOR SIGNATURE	DATE APPROVED
0				
1				
2				
3				
4	x Lanette Bohn	7/14/04	x Steven Bennett	7/14/04
5	x S. Guron	7/13/05	x Steven Bennett	7/13/05
6	x Sara Guron	3/2/06	x	3/2/06
7	x S. Guron	1/17/08.	x	1-21-08
8	x S. Guron	x 4/18/08.		4-22-08
9	x S. Guron	x 12/22/10	x Steve Bennett	12/22/10
10	x S. Guron	x 4/14/11	x Steve Bennett	4/13/11
11	x S. Guron	x 1/11/2012	Steve Bennett	1/11/12
12	x S. Guron	1/16/14		1/16/14
13	x S. Guron	1/19/15		1/19/15
14	x S. Guron	1/21/16		1/21/16
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

BC LABORATORIES, INC.

SOP REVIEWED LOG
SOPs are review on a yearly basis
(No changes were made on the following revisions)
Method 8082 BCORG019

REV #	QA OFFICER SIGNATURE	DATE REVIEWED	DEPARTMENT SUPERVISOR SIGNATURE	DATE REVIEWED
11	S. Guron	1/14/13		1/14/13
14	S. Guron	1/23/17		1/23/17

BC LABORATORIES, INC.

SOP APPROVAL LOG

ICP-OES 200.7/6010B ***BCMET013***

REV #	QA OFFICER SIGNATURE	DATE APPROVED	DEPARTMENT SUPERVISOR SIGNATURE	DATE APPROVED
0				
1				
2				
3				
4				
5				
6				
7				
8	[illegible]	5/8/03	M. Atkins	5/6/03
9	x S. Guron	9/8/05	x M. Atkins	9/8/05
10	x S. Guron	11/8/05	x M. Atkins	11/7/05
11	x Sara Guron	2/28/06	x M. Atkins	2/28/06
12	x S. Guron	4/27/07	x M. Atkins	4/27/07
13	x S. Guron	11/21/07	x M. Atkins	11/28/07
14	x S. Guron	4/21/08	x M. Atkins	4/21/08
15	x S. Guron	5/11/09	RPS	5-11-09
16	x S. Guron	12/17/10	Richard L. [illegible]	12/17/10
17	x S. Guron	x 2/9/12	x M. Atkins	2/9/12
18	x S. Guron	6/12/14	M. Atkins	6/12/14
19	x S. Guron	2/18/15	M. Atkins	2/18/15
20				
21				
22				
23				
24				

[H:\DOCS\WORD97\LAB_DOCS]SOP\SOPAPVL]

BC LABORATORIES, INC.

SOP REVIEWED LOG
SOPs are review on a yearly basis
(No changes were made on the following revisions)
ICP-OES 200.7/6010B **BCMET013**

REV #	QA OFFICER SIGNATURE	DATE REVIEWED	DEPARTMENT SUPERVISOR SIGNATURE	DATE REVIEWED
17	S. Guron	5/1/13	M. Alonso	5/1/13
19	S. Guron	4/8/16	M. Alonso	4/8/16
~~19~~		~~4/10/16~~ 17		~~4/10/17~~
19	S. Guron	4/10/17	M. Alonso	4/10/17

BC LABORATORIES, INC.

SOP APPROVAL LOG

SPLITTING AND REFRIGERATING SAMPLES BCPREP014

REV #	QA OFFICER SIGNATURE	DATE APPROVED	DEPARTMENT SUPERVISOR SIGNATURE	DATE APPROVED
0				
1				
2				
3	x Sara Guron/Danette Bohm	9/18/04	x M. Atanasio	9/14/04
4	x S. Guron	5/17/06	x M. Atanasio	5/17/06
5	x S. Guron	4/22/08	x M. Atanasio	4/22/08
6	x S. Guron	x 9/5/12	x Richard T Purvis	9/6/12
7	x S. Guron	x 5/19/15	Richard T Purvis	6/10/15
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

BC LABORATORIES, INC.

SOP REVIEWED LOG

SPLITTING AND REFRIGERATING SAMPLES **BCPREP014**

REV #	QA OFFICER SIGNATURE	DATE REVIEWED	DEPARTMENT SUPERVISOR SIGNATURE	DATE REVIEWED
5	x S. Guron	5/13/10	x M. Atanacio	5/12/10
5	x S. Guron	10/11/11	M. Atanacio	10/11/11
6	x S. Guron	1/6/14 MA 1/5/15	M. Atanacio	1/6/14 MA 1/5/15
6	x S. Guron	1/5/14 15	M. Atanacio	1/5/14 15
7	x S. Guron	10/17/16	M. Atanacio	10/17/16

UnControlled Copy:
Issued To:
Approved by: Semi Volatile Supervisor
Approval Date: 01/20/2016
Effective Date: 01/23/2017
Printed Date:
Location:
Printed By:

1.0 SCOPE AND APPLICATION

1.1 These methods are used to determine the concentrations of chlorinated pesticides and polychlorinated biphenyls (PCB's) in a variety of matrices. These methods are based on gas chromatographic (GC) procedures. The components identified by these methods and their detection limits are listed below:

COMPONENT	WATER PQL (µg/L)	SOIL (mg/kg)	OIL (mg/kg)
HCCPD**	0.05		Varies
Alpha-BHC	0.005	0.0005	Varies
Beta-BHC	0.005	0.0005	Varies
Gamma-BHC	0.005	0.0005	Varies
Delta B-BHC	0.005	0.0005	Varies
Chlorothalonil**	0.05		Varies
Heptachlor	0.005	0.0005	Varies
Aldrin	0.005	0.0005	Varies
Heptachlor Epoxide	0.005	0.0005	Varies
Endosulfan I	0.005	0.0005	Varies
PP – DDE	0.005	0.0005	Varies
Dieldrin	0.005	0.0005	Varies
Endrin	0.005	0.0005	Varies
Endosulfan II	0.005	0.0005	Varies
PP – DDD	0.005	0.0005	Varies
Endrin Aldehyde	0.01	0.0005	Varies
Endosulfan Sulfate	0.005	0.0005	
PP – DDT	0.005	0.0005	
Methoxychlor	0.005	0.0005	
Chlordane	0.5	0.05	
Toxaphene	2	0.05	
Arachlor 1016	0.2	0.01	
Arachlor 1221	0.2	0.01	
Arachlor 1232	0.2	0.01	
Arachlor 1242	0.2	0.01	
Arachlor 1248	0.2	0.01	
Arachlor 1254	0.2	0.01	
Arachlor 1260	0.2	0.01	

Trifluralin*	0.7	0.005	
Propachlor*			
Alpha chlordane	0.005	0.005	
Beta chlordane	0.010	0.005	
mirex	0.01	0.005	
Hexachlorobenzene	0.05	0.005	
Kepone	1.0	0.0050	
Endrin Ketone	0.0050	0.0005	
PCNB	0.050	0.0020	
GAMMA-CHLORDANE	0.5	0.005	

* These analytes are reported upon request.
** 508 analyses only.

1.2 Method 508 is used for drinking waters.
Method 608 is used for wastewaters.
Method 8080, 8081A is used for wastewaters, soils, solid wastes, transformer oil and auto shredder wastes.

2.0 SUMMARY OF METHOD

2.1 Prior to analysis, samples are prepared by the extraction department using the appropriate sample preparation and clean up procedures (EPA 3510, 3550, 3580 Form 9). 5 µl of the extracted sample is introduced into the gas chromatograph via direct injection by an autosampler. The components are separated by the chromatographic column and a specific pattern is yielded from the analytes present in the sample. A chromatogram is obtained through the data system. The individual peaks for pesticide are identified by a retention time comparison with the standard peaks. Each component is quantitated separately. For quantitation of PCB's a minimum of five peaks (typically seven) are used in the standard and the same peaks are used in the sample. The peaks are identified by a retention time comparison with the standard peaks. The specific PCB is then quantitated based upon the sum of all the peaks seen in a retention time window of the chromatogram. The identification of samples containing toxaphene and chlordane is based upon a pattern comparison with the specific standard.

3.0 INTERFERENCES AND THEIR CORRECTIVE ACTIONS

3.1 Method interferences may be caused by contaminants in solvents, reagents, glassware and other sample processing apparatus that lead to discrete artifacts or elevated baselines in gas chromatograms. All reagents and apparatus must be routinely demonstrated to be free from interferences under the conditions of the analysis by running instrument blanks.

3.1.1 Glassware must be scrupulously cleaned. Clean all glassware as soon as possible after use by rinsing thoroughly with the last solvent used. Follow by washing with hot water and detergent and thorough rinsing with tap and distilled water. Drain dry and heat in an oven at 400^0C for 2 hours. Thermally stable materials such as PCB's might not be eliminated by this treatment. Thorough rinsing with acetone and hexane may be done. After drying and cooling, seal and store glassware in a clean environment to prevent any accumulation of dust or other contaminants. Store inverted or capped.

3.1.2 The use of high purity reagents and solvents helps to minimize interference problems.

3.2 Interfering contamination may occur when a sample containing low concentrations of analytes is analyzed immediately following a sample containing relatively high concentration of analytes. Between sample rinsing of the sample syringe and associated equipment with hexane can minimize sample cross contamination. After analysis of a sample containing high concentrations of analytes, one or more instrument blanks should be run to ensure that accurate values are obtained for the next sample.

3.3 H^2SO^4 Cleanup: PCB's samples with H_2SO_4 cleanup may require another acid cleanup if the extract looks dark or cloudy. For acid cleanup, pipet out the upper hexane layer into a VOA vial. Add about 5 mls of H^2SO^4 into the extract. Shake it and centrifuge if for 5 minutes. If repeated acid cleanups are required, repeat the same process until the extract is as clean as possible.

3.4 DDT and endrin are easily degraded in the injection port if the injection port or front of the guard column is dirty. This is the result of buildup of high boiling residue from sample injections. If the degradation of either PP-DDT or endrin exceeds 15%, change the liner and guard column.

3.5 Each instrument has a specific bake method. The column, injector and detector temperatures are all raised in these instances. Bake until baseline (in mV) is at a normal range for instrumentation in question.

4.0 APPARATUS AND MATERIALS

4.1 Apparatus

4.1.1 Gas Chromatograph: Analytical system complete with gas chromatograph suitable for injections and all required accessories, including detectors, column supplier, recorder, gases and syringes. A data system for measuring peak heights and peak areas.

4.1.2 Primary column is Zebron-CLPesticides 30m x 0.32mm ID, 0.32µm *df*

4.1.3 Confirmation columns is Zebron-CLPesticides 30m x 0.32mm ID, 0.32 film thickness µm

4.1.4 The Guard column is Restek RTX- 440 30m x 0.32mm ID, 0.5µm *df*

4.1.5 Detectors: Electron Capture Detector (ECD)

4.1.6 Volumetric flask, class A: sizes as appropriate with ground glass stoppers.

4.1.7 Syringes: glass, gastight. 10 µl, 25 µl, 100 µl, 250 µl, 500 µl, 1 ml.

4.1.8 Vials: 2 ml Verex Vial with teflon lined crimp tops and screw tops.

4.1.9 Balances: analytical, accurate to 0.0001 g.

4.1.10 HPCHEM data systems are used for data collection and Excel for QC entry and control charting.

4.2 Instrument Parameters

4.2.1 Gas Chromatograph: The Gas Chromatograph used is Hewlett Packard HP 6890 Series GC System and GC Injector/Autosampler.

4.2.1.1 Conditions: 8080 Method
Instrument Hewlett Packard HP 6890 Series GC System and GC Injector/Autosampler.

Initial Oven Temp.	140°C
Initial hold time	0.5 min.
Inlet Temp.	250°C
Detector Temp.	340°C
Prog.1 Final col.	330°C

4.2.1.3 Bake Method:

Column Temp:	340^0C
Injector Temp:	250^oC
Detector Temp:	380^0C

5.0 REAGENTS AND STANDARD SOLUTIONS

5.1 Reagents - Name and Source: Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the committee on the Analytical Reagents of American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.1.1 Solvents

TABLE 2

Solvent	Source	Catalog #	CAS #
Acetone	BDH	010-4	67-64-1
Dichloromethane	BDH	300-4	75-09-2
Hexane	Honeywell	217-4	110-54-3
Iso-octane	BDH	362-4	540-84-1
MTBE	BDH	242-4	1634-04-4

All solvents must be of pesticide quality or equivalent.

5.1.2 Organic Free Water: Deionized water free of organic compounds.

5.1.3 Sulfuric Acid: Available from Fisher. Catalog #UN1830.

5.2 Standard Stocks:

5.2.1 Standard Stock Solutions for Pesticides - Stock of all the analytes are purchased from various vendors. The primary stocks are diluted in appropriate solvents and a

final stock solution is prepared to make the working standards. The compounds along with their primary and final concentrations are listed below:

TABLE 3
Pesticide B Mix

Compound	Supplier	Primary Stock Conc. (µg/ml)	Solvents Used	Final Stock Conc. (µg/ml)
Pesticide Mix*	CPI	2,000	Hexane	2.5
Chlorothalonil**	CPI	100	methanol	1
Dicofol	CPI	1,000	methanol	20
Methoxychlor*	CPI	1,000	Acetone/Hexane	2.5
HCB**	CPI	100	methanol	1
HCCPD**	CPI	100	methanol	1
Chlordane	CPI	1,000	Acetone/Hexane	10
Toxaphene	CPI	5,000	Acetone/Hexane	10
Trifluralin	CPI	1,000	Hexane	1
Kepone	CPI	2,000	Hexane	0.5
Mirex	CPI	1,000	Hexane	10
PCNB	CPI	100	methanol	1

* Pesticide Mix and Mirex are combined together to a stock of 2.5 µg/ml. This mix is called Pesticide Mix 'A' stock. Pesticide Mix contains the following analytes at the same concentration:

Aldrin	Alpha Chlordane	Dieldrin
A-BHC	Beta Chlordane	Endosulfan I
B-BHC	Endrin Ketone	Endosulfan II
Delta-BHC	Methoxychlor	Endosulfan Sulfate
Gamma-BHC		Endrin
PP-DDD		Endrin Aldehyde
PP-DDE		Heptachlor
PP-DDT		Heptachlor Epoxide

** Kepone PCNB, HCCPD, HCB & Chlorothalonil are combined together to a concentration of 2 µg/ml and this stock is called mix 'B' stock. Curve standards for mix 'B' are made from this stock. They are only run for 508 samples.

5.2.2 Stock Solutions for PCB's: The polychlorinated biphenyls are purchased individually from different sources. The final stock solution required for preparation of working standards is prepared by diluting primary stocks of PCB's in appropriate solvents. The primary & final stock concentrations of PCB's are as follows:

TABLE 4

PCB	Supplier	Primary Stock Conc. (µg/ml)	Solvents Used
AR1268	Absolute Std.	1000	MeOH
AR1262	Absolute Std.	1000	Isooctane
AR1260	Absolute Std.	1000	Hexane
AR1254	Absolute Std.	1000	Isooctane
AR1248	Absolute Std.	1000	Isooctane
AR1242	Absolute Std.	1000	Isooctane
AR1232	Absolute Std.	1000	Isooctane
AR1221	Absolute Std.	1000	Isooctane
AR1016	Absolute Std.	1000	Hexane
AR1260 ICV	RESTEK	1000	Hexane
AR1016 ICV	Supelco	1000	Isooctane
DCB Surrogate	RESTEK	200	Acetone
TCMX Surrogate	RESTEK	100	Acetone

* Hexane may also be used.

Stocks for AR1221 and AR1016 are purchased when needed. PCB 1260/1016 from Method 8082 can also be used.

5.3 Working Standards

5.3.1 Curve standards for Pesticides: Begin by obtaining five 10 ml volumetric flasks and adding 1 mls of hexane to each flask. Next, add aliquots if individual stock standards as shown in Table 5 to each flask. Make up the volume with hexane and transfer the standard solutions into labelled voa vials. All standards must be entered into Element following the std. log SOP.

TABLE 5
Mix 'A' Curve Standards

Compound	Stock Conc. (µg/ml)	Aliquot Added (mls)						Final Conc. (µg/ml)					
		# 1	#2	#3	#4	#5	#6	# 1	#2	#3	#4	#5	#6
Pesticide Mix & Methoxychlor	2.5	0.002	0.1	0.2	0.5	1	2	0.0005	0.005	0.01	0.015	0.02	0.25
DCB Surrogate	3	0.04	0.06	0.08	0.1	0.12	0.14	0.012	0.018	0.024	0.03	0.036	0.042
TCMX Surrogate	6	0.04	0.06	0.08	0.1	0.12	0.14	0.024	0.036	0.048	0.06	0.072	0.084

Mix 'B' Curve Standards

Compound	Stock Conc. (µg/ml)	Aliquot Added (mls)						Final Conc. (µg/ml) to 25 mls					
		#1	#2	#3	#4	#5	#6	#1	#2	#3	#4	#5	#6
Mix 'B' Stock (HCB + HCCPD + Chlorothalonil Stock + PCNB + Kepone	2	0.025	0.05	0.125	0.25	0.5	1.25	0.005	0.01	0.025	0.05	0.1	0.25

5.3.2 Reference Standard for Pesticides: The reference standard also called initial calibration verification (ICV) standard should be analyzed after each calibration curve analysis to verify the accuracy of the initial calibration. The ICV stocks for all analyses are obtained from different lot # or vendors. The stock solutions are prepared by dilutions in appropriate solvents. Prepare the ICV standards as shown in Table 6 in a 50 ml volumetric flask and make up the volume with hexane.

TABLE 6
Reference (ICV) Standard
Mix 'A'

Compound	Primary Stock Conc. (µg/ml)	Source	Final Stock Conc. (µg/ml)	Aliquot Added ml	Final Conc. (µg/ml)
Pesticide Mix	2000	Absolute Standard Inc.	2.5	0.6	0.015
DCB (Surrogate)	200	RESTEK	6	1	0.06
TCMX (Surrogate)	100	RESTEK	3	1	0.030

TABLE 6
Reference (ICV) Standard Mix 'B'

Compound	Primary Stock Conc. (µg/ml)	Source	Final Stock Conc. (µg/ml)	Aliquot Added ml	Final Conc. (µg/ml)
PNCB	1000	Absolute Std	2	0.25	0.05
HCB	1000	Absolute Std			
Chlorothalonil	1000	Absolute Std			
HCCPD	1000	Absolute Std			
Kepone	1000	Absolute Std			

* The pesticide mix contains the following analytes at same concentration.

Aldrin
A-BHC
B-BHC
G-BHC
D-BHC
PP-DDD
PP-DDE
PP-DDT
Dieldrin
Alpha Chlordane
Beta Chlordane
Endrin Ketone
Mirex
Endosulfan I
Endosulfan II
Endosulfan Sulfate
Endrin
Endrin Aldehyde
Heptachlor
Heptachlor Epoxide
Methoxychlor

5.3.3 Curve Standards for PCB's: The curve standards for PCB's are prepared in 10 ml volumetric flasks. A small amount of hexane is added to each flask followed by aliquots of individual stocks as shown in Table 7. The final volume is made up with hexane.

TABLE 7

Arochlor	Compound	Stock Conc. µg/ml	Aliquot Added (mls)						Final Concentration (µg/ml)					
			#1	#2	#3	#4	#5	#6	#1	#2	#3	#4	#5	#6
AR1260/ 1016	PCB (AR1260)	10	0.02	0.1	0.15	0.25	0.35	0.5	0.02	0.1	0.15	0.25	0.35	0.5
	DCB Surrogate	6	0.04	0.06	0.08	0.1	0.12	0.14	0.012	0.036	0.048	0.06	0.072	0.084
	TCMX Surrogate	3	0.04	0.06	0.08	0.1	0.12	0.14	0.012	0.18	0.24	0.03	0.036	0.012
AR1254	PCB (AR1254)	10	0.02	0.1	0.15	0.25	0.35	0.50	0.02	0.1	0.15	0.25	0.35	0.5
AR1248	PCB (AR1248)	10	0.02	0.1	0.15	0.25	0.35	0.50	0.02	0.1	0.15	0.25	0.35	0.5
AR1242	PCB (AR1242)	10	0.02	0.1	0.15	0.25	0.35	0.50	0.02	0.1	0.15	0.25	0.35	.05
AR1232	PCB (AR1232)	10	0.02	0.1	0.15	0.25	0.35	0.50	0.02	0.1	0.15	0.25	0.35	0.5

Refer to method 8082 for further information.

5.3.4 Reference Standards for PCB's: The reference standards or ICV standards for all the PCB's are prepared from different sources at the midpoint concentration.

5.3.5 Curve Standard for Chlordane: A six point calibration is done for chlordane analysis. The standards are prepared in 10 mls of hexane as follows:

TABLE 8

Standard #	Supplier	Stock Conc. (µg/ml)	Aliquot Added (mls)	Final Volume (mls)	Final Conc. (µg/ml)
#1	Absolute	10	0.02	10	0.02
#2	Absolute	10	0.10	10	0.1
#3	Absolute	10	0.25	10	0.25
#4	Absolute	10	0.50	10	0.50
#5	Absolute	10	0.75	10	0.75
#6	Absolute	10	1	10	1

5.3.6 Curve Standards for Toxaphene: A six point calibration curve is run for toxaphene analysis. The standards are prepared as follows:

TABLE 9

Standard #	Supplier	Stock Conc. Tox./Surr. (µg/mL)	Aliquot Added mL	Final Volume mL	Final Conc. (µg/mL)
#1	Accustandard	10	0.20	10	0.2
#2	Accustandard	10	0.4	10	0.4
#3	Accustandard	10	0.5	10	0.5
#4	Accustandard	10	0.1	10	1
#5	Accustandard	100	0.3	10	3
#6	Accustandard	100	0.5	10	5

5.3.7 Reference Standards for Chlordane, Toxaphene, Trifluralin and Propachlor: The ICV standard for these analytes are purchased from different sources and prepared at mid point concentration.

TABLE 10

Compound	Stock Conc. µg/ml	Aliquot Added (mls)					Final Concentration (µg/ml)				
		#1	#2	#3	#4	#5	#1	#2	#3	#4	#5
Propachlor	1	0.05	0.1	0.25	0.5	1.0	0.005	0.01	0.025	0.05	0.1
Trifluralin	1	0.01	0.05	0.1	0.25	0.5	0.001	0.005	0.01	0.025	0.05

5.4 Surrogate Solutions:

5.4.1 DCB and TCMX are purchased from Restek at 200µg/ml and 100µg/ml respectively. Transfer 0.3ml of primary stock into a 10 ml volumetric flask and fill to mark. The final concentrations of DCB and TCMX are 6 ppm and 3ppm, respectively.

5.5 Spike Solutions:

5.5.1 Spike Solution for PCB's: Arochlor 1260 is used for making spiking solution. 25 mls of AR1260 (100 µg/ml) is transferred into a 100 ml Class A volumetric flask. The volume is made up with acetone to prepare a spiking solution at 2.5 µg/ml.

5.5.2 Spike Solution for Pesticides: 0.125 ml of pesticide mix at 200 µg/ml is diluted in 100 mls of acetone to prepare a solution at 0.25 µg/ml.

5.6 Laboratory Performance Check Standard:

5.6.1 The LPC Standard also contains endrin and PP-DDT to monitor their breakdown during analysis. The analyses present in LPC standard solution and their final concentrations are as follows: The final volume is 100 mls.

5.6.2 A 508.1 laboratory performance standard is also purchased. See Appendix for Certificate of Analysis. This standard contains Dacthal, Chlorothalonil, and Delta-BHC. Resolution and PGF must meet the requirements set in Section 9.

TABLE 11

Compound	Supplier	Primary Stock Conc. (µg/mL)	Solvents Used	Final Stock Conc. (µg/mL)
8080 LPC Mix	Supelco	5	Acetone/Hexane	0.02
508.1 LPC Mix	Supelco	Varied	Hexane	Varied

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

6.1 Water samples are collected in quart amber glass bottles with teflon lined caps. Soil samples are collected in glass jars or soil sleeve. Waters require a minimum of one liter. Soils require at least 30 g of each sample to ensure the detection limits stated in section 1.2.

6.2 The samples should be refrigerated at 4^0C after collection. Extraction of water and soil samples will need to be completed in 7 and 14 days respectively.

6.3 Extracts of samples must also be refrigerated at 4^0C. Preservation studies indicate that most analytes are stable for 40 days. However, the analyst should verify appropriate extract holding time for matrix under study.

7.0 PROCEDURE

7.1 Sample preparation: Samples must be prepared by one of the following method prior to GC analysis.

Matrix	Method
Water	3510
Soil	3550
Oil/Waste	3580

See the appropriate SOP for information regarding these methods.

Note: For DOD work, DOD QSM requirement version 5.0 must be followed. DOD compliance has been documented in BCL SOP BCDOD001 in section 3.0 thru section 8.0 to be followed. A copy of BCL SOP BCDOD001 is available for reference with Department Supervisors.

8.0 ANALYTICAL PROCEDURE

8.1 Prior to analyzing any samples, instrument blank (5 µl of hexane) must be introduced into the GC by direct injection to make sure that there is no instrument contamination of any kind i.e., extraneous peaks or baseline rise.

8.2 Then toxaphene, chlordane and 1260 standards at 0.02 µg/ml level are run at beginning of each 24 hour period of analyses to check the sensitivity of the instrument to multi-component standards.

8.3 Laboratory Performance check solutions (Endrin and DDT, and 508.1 LPC mix, and Chlorpyrifos) must be run before calibrating the system. The result of this analysis must satisfy the requirements in section 9.1.7 before proceeding.

8.4 The instrument must be calibrated to assure stable response and adequate sensitivity. At least a 5 point curve must be generated using the six calibration standards listed in section 5.3. If the RF relative standard deviation is less than 20% then an Average of Response

Factors curve fit is used. If the % RSD is greater than 20 and the coefficient of determination (r^2) is greater than 0.990 then a Linear Regression curve fit can be used. If the % RSD is greater than 20 and the coefficient of determination is greater than 0.990 then a Quadratic Regression curve fit can be used provided six standards are run for calibration. The Chemstation software reports the r^2 value. The requirements for Department of Defense work is a correlation coefficient (r) greater than 0.995 for both a Linear Regression and Quadratic Regression curve fit. For reference, an r value of 0.995 corresponds to an r^2 value of 0.990. The curve, once generated, must have its accuracy verified by the reference standard (ICV). All calculations associated with each of these procedures may be reviewed in section 9.

8.5 If the initial calibration and the external reference source have met the quality control requirements in section 9 and the instrument is otherwise determined to be fit for operation, then analysis may proceed. Once the extracts have been obtained from the sample preparation department, it will be necessary to transfer an aliquot into a smaller autosampler vial. Use a clean glass Pasteur Pipet to transfer a small aliquot (1.2 ml) into the vial. Cap this and place it into the autosampler tray. Do this for all the samples awaiting analysis. Prescreening of the extracts by visual inspection is sometimes necessary to avoid contamination of the analytical system. If the extract appears excessively cloudy or otherwise dark, make a dilution initially to protect the system. Remember, it is better to start with a high dilution and bring the dilution factor down, than to overload the analytical system. Sometimes, however, requirements may necessitate that dilutions may be held to a minimum (i.e., PQL). PCB's samples with H^2SO^4 clean may require another acid cleanup if the extract looks darker cloudy. (Refer to Section 3.3) ***NEVER transfer acid to an autosampler vial! Injection of acid will ruin the analytical column.***

8.6 Prepare a schedule using the HPCHEM software installed on the instrument's PC. All the files are stored on the D drive. These files are stored under D:\HPCHEM\DATA\GC14, 15, or 17|MONTHYEAR\MONTHDATE\i.e., D:\HPCHEM\DATA\GC1\SEPT98\SEPT01\. All files are ultimately copied onto CD and stored in a data room. Generally the order of analysis will be Instrument Blank (IB), DDT-Endrin, LPC, Chlordane 0.02 ppm, TOX 0.02 ppm, 1260 0.02 ppm, 508, and B-IC-2. Standard(s), method blank (MB), Laboratory Control Sample (LCSS, LCSW), Matrix Spikes (MS, MSD), Sample(s), end standard, CCB. The analyst analyzes a midpoint standard after 10 samples or 12 hours, whichever comes first during the analysis sequence. The requirements to be met are also listed in section 9. After the data has been collected and all the requirements set forth in section 9 have been satisfied, the sample chromatograms must be reviewed to determine if there are interferences requiring dilution. If there are no interferences which may require reanalysis with dilution, then the analytes must be checked for their presence.

8.7 <u>Qualitative Analysis:</u> The qualitative analyses for single component analytes are as follows:

8.7.1 **Retention Time Window** Using 3-5 days over a 72 hour period, the analyst must bi-annually update retention time windows for GC-methods. This is accomplished by tabulating at least 3 retention times for each peak to be identified from each day. The standard deviation and upper and lower control limits are calculated from this data. RT windows are determined using the broadest window found of any compound, and entering this value, or another chosen value with regard to appropriateness, into the chemstation software (page 1 of "Edit Compounds" under "IntCal") . The group leader or supervisor must be consulted for this option. These values are to be used for the next 6 month period or until a new column is

installed. If the RT windows are deemed inappropriate by an analyst or supervisor, new RT windows are to be calculated. The supervisor must accept and sign off all new retention time window updates.

8.7.1.1 The analyst plays a significant role in the determination of correct analyte identification and confirmation. He/ she may question positive or negative results based upon RT shifts, GC/MS confirmation, prior knowledge of sample composition, or by consultation with a group leader or supervisor. Analyte retention time should be updated after column maintenance using the midpoint of the curve. This will help ensure proper peak integration by the software (Chemstation) and make the identification of analytes in samples easier. Compare these retention times to the retention times of peaks in the sample chromatograms. If there are peaks which have retention times within these windows and they are also confirmed by the same method on the confirmation column, then one last effort will be made for the qualitative portion. This final confirmation is the procedure of response (area counts) ratios. To perform this test, the response for each analyte will be documented for each analytical column. Then the response for the primary column standard will be divided by the response for the primary column (sample analyte) to arrive at a ratio. Then the confirmation column response for the analyte is divided by the sample response on the confirmation column for that analyte to obtain the second ratio. Finally, the higher ratio is divided by the lower ratio. For those analytes which are suspected, and have passed the retention time test, the response ratio will be performed. If the response ratio is within 0.6 to 1.4, the quantitation and reporting will be performed. If the response ratio is between 0.3 to 0.6 & 1.4 to 1.70, then the result is semi-confirmed and a result is reported with a note. GC/MS confirmation will be attempted in those cases where analyte concentrations are high enough. For Department of Defense samples, the higher of the two results is reported unless co-eluting peaks cause the result to be skewed high. In this case the non-effected result is reported and documentation in the case narrative. When reviewing QC sample and calibration standard data, these same rules should be followed. In addition, the QC and standard results between the primary and secondary columns should have an RPD ≤ 40%.

8.7.1.2 When manual integrations are performed on Department of Defense sample chromatograms, the analyst is required to provide a chromatogram of the peak before and after integration. These should be initialed, dated and a given a brief explanation for the manual integration.

8.7.2 Toxaphene Analysis: When GC pattern of the sample "matches" that of toxaphene standard, quantitate toxaphene by comparing the total area of toxaphene chromatogram in the sample versus the standard toxaphene chromatogram.

If PP-DDE, PP-DDT or any other analyte is also present along with toxaphene, the toxaphene chromatogram gets superimposed by these analytes. If such analytes are present calculate them separately and subtract their areas from sample area for toxaphene. All surrogate recoveries are also subtracted from the total area. If any kind of contamination peaks are seen in the chromatogram which do not match with the standard chromatogram, subtract their areas from the sample area to give corrected area for toxaphene in the sample.

8.7.3 Chlordane Analysis: When the chromatogram of the sample "matches" that of chlordane, quantitate chlordane by comparing the sample chromatogram with the standard chromatogram. Surrogate peak areas and any kind of contamination peak areas should be subtracted from the total sample area to give corrected area for chlordane in the sample.

8.7.4 Polychlorinated biphenyls (PCB's) Analysis: PCB's are identified by their fingerprint. Enough of the fingerprint must be present for positive identification, i.e., at least 1/2 of the pattern. Secondly the retention times of peaks in the samples should match with retention times in the standard. For reference the daily calibration run retention time is used. Typically when no interferences are present, the sample is quantitated using a sum of the same seven peaks used for calibration. If interferences are present a minimum of five peaks may be used for quantitation. The five peaks thus used should not have any interferences and the relative intensities of the peaks in the sample should "match" those of the standard PCB run being quantitated.

The calibrations run must then be re-quantitated using the four interference free peaks and the sample can then be quantitated. Refer to Method 8082.

8.8 Quantitative Analysis - Quantitative analysis is the method of determining the concentration of the analyte in the sample. The concentration of the analyte in the sample will be determined by use of the following formula (incorporated into the calculation sheet in the Excel® program).

$$Concentration\,(\mu g/L) = \frac{(\frac{a}{CF})(fv)(d)}{sv}$$

Where:	a*	=	Response of the compound (area)
	fv	=	Final Volume of the Sample (ml)
	d	=	Dilution Factor
	CF	=	Average Calibration Factor of the Compound
	sv	=	Sample Volume extracted (Litre)

* This area value must be bracketed by the curve's analyte response (lowest and highest)

This result must then be reported on the worksheet along with the adjusted PQL, and a note if any.

8.9 Data Review - A review system has been established whereby the semi-volatile organics team leader or supervisor verifies that all stages of an analytical run are done correctly. The reviewer checks the daily folders associated with each sample run to ensure calculations are correct and QC is in order. If any manual integration is done on the chromatogram, it must be printed so that the reviewer can verify the appropriateness of all manual integrations.

8.10 The raw data for each is stapled and kept in a manilla folder which is labeled appropriately i.e., Instrument #, Method and Date. The data is collected in file boxes labeled with Instr. #, Method, From:, To: and when filled is given to the QC Dept.

9.0 QUALITY CONTROL

The results generated must have some evidence to substantiate them. This is the function of quality control; to establish confidence in the results generated.

9.1 Results, Parameters, Calculations and Statistical Limits

There are guidelines which must be adhered to as part of the quality control program.

9.1.1 Initial Calibration Factor Relative Standard Deviation Percent - % RSD

$$\% RSD = \frac{s}{x} x 100$$

Where s = Standard Deviation (sample) n-1 degrees of freedom
x = Average Calibration factor (CF_{ave})

Requirements: %RSD must be less that 20% for each analyte to use Average of Response Factor" curve fit. If %RSD is more than 20% then we can use "Linear Regression" curve fit. All the compounds which have more than 20%RSD are marked with one * and at the end of the initial calibration page it is specified that = Linear Regression. This helps in specifying that only those compounds have "Linear Regression" curve fit. If quadratic regression is used it is specified by two **.

9.1.2 Initial Calibration Verification (ICV)

This sample is the reference standard. It is used to check the accuracy of the initial calibration. Each analytes calibration factor must be compared to the curves average calibration factor for that analyte. For those compounds where "Linear Regression" curve fit is used, this standard's CF is calculated by dividing the present concentration of the compound in the standard to the actual concentration of the compound in the standard, then we multiply this result by 100 to give us %RSD. This %RSD is then entered on to the ICV page by hand. Again on ICV page, the compounds where "Linear Regression" curve fit is used are highlighted by one *. ”quadratic regression” by two **.

Requirements: The % difference (see CCV calculations) between this standard's CF and the curve's average CF must be below 15% for analyses to continue.

9.1.2.1 Each analyst must undergo a yearly demonstration of capability. This can be accomplished by passing a yearly audit sample. If a given analyst does not run an annual audit sample then they can perform an IDC to satisfy this requirement.

9.1.3 Continuing Calibration Verification (CCV)

This is a midpoint curve standard which is analyzed to validate instrument calibration on a continuing basis. The CCV should be of the same source as the initial curve. It is

analyzed at the beginning of the sample set, at the end of the set and after every 10 samples or twelve hours (whichever comes first) of operation.

The calibration factor for each analyte will be calculated, and the percent difference (%D) between this and the curves average calibration factor will be determined:

$$\% D = \frac{CF_{daily} - CF_{ave}}{CF_{ave}} x\, 100$$

For "Linear Regression" curve fit compounds:

$$\% D = \frac{conc.\, of\ compound\ of\ the\ standard}{Actual\ conc.\, of\ compound} x\, 100$$

Requirements: This result must be less than 15% in order to continue analysis or in the case of a finish CCV, the use any data.

Note: Change %RSD of compounds with "Linear Regression" curve fit manually. Then highlight it by marking two ** to show that "Linear Regression" curve fit is used for those compounds.

9.1.3.1 Begin CCV should pass <15%D.

9.1.3.2 End CCV must pass for quantitation, and to bracket QC.

9.1.3.3 If end CCV fails >15%D no quantitations and flag VII if high.

9.1.3.4 If end CCV fails >15%D no quantitation but flag 9C if low. But no more that 40% low, if so re-analyze.

9.1.3.5 If continuous failure, take remedial action to correct problem.

9.1.4 Matrix Spikes - Matrix spikes will be extracted and analyzed in duplicate if there is enough sample. The spiked analytes are those listed in Table 1. The two results of importance are the recovery and the precision, defined below:

$$Recovery\ Percent = (((\frac{A}{CF_{ave}} x \frac{fv}{sv}) - Samp) x) x\, 100$$

Where:	A	= Response of the analyte (area)
	CF_{ave}	= Average Calibration factor for the analyte (area/ppm)
	fv	= Final volume of the extract (ml)
	sv	= Initial volume/mass of sample (Litre/Kg)
	x	= Original spike concentration (ppb)
	Samp	= Conc. found in sample

$$Relative\ Percent\ Difference\ (RPD\ \%\ ) = \frac{MS\% - MSD\%}{Ave}\ \%\ x\ 100$$

Where: MS% = Analyte % Recovery for the spike
MSD% = Analyte % Recovery for the spike duplicate
Ave% = Average % Recovery for MS and MSD

The recovery percent is guided by the control limits established for each analyte. The relative percent difference is the measure of precision, and has a limit which is also statistically determined by control limits. See section 9.1.8 below. Accuracy and precision control limits.

9.1.4.1 For all Navy work, all target compounds will be used in the LCS, MS, and MSD. However, multi-component analytes (technical chlordane, toxaphene) will not be used.

9.1.5 **QC Failure (If applicable)**

9.1.5.1 The following is a list of possible QC failures that can occur:

A. Initial calibration (Linearity, % RSD)
Initial calibration verification (% D)
Continuing calibrations (%D)
Laboratory control sample
MS and MSD % Recovery or Precision not within established criteria (Same origin or Batch specific)
MB positive above the PQL (in all cases of positive compounds)
MB positive above ½ the PQL (in all cases of positive compounds for Navy related projects)
Sample precision (Same origin or Batch specific)
Sample holding time exceeded
Sample extract holding time exceeded
Surrogate(s) not within established criteria

B. Laboratory Performance Checks (If applicable)
Tuning criteria (GC/MS only)
Internal Standard incompliance (If applicable)
Sample frequency (CCV frequency)
SPCC or CCC criteria (GC/MS only)

9.1.6 For situations involving category A above, re-extract, re-run the incompliant samples, or note with appropriate flags. For situations involving category B, the analysis must stop immediately, and the analyst must evaluate possible causes and initiate corrective action. Maintenance of the instrument or the remaking of stock standard solutions may be the cure for both categories.

9.1.6.1 In instances where the MB, LCS, MS, or MSD is outside of established limits the following is the protocol:

1) Re-run the incompliant sample to confirm extraction or instrument error.

2) If the sample is within holding time, and there is enough sample to re-extract, it will be re-extracted.

3) If the sample is not within holding time, and there is enough sample to re-extract, the client service representative will be asked to notify the client of their options. Expired samples will be extracted only at clients request or with the permission of the supervisor or team leader.

4) If there is insufficient sample for re-extraction, the original result is reported with appropriate flags.

9.1.7 For further information refer to the current revision of the Quality Assurance Program Plan Appendix D.

9.1.8 Laboratory Control Sample - This spike is used to monitor the method (extraction and analysis) for losses of analytes. A laboratory sample (water or soil) is spiked with the analytes of interest and the percent recoveries are calculated as they are for a matrix spike. The control limits are established as outlined under Section 9.1.8.

9.1.9 Method Blank - This sample is used to monitor for interferences and the efficiency to some degree for the method. For water samples, 1 litre of laboratory reagent water is processed through the entire extraction and analysis process. The surrogate recovery expressed as a percentage is reported. If it is not within the established limits, a corrective action form (see below) must be filed for a re-extraction. Solid samples must also undergo this treatment, except that a laboratory glassware sample is used in place of water. Interferences must be noted and corrected.

9.1.10 Laboratory Performance Check Solution: This solution monitors the column and its performance for method 508. It monitors for endrin and DDT breakdown in method 8080, 8081A. This is important because it can help to assure that the system sensitivity and resolution are adequate and meet quality control requirements. Table 12 lists the requirements that must be met for the LPC solution to pass and analysis to continue.

Table 12. Laboratory performance check solution for 508. (See Appendix for examples). 508 calculated for XLB column.

Test	Analyte	Conc (ug/ml)	Requirements
Sensitivity	Chlorpyrifos	0.002	Detection of analyte: S/N >3

Chromatographic performance	DCPA	0.050	PGF between 0.80 & 1.15 (a)
Column Performance	Chlorothalonil	0.050	Resolution > 0.50 (b)
	d-BHC	0.040	

(a) = PGF - Peak Gaussian factor. Calculated using the equation:

$$PGF = \frac{1.83 \times W(1/2)}{W(1/10)}$$

where W(1/2) is the peak width at half height in secs, and W(1/10) is the peak width in secs. At tenth height.

(b) = Resolution between the two peaks as defined by the equation:

$$R = \frac{t}{W}$$

where t is the difference in elution times between the two peaks and W is the average peak width, at the baseline, of the two peaks.

The breakdown of Endrin and PP-DDT is calculated as follows:

$$\%\ Breakdown\ of\ PP\text{-}DDT = \frac{Total\ DDT\ degradation\ peak\ area\ (DDE + DDD)}{Total\ DDT\ peak\ area\ (DDT + DDE + DDD\ )} x\,100$$

% Breakdown of Endrin and DDT must be ≤ 15% separately.

9.1.11 Spikes: Accuracy and Precision Control Limits - The control limits for each analyte are established once data has been obtained from 20-30 spike sets (MS/MSD/LCS). The calculation for the accuracy control limit and the calculation for the precision control limit are listed below.

Upper/Lower Control Limit Accuracy = x +/- 3s for 8080, 3s for 508

Where x = average % recovery for 20-30 spikes

Upper/Lower Control Limit Precision = x +/- 3s for 8080, 3s for 508

Where x = average %RPD for 20-30 MS/MSD's*
s = standard deviation
* Surrogate control limits x ± 3s

9.2 Detection and Quantitation Limits

9.2.1 Method Detection Limit - This is defined as the minimum concentration of a compound that can be qualitatively reported with a 99% confidence that the analyte concentration is greater that zero for a given matrix. For the purposed here, seven identical spikes are prepared at approximately three times the estimated detection limit. The concentration is important, since a concentration which is too low might not be subject to quantitation. Likewise, a concentration which is too high may provide a relatively small standard deviation, thereby producing an unusually low method detection limit. These spikes are extracted and processed in exactly the same manner as any sample. The final concentration results are recorded and the standard deviation for them calculated for each analyte. The Method Detection Limit (MDL) is then calculated as:

Method Detection Limit = t_{n-1}*s
Where:
s = Standard Deviation (ppb)
t = Students' t value @ 99% confidence level
(t_{n-1} = 3.14 for n = 7)

9.2.2 Practical Quantitation Limit - This is the limit which this laboratory specifies is that concentration which will be quantitated and reported. The PQL should be in range of 3-5 times the MDL. It is chosen such that it is above the method detection limit, but below the MCL (Maximum Contamination Limit) for a particular analyte. For those levels which confirm between the MDL and the PQL, a level of "Trace" will be reported for certain clients. Detection limit studies are performed on an annual matrix by matrix basis.

9.2.2.1 An MDL verification check sample must be run on the instrument immediately following an MDL study. This check sample is spiked at approximately two times the current reported MDL. It is determined to be successful if it yields a response that is three times above the instruments noise level.

9.2.2.2 A limit of quantitation (LOQ) verification sample must be run on the instrument immediately following an MDL study. This check sample is spiked at approximately, but no higher than, two times the currently reported PQL. It is determined to be successful if it yields a recovery within the limits specified in Appendix DoD-D of the Department Quality Systems Manual for Environmental Laboratories for laboratory control samples.

9.3 Control Charts

Control charts will be maintained in Excel to trend the recoveries of several analytes for water, soil and oil matrices. A control chart will plot recovery % vs. spike date. The upper and lower control limit will also be highlighted on the chart to easily identify those particular spikes which do not pass. Any spikes that do not pass should also be entered and the reason of failure should be noted. In addition, long term trends may be observed in order to identify problems, or, in the case of better spike recoveries, to re-evaluate the control limits. When control charts are completed, new limits are generated from Element. A copy of the new limits is given to the QC department after approval from the supervisor.

9.3.1 For Navy related projects, Department of Defense Quality Systems Manual limits must also be met. In cases where spike and surrogate recoveries fall outside of DoD QSM limits the LCS and/or samples must be re-run to confirm recoveries.

9.4 Logbooks

Logbooks and careful documentation are the cornerstone of a sound analysis.

9.4.1 Standard Logbook - The first logbook is the Standard Logbook. This is a record of all standards which are made for semi-volatile analyses. All pertinent information is to be documented including dates, manufacturer, lot #, solvent used, initial and final volumes, and components. (See Standard Log SOP.)

9.4.2 Reagent Logbook - The second logbook of for all reagents which are prepared for extractions, and instrument analysis. Again, as with the Standard Logbook, all items must be documented. Date of preparation, neat compounds (and all of its related information), initial and final volumes, etc. must be addressed and recorded. (See Reagent Log SOP.)

9.4.3 Maintenance Logbook - All instruments also have Maintenance Logbooks which must be maintained including routine service and repairs. Detailed descriptions and drawings, if helpful, should also be included. Each entry in this log should include, at a minimum, identification of problems, their corrective actions and the results of those actions. One may be surprised later that very detailed notes may help solve future problems. Often, suspicious components may be exempt from repair because they were replaced at an earlier time.

9.4.4 Run Logbook - The HPCHEM schedules are used as run log pages and are stored in run log folder labelled Run Log, Inst #, Month, Year. Al schedules are kept on hard drive as D:\instrmnt\GC-14,15 or 17\Data\YEAR\Month\Monday\. The final extract volume of the sample is entered in the volume column. The dilution column is used for any dilutions made. All the schedules are printed and kept daily.

A copy of the schedule is stored on hard drive, in raw data folder and in run log folder. After the completion of the month these schedules will be bound and kept as a book.

10.0 FORMS

10.1 System Improvement Forms – These forms are to be used only in cases of error due to system equipment/reagent, or human errors, not to document matrix related problems. When a System Improvement Form (SIF) is generated it should be taken to the supervisor for approval who in turn will take it the Quality Control Supervisor.

10.2 Initial Calibration Summary for Mix A

10.3 Initial Calibration Verification Summary for Mix A

10.4 Initial Calibration Verification Summary for Mix B

10.5 Initial Calibration Summary for PCBs

10.6 Initial Calibration Verification Summary for PCB 1260

10.7 Extraction Logbook

10.8 Reagent Logbook

10.9 Sample Sequence

10.10 Typical Sample Sequence (Injection Log)

10.11 Control Limits

10.12 Maintenance Logbook

10.13 Sample Qualification Flags

10.14 IDC Study Report

10.15 Certificate of Analysis

10.16 Laboratory Performance Check

10.17 508 Mix

10.18 Quantitation Report (QT Reviewed)

10.19 Example of DDT/Endrin Breakdown

11.0 METHOD PERFORMANCE

11.1 The performance of this method will be monitored by various outside agencies and by our own quality control department. The method of monitoring will vary from agency to agency, but will all contain the common thread of identifying unsound analyses.

11.2 The outside agencies may periodically visit the laboratory to meet with our management and our staff. They may come to specifically identify a suspected or known problem with one or more methods. Part of that visit may include a discussion with the analyst(s) and will help to identify deficiencies with specific portions of the method. Outside agencies whether private or public ,may also send samples to the laboratory which have been fortified with one or more compounds in the method. Our laboratory may or may not be informed in advance of this; this is one way the agency may monitor our performance.

11.3 Internal audits by our quality control department may also include fortified samples, unknown to the department. As these samples pass through the lab, and encounter the various departments, there is a chance that deficiencies may be discovered at any point. If the reported results meet the requirements of the quality control department, then the quality control department may state that the method is in control. If, on the other hand, the results do not meet the control limits, then an investigation may be conducted to locate the deficiency.

12.0 GENERAL MAINTENANCE

The maintenance of the equipment and apparatus is essential to the integrity of results generated by this method. The many components of the instrument work together much like the components of a fine watch. If one component is not able to perform its function, then the entire system will not perform correctly.

Daily Maintenance consists of change septa, injection insert, replace lines plates and guard column.

12.1 Septa Changes - The septum is the silicon based component which seals off the injection port after the sample syringe introduces its 5 µl aliquot. It is located just under the sample injection port nut on the top of the instrument. This should be replaced after every 100 sample injections, or when there is a noticeable change in the chromatography (i.e., significant response changes, septa bleed, etc.). To change the septum, simply remove the injection nut, replace the septum, and carefully replace the nut and tighten slowly until the column head pressure returns.

12.2 Injection Insert and Guard Column - Occasionally, the septum change may not be sufficient to restore the system's integrity and performance. The glass injection insert and the guard column are particularly prone to contamination by permanently retained compounds and general contaminants. These deposits can significantly hinder component resolution and column performance. The injection insert is located just under the septum and should be removed with forceps; but be careful because this insert is very hot! The insert should then be immersed in sulfuric acid to dissolve the residue. Finally, the guard column should be clipped or replaced to restore its proper function. The guard column must then be setup to be connected to the injection port. The nut and graphite/vespel ferrul will first be placed over the column to be ready for installation. Next, this instrument requires the column to be inserted into the injection insert in a tapered closure arrangement. To assure gas-tight seal, the insert must first be wetted with methanol, and the column pressed into the tapered end of the glass insert.

The nut and ferrel are then placed over the injector tip and moderately tightened to assure a gas-tight seal.

12.3 Column Change - The column is the heart of the analytical system. If properly cared for, it should provide at least six months of trouble free service. The worst enemies to these columns are oxidants and extreme temperatures. The most fatal enemy to the column is the combination of these two. The most prevalent oxidant is oxygen found in the atmosphere. It is therefore crucial that the column temperature be reduced prior to opening the system to the atmosphere. By participating this one rule, the system will be assured to be protected from the most damaging conditions. Likewise, the injection of samples which are acidic or known to be oxidants should never be injected onto the column. Dark or foul smelling extracts can also result in column performance. When possible, inject high dilutions of these type samples to avoid destruction of the column performance.

12.3.1 Periodically, the column performance will suffer to the point that it is no longer acceptable. This is the indication that a new column is necessary to restore the system performance. This method requires the two columns mentioned earlier. One or both columns may need to be changed as necessary. The two columns are connected to the guard column via a "Y" connector. This allows the carrier gas and injection components to be distributed equally between the two columns. The column will first be removed from its end of the Y. If this removal is clean, and there are no visible pieces of the column in the Y, then the new column may be inserted into this void. Again, as mentioned above, a small amount of CH_3OH should be placed in the Y to allow for the smooth insertion of the column. If, however, the old column does not come out of the Y cleanly, then a new Y must be installed. This required the removal of both column heads and the guard column. All ends must then be cut smoothly with an appropriate cutting tool. Always check the column end with a magnifying glass to assure a right angle cut. The column end will then be inserted into the electron capture detector and will extend 115 mm from the button of the detector nut to the tip of the column. Maintain this length while carefully securing the nut to the bottom of the detector body.

12.3.2 With the column installed, it will then be necessary to allow the atmospheric gas to be displaced by the nitrogen carrier gas. Allow the column to sit for about a half an hour at room temperature before heating.

12.4 When documenting maintenance log for non-routine instrument problems, certain information is necessary.

1. List the symptoms.
2. Document what you think is wrong.
3. Document what you did to correct the problem.
4. Document if the corrective action worked.
5. Document when instrument was returned to control, initial and date.
6. Ask supervisor to check maintenance log for correct information, initial and date.

13.0 WASTE MANAGEMENT

13.1 Waste streams from all laboratory operations are identified, segregated, and characterized. They are also profiled for disposal, drummed, and transferred by licensed hazardous waste haulers to licensed facilities.

14.0 POLLUTION PREVENTION

14.1 The laboratory pollution prevention practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are characterized and disposed of in the proper manner. The laboratory minimizes all releases from hoods and bench chemistries, complying with all solid and hazardous waste regulations.

14.2 It is the responsibility of each and every analyst or technician to monitor and minimize their waste and the disposal cost of unused materials. Analysts only prepare volumes of reagents and standards to reflect there anticipated usage and reagent stability. These include all stock, initial calibration, and continuing calibration standards, spike and surrogate solution, and any waste generated in their preparation.

14.3 Laboratory is concerned about pollution prevention, and will therefore employ any technique found to be effective in its reduction; provided its use does not compromise data quality, integrity, or defensibility.

15.0 SAFETY

15.1 Safety of the employees is of primary concern at BC Laboratories. Perhaps the most effective means of securing the safety of employees is through the process of education and training. Ideally, the analyst should follow the chain of thought to assure safe practice:

15.1.1 What is my objective? How will I complete my objective?

15.1.2 What are the potential hazards while performing the procedures necessary to obtain this objective?

15.1.3 Can the hazards involved be eliminated or minimized by hardware (i.e., safety goggles, gloves, respirators) or behavioral modifications (i.e., waiting for the oven to cool, or avoiding the high voltage section of the instrument)?

15.1.4 Where may I obtain the necessary hardware to protect myself and/or others from the potential hazards?

15.1.5 How will I employ the hardware? Do I need special training?

Once the above questions have been answered and satisfied, the goal will be to begin the procedure.

15.2 The hazards associated with this method can be classified as chemical, physical, or radioactive. These may be further classified as chronic or acute hazards. Specific chemical hazards include the solvents and the preparative reagents. The solvents hexane is used extensively in this method for dissolving sample extracts, cleaning preparation and instrument syringes, and making standard solutions. Exposure to this and all other solvents in this method should be avoided. Skin contact can be minimized by using vinyl or nitrile gloves. The exposure to the respiratory system should be avoided by using the solvents under a fume hood when necessary. Preparation of the standards, spikes, etc. should also be performed under a hood if solvent exposure is expected to be extensive.

15.3 Another potentially damaging compound is the diazomethane generated in this method to produce the methyl esters of the pesticides. This compound is a proven carcinogen and mutagen . This compound as all toxic compounds should always be handled with the utmost respect.

Gloves, and respirators should always be used when handling any container proven or suspected to contain diazomethane. A fume hood may be substituted for the respirator if necessary.

15.4 The analytes of this method also pose another potential hazard to health. Again, minimization of the exposure hazard is required. Neat compounds and stock solutions have the greatest potential for acute poisoning. For this reason these should be handled the most carefully. The MSDS sheet for each compound may be found in the MSDS library for any or all solvents and analytes. The MSDS will designate the physical and chemical properties as well as the health hazards. The physical hazards involved with this method can be encountered while preparing samples and performing instrument repairs or maintenance. The column oven, injector, and detectors all have the potential to inflict major burns. Be extra careful when working around these hot surfaces to avoid burns.

15.5 The detectors for this method are the electron detectors. These detectors will be inspected semi-annually for radiation leaks as required by federal law. If a leak is discovered, the detector will be removed and replaced immediately. If no leaks are discovered, then the exposure to radiation is not a threat to the analyst or lab personnel. In any case, the detector should never be disassembled except by qualified personnel. Never disassemble the detectors.

16.0 REFERENCES

16.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update III. EPA Method 8081A, Rev. 1, December 1996.

16.2 USEPA Contract Laboratory Program, Statement of Work of Organics Analysis.

16.3 USEPA 40 CFR Part 136, Guidelines Establishing Procedures for the Analysis of Pollutants Under the CWA, Method 608, July 1, 1994.

16.4 Methods for the Determination of Organic Compounds in Drinking Water, Supplement III, USEPA, EPA Method 508, August 1995.

16.5 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 2, DoD Environmental Data Quality Workshop, Department of Navy, Lead Service, June 2002.

APPENDIX

FORM 10.1

System Improvement Form (SIF)

Non Conformance Type (Circle One) _____

001-Audit
002-Equipmen _____ *Specify*
003-LIMS
004-Policy
005-Procedur
006-Supply
007-Health and Safey
008-Other (Specify) _____

SIF ID _____ *SIF-mmddyyyy-000*

Initiated By BC Labs

Initiated Date _____

Responsible Party for Restoring System _____

Schedule Completion Date _____

Actual Date of Completion _____

Stopped Work? Yes / No

NCR Description

Cause

Corrective Action

Verification of Corrective Procedure

Client Notification Required? Yes / No

Company Name: _____ *Date* _____

Contact Name: _____

How was client work impacted?

Comments

Department Manager Signature _____ *Date* _____

QC Officer Signature _____ *Date* _____

FORM 10.2

Response Factor Report GC-14

Method : C:\HPCHEM\1\METHODS\GC-14\201303\19-1350\608GC14.M (Chemstation Integrator)
Title : EPA 608 Pesticides
Last Update : Wed Mar 20 08:07:04 2013

Calibration Files
1 =19MAR010.D 2 =19MAR009.D 3 =19MAR008.D
4 =19MAR007.D 5 =19MAR006.D 6 =19MAR005.D

		Compound	1	2	3	4	5	6	Avg		%RSD
1)	S	TCMX (SURROGATE)	4.150	4.360	3.930	3.886	3.972	3.634	3.989	E7	6.18
2)	T	A-BHC	6.812	5.089	4.758	4.834	4.675	4.624	5.132	E7	16.35
3)	T	LINDANE	6.894	4.750	4.393	4.562	4.340	4.173	4.852	E7	21.01
4)	T	B-BHC	7.475	1.762	1.375	1.342	1.226	1.150	2.388	E7	104.70
5)	T	D-BHC	9.376	4.527	3.832	3.999	3.800	3.570	4.851	E7	46.18
6)	T	HEPTACHLOR	7.297	4.451	4.037	4.191	3.917	3.709	4.600	E7	29.23
7)	T	ALDRIN	4.880	3.965	3.626	3.842	3.663	3.491	3.911	E7	12.87
8)	T	HEPTACHLOR EPOXIDE	5.078	3.861	3.435	3.540	3.341	3.188	3.740	E7	18.53
9)	T	g-CHLORDANE	4.851	3.840	3.397	3.581	3.369	3.179	3.703	E7	16.34
10)	T	a-CHLORDANE	4.688	3.856	3.407	3.560	3.350	3.178	3.673	E7	14.89
11)	T	ENDOSULFAN I	4.067	3.326	2.960	3.151	2.976	2.797	3.213	E7	14.18
12)	T	PP-DDE	4.335	3.447	3.071	3.311	3.109	2.948	3.370	E7	15.00
13)	T	DIELDRIN	4.375	3.478	3.113	3.328	3.140	2.974	3.401	E7	14.95
14)	T	ENDRIN	3.726	3.079	2.809	3.040	2.866	2.719	3.040	E7	11.94
15)	T	PP-DDD	4.285	3.005	2.649	2.839	2.699	2.533	3.002	E7	21.63
16)	T	ENDOSULFAN II	3.865	3.130	2.661	2.900	2.688	2.543	2.964	E7	16.45
17)	T	PP-DDT	3.768	2.516	2.213	2.533	2.225	2.063	2.553	E7	24.41
18)	T	ENDRIN ALDEHYDE	3.009	2.273	1.870	2.104	1.861	1.679	2.133	E7	22.36
19)	T	ENDOSULFAN SULFATE	4.076	2.912	2.522	2.707	2.475	2.333	2.838	E7	22.52
20)	T	METHOXYCHLOR	2.048	1.362	1.171	1.327	1.152	1.068	1.355	E7	26.37
21)	S	DBC (SURROGATE)	2.488	3.096	2.855	3.138	3.099	2.851	2.921	E7	8.47
22)	T	ENDRIN KETONE	1.493	0.279	0.171	0.157	0.139	0.120	0.393	E9	137.75
23)	T	MIREX	9.515	5.338	4.457	4.586	4.204	4.077	5.363	E7	38.82

Signal #2 Calibration Files
1 =19MAR010.D 2 =19MAR009.D 3 =19MAR008.D
4 =19MAR007.D 5 =19MAR006.D 6 =19MAR005.D

		Compound	1	2	3	4	5	6	Avg		%RSD
1)	S	TCMX (SURROGATE)	3.848	4.057	3.720	3.638	3.730	3.403	3.733	E7	5.83
2)	T	A-BHC	1.161	0.560	0.511	0.519	0.487	0.470	0.618	E8	43.33
3)	T	LINDANE	6.428	4.414	4.195	4.222	4.016	3.934	4.535	E7	20.78
4)	T	B-BHC	9.853	5.587	4.929	5.014	4.690	4.388	5.744	E7	35.72
5)	T	D-BHC	9.853	5.587	4.929	5.014	4.690	4.388	5.744	E7	35.72
6)	T	HEPTACHLOR	4.454	3.862	3.582	3.868	3.630	3.444	3.807	E7	9.39
7)	T	ALDRIN	4.596	4.064	3.734	3.933	3.742	3.556	3.938	E7	9.33
8)	T	HEPTACHLOR EPOXIDE	4.404	3.813	3.383	3.571	3.364	3.148	3.614	E7	12.37
9)	T	g-CHLORDANE	4.648	3.806	3.392	3.593	3.384	3.187	3.669	E7	14.28
10)	T	a-CHLORDANE	4.745	3.767	3.344	3.525	3.322	3.114	3.636	E7	16.11
11)	T	ENDOSULFAN I	4.254	3.544	3.135	3.281	3.089	2.919	3.370	E7	14.27
12)	T	PP-DDE	4.023	3.527	3.152	3.412	3.201	3.016	3.389	E7	10.66
13)	T	DIELDRIN	4.176	3.595	3.162	3.335	3.152	3.001	3.404	E7	12.61
14)	T	ENDRIN	3.601	3.014	2.762	2.985	2.791	2.625	2.963	E7	11.63
15)	T	PP-DDD	3.934	3.173	2.763	2.937	2.768	2.613	3.031	E7	15.89
16)	T	ENDOSULFAN II	4.774	3.305	2.813	3.031	2.809	2.625	3.226	E7	24.59
17)	T	PP-DDT	3.570	2.450	2.146	2.464	2.163	1.993	2.464	E7	23.22
18)	T	ENDRIN ALDEHYDE	3.155	2.353	1.930	2.141	1.910	1.693	2.197	E7	23.67
19)	T	ENDOSULFAN SULFATE	9.278	3.957	3.093	3.197	2.914	2.667	4.185	E7	60.53
20)	T	METHOXYCHLOR	3.383	1.602	1.312	1.425	1.243	1.125	1.682	E7	50.50
21)	S	DBC (SURROGATE)	2.601	2.914	2.515	2.649	2.598	2.320	2.600	E7	7.43
22)	T	ENDRIN KETONE	6.375	3.685	3.096	3.309	3.008	2.754	3.705	E7	36.31
23)	T	MIREX	8.867	5.046	4.190	4.381	4.022	3.701	5.034	E7	38.35

(#) = Out of Range

608GC14.M Thu Mar 21 11:35:18 2013

FORM 10.3

Evaluate Continuing Calibration Report

Signal #1 : D:\INSTRMNT\GC-14\DATA\2013\MAR\MAR04\04MAR008.D\ECD1A.CH Vial: 99
Signal #2 : D:\INSTRMNT\GC-14\DATA\2013\MAR\MAR04\04MAR008.D\ECD2B.CH
Acq On : 4 Mar 2013 3:50 pm Operator: VH1
Sample : ICV Inst : GC-14
Misc : Multiplr: 1.00
IntFile Signal #1: EVENTS.E IntFile Signal #2: EVENTS2.E

Method : C:\HPCHEM\1\METHODS\GC-14\201303\04-1200\608GC14.M (Chemstation Integrator)
Title : EPA 608 Pesticides
Last Update : Thu Mar 14 13:19:06 2013
Response via : Multiple Level Calibration

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.50min
Max. RRF Dev : 25% Max. Rel. Area : 150%

		Compound	Amount	Calc.	%Dev	Area%	Dev(min)
1	S	TCMX (SURROGATE)	30.000	29.748	0.8	97	0.12
2	T	A-BHC	15.000	15.355	-2.4	97	0.12
3	T	LINDANE	15.000	14.906	0.6	97	0.12
4	T	B-BHC	15.000	15.052	-0.3	98	0.12
5	T	D-BHC	15.000	15.259	-1.7	98	0.12
6	T	HEPTACHLOR	15.000	14.991	0.1	98	0.13
7	T	ALDRIN	15.000	14.890	0.7	97	0.13
8	T	HEPTACHLOR EPOXIDE	15.000	14.605	2.6	98	0.13
9	T	g-CHLORDANE	15.000	14.433	3.8	97	0.13
10	T	a-CHLORDANE	15.000	14.406	4.0	97	0.13
11	T	ENDOSULFAN I	15.000	14.866	0.9	99	0.14
12	T	PP-DDE	15.000	14.960	0.3	97	0.13
13	T	DIELDRIN	15.000	14.789	1.4	98	0.14
14	T	ENDRIN	15.000	14.832	1.1	99	0.14
15	T	PP-DDD	15.000	15.921	-6.1	98	0.13
16	T	ENDOSULFAN II	15.000	16.044	-7.0	100	0.14
17	T	PP-DDT	15.000	15.043	-0.3	101	0.03
18	T	ENDRIN ALDEHYDE	15.000	15.114	-0.8	102	0.14
19	T	ENDOSULFAN SULFATE	15.000	14.723	1.8	99	0.14
20	T	METHOXYCHLOR	15.000	16.486	-9.9	101	0.13
21	S	DBC (SURROGATE)	75.000	78.839	-5.1	97	0.13
22	T	ENDRIN KETONE	15.000	15.520	-3.5	102	0.13
23	T	MIREX	15.000	14.607	2.6	100	0.15

Signal #2

1	S	TCMX (SURROGATE)	30.000	29.869	0.4	98	0.07
2	T	A-BHC	15.000	15.476	-3.2	100	0.06
3	T	LINDANE	15.000	15.169	-1.1	99	0.07
4	T	B-BHC	15.000	14.145	5.7	98	0.07
5	T	D-BHC	15.000	15.319	-2.1	98	0.07
6	T	HEPTACHLOR	15.000	15.425	-2.8	99	0.07
7	T	ALDRIN	15.000	14.679	2.1	97	0.08
8	T	HEPTACHLOR EPOXIDE	15.000	14.186	5.4	97	0.08
9	T	g-CHLORDANE	15.000	14.134	5.8	97	0.08
10	T	a-CHLORDANE	15.000	14.196	5.4	97	0.08
11	T	ENDOSULFAN I	15.000	14.861	0.9	98	0.08
12	T	PP-DDE	15.000	15.281	-1.9	97	0.07
13	T	DIELDRIN	15.000	14.977	0.2	98	0.08
14	T	ENDRIN	15.000	14.925	0.5	99	0.08
15	T	PP-DDD	15.000	15.167	-1.1	97	0.07
16	T	ENDOSULFAN II	15.000	15.576	-3.8	98	0.08
17	T	PP-DDT	15.000	16.615	-10.8	102	0.08
18	T	ENDRIN ALDEHYDE	15.000	16.073	-7.2	102	0.07
19	T	ENDOSULFAN SULFATE	15.000	15.844	-5.6	98	0.07
20	T	METHOXYCHLOR	15.000	15.130	-0.9	101	0.08
21	S	DBC (SURROGATE)	75.000	78.668	-4.9	100	0.08
22	T	ENDRIN KETONE	15.000	15.125	-0.8	100	0.08
23	T	MIREX	15.000	14.658	2.3	100	0.09

(#) = Out of Range SPCC's out = 0 CCC's out = 0
04MAR008.D 608GC14.M Thu Mar 21 11:36:01 2013 Page 1

FORM 10.4

```
Data File : C:\HPCHEM\1\DATA\JUNE2000\JUNE19\19JUNE22.D\ADC1A.CH Vial: 22
Acq On    : 20 Jun 2000  12:01 am                    Operator: JKR
Sample    : 508 MIX B ICV EX-10-0526                 Inst    : GC-1
Misc      : MIX [B]                                  Multiplr: 1.00
IntFile   : autoint1.e

Data File : C:\HPCHEM\1\DATA\JUNE2000\JUNE19\19JUNE22.D\ADC1B.CH Vial: 22
Acq On    : 20 Jun 2000  12:01 am                    Operator: JKR
Sample    : 508 MIX B ICV EX-10-0526                 Inst    : GC-1
Misc      : MIX [B]                                  Multiplr: 1.00
IntFile   : autoint2.e

Method        : C:\HPCHEM\1\METHODS\0619001.M (Chemstation Integrator)
Title         : EPA 8080 / 8081 / 508
Last Update   : Fri Jun 16 16:58:03 2000
Response via  : Multiple Level Calibration

Min. RRF      :   0.000  Min. Rel. Area :  50%  Max. R.T. Dev  0.50min
Max. RRF Dev  :  15%     Max. Rel. Area : 150%
```

	Compound	AvgRF	CCRF	%Dev	Area%	Dev(Min)
1 B	HCCPD	688.581	702.430 E6	-2.0	97	0.00
5 B	HEXACHLOROBENZENE	995.938	1089.468 E6	-9.4	97	0.00
11 B	CHLOROTHALONIL	822.409	784.210 E6	4.6	91	0.00
Signal #2						
1 B	HCCPD	489.272	486.776 E6	0.5	97	0.00
5 B	HEXACHLOROBENZENE	652.334	646.896 E6	0.8	100	0.00
11 B	CHLOROTHALONIL	568.995	533.987 E6	6.2	94	0.00

Evaluate Continuing Calibration Report - Not Founds

(#) = Out of Range SPCC's out = 0 CCC's out = 0

(*) = Linear regression (**) = Quadratic regression

19JUNE18.D 0619001.M Tue Jun 20 08:48:01 2000

FORM 10.5

Response Factor Report GC-14

Method : C:\HPCHEM\1\METHODS\GC-14\201302\06-1400\8082PCB.M (Chemstation Integrator)
Title : EPA 8080 PCB
Last Update : Thu Feb 07 09:06:27 2013

Calibration Files
.02 =06FEB008.D .1 =06FEB007.D .15 =06FEB006.D
.25 =06FEB005.D .35 =06FEB004.D .5 =06FEB003.D

	Compound	.02	.1	.15	.25	.35	.5	Avg		%RSD
1)	AML1AROCLOR 1260 {1}	7.756	4.371	4.336	4.106	3.977	3.912	4.743	E7	31.37
2)	AML1AROCLOR 1260 {2}	9.767	6.090	6.070	5.702	5.508	5.405	6.424	E7	25.87
3)	AML1AROCLOR 1260 {3}	1.625	1.050	1.062	0.994	0.955	0.937	1.104	E8	23.55
4)	AML1AROCLOR 1260 {4}	1.008	0.816	0.905	0.813	0.819	0.819	0.863	E8	9.17
5)	AML1AROCLOR 1260 {5}	8.266	5.252	5.378	5.216	4.934	5.030	5.679	E7	22.49
6)	AML1AROCLOR 1260 {6}	1.491	0.978	1.005	0.972	0.914	0.951	1.052	E8	20.65
7)	AML1AROCLOR 1260 {7}	8.868	5.960	6.124	5.956	5.413	5.659	6.330	E7	20.05
8)	AML1AROCLOR 1260 - TOTA	7.589	5.011	5.163	4.878	4.671	4.708	5.337	E8	20.96
9)	JL6 AROCLOR 1016 {1}	6.207	2.273	2.281	1.908	2.100	1.958	2.788	E7	60.35
10)	JL6 AROCLOR 1016 {2}	1.157	0.559	0.558	0.501	0.494	0.477	0.624	E8	42.14
11)	JL6 AROCLOR 1016 {3}	9.347	3.880	3.836	3.211	3.453	3.249	4.496	E7	53.24
12)	JL6 AROCLOR 1016 {4}	1.755	1.117	1.132	1.039	1.034	1.007	1.181	E8	24.20
13)	JL6 AROCLOR 1016 {5}	6.278	3.502	3.492	3.234	3.170	3.074	3.792	E7	32.45
14)	JL6 AROCLOR 1016 {6}	8.788	4.549	4.541	4.252	4.176	4.053	5.060	E7	36.31
15)	JL6 AROCLOR 1016 {7}	7.021	3.512	3.521	3.291	2.574	3.185	3.851	E7	41.32
16)	JL6 AROCLOR 1016 - TOTA	6.676	3.448	3.457	3.129	3.075	3.036	3.803	E8	37.31
17)	AS DCB (Surrogate)	6.781	6.876	6.758	8.324	5.523	6.804	6.844	E8	12.98

Signal #2 Calibration Files
.02 =07FEB016.D .1 =07FEB015.D .15 =07FEB014.D
.25 =07FEB013.D .35 =07FEB012.D .5 =07FEB011.D

	Compound	.02	.1	.15	.25	.35	.5	Avg		%RSD
1)	AML1AROCLOR 1260 {1}	8.864	6.702	6.928	6.464	6.953	6.175	7.014	E7	13.58
2)	AML1AROCLOR 1260 {2}	7.447	5.990	6.149	5.723	5.964	5.441	6.119	E7	11.37
3)	AML1AROCLOR 1260 {3}	4.921	6.808	7.614	7.178	7.385	6.882	6.798	E7	14.24
4)	AML1AROCLOR 1260 {4}	8.409	7.104	7.365	6.978	7.226	6.173	7.209	E7	10.01
5)	AML1AROCLOR 1260 {5}	6.967	5.414	5.592	5.392	5.343	5.186	5.649	E7	11.66
6)	AML1AROCLOR 1260 {6}	1.441	1.214	1.265	1.235	1.203	1.195	1.259	E8	7.37
7)	AML1AROCLOR 1260 {7}	9.647	8.057	8.402	8.406	7.907	7.990	8.402	E7	7.69
8)	AML1AROCLOR 1260 - TOTA	6.067	5.221	5.470	5.249	5.281	4.979	5.378	E8	6.92
9)	JL6 AROCLOR 1016 {1}	1.595	0.315	0.309	0.256	0.355	0.212	0.507	E8	105.60
10)	JL6 AROCLOR 1016 {2}	7.435	4.778	4.965	4.431	5.228	4.190	5.171	E7	22.61
11)	JL6 AROCLOR 1016 {3}	6.057	3.414	3.615	3.302	4.229	3.093	3.952	E7	27.89
12)	JL6 AROCLOR 1016 {4}	1.272	0.962	1.002	0.895	0.980	0.893	1.001	E8	13.99
13)	JL6 AROCLOR 1016 {5}	4.724	3.084	3.195	2.935	3.391	2.816	3.358	E7	20.80
14)	JL6 AROCLOR 1016 {6}	6.926	5.034	5.263	4.857	5.676	4.646	5.400	E7	15.31
15)	JL6 AROCLOR 1016 {7}	3.658	2.475	2.612	2.440	2.896	2.352	2.739	E7	17.85
16)	JL6 AROCLOR 1016 - TOTA	5.746	3.156	3.276	2.948	3.477	2.814	3.569	E8	30.59
17)	AS DCB (Surrogate)	0.835	0.804	0.805	1.045	0.662	0.819	0.828	E9	14.88

FORM 10.6

Evaluate Continuing Calibration Report

Signal #1 : D:\INSTRMNT\GC-14\DATA\2013\FEB\FEB06\06FEB009.D\ECD1A.CH Vial: 99
Signal #2 : D:\INSTRMNT\GC-14\DATA\2013\FEB\FEB06\06FEB009.D\ECD2B.CH
Acq On : 6 Feb 2013 3:00 pm Operator: VH1
Sample : ICV Inst : GC-14
Misc : Multiplr: 1.00
IntFile Signal #1: AUTOINT1.E IntFile Signal #2: AUTOINT2.E

Method : C:\HPCHEM\1\METHODS\GC-14\201302\06-1400\8082PCB.M (Chemstation Integrator)
Title : EPA 8080 PCB
Last Update : Thu Feb 07 09:06:27 2013
Response via : Multiple Level Calibration

Min. RRF : 0.000 Min. Rel. Area : 50% Max. R.T. Dev 0.50min
Max. RRF Dev : 15% Max. Rel. Area : 150%

	Compound	Amount	Calc.	%Dev	Area%	Dev(Min)
1	AML1AROCLOR 1260 {1}	0.250	0.261	-4.4	103	0.00
2	AML1AROCLOR 1260 {2}	0.250	0.261	-4.4	103	0.00
3	AML1AROCLOR 1260 {3}	0.250	0.261	-4.4	102	0.00
4	AML1AROCLOR 1260 {4}	0.250	0.238	4.8	97	0.00
5	AML1AROCLOR 1260 {5}	0.250	0.257	-2.8	101	0.00
6	AML1AROCLOR 1260 {6}	0.250	0.257	-2.8	101	0.00
7	AML1AROCLOR 1260 {7}	0.250	0.265	-6.0	102	0.00
8	AML1AROCLOR 1260 - TOTAL	0.250	0.256	-2.4	101	-12.00#
9	JL6 AROCLOR 1016 {1}	0.250	0.218	12.8	97	0.00
10	JL6 AROCLOR 1016 {2}	0.250	0.253	-1.2	102	0.00
11	JL6 AROCLOR 1016 {3}	0.250	0.218	12.8	95	0.00
12	JL6 AROCLOR 1016 {4}	0.250	0.253	-1.2	102	0.00
13	JL6 AROCLOR 1016 {5}	0.250	0.254	-1.6	101	0.00
14	JL6 AROCLOR 1016 {6}	0.250	0.256	-2.4	102	0.00
15	JL6 AROCLOR 1016 {7}	0.250	0.270	-8.0	102	0.00
16	JL6 AROCLOR 1016 - TOTAL	0.250	0.249	0.4	101	-5.00#
17	AS DCB (Surrogate)	0.020	0.024	-20.0#	97	0.00

Signal #2

1	AML1AROCLOR 1260 {1}	0.250	0.231	7.6	100	0.00
2	AML1AROCLOR 1260 {2}	0.250	0.235	6.0	101	0.00
3	AML1AROCLOR 1260 {3}	0.250	0.261	-4.4	99	0.00
4	AML1AROCLOR 1260 {4}	0.250	0.243	2.8	100	0.00
5	AML1AROCLOR 1260 {5}	0.250	0.235	6.0	99	0.00
6	AML1AROCLOR 1260 {6}	0.250	0.244	2.4	100	0.00
7	AML1AROCLOR 1260 {7}	0.250	0.309	-23.6#	124	0.00
8	AML1AROCLOR 1260 - TOTAL	0.250	0.253	-1.2	104	-10.00#
9	JL6 AROCLOR 1016 {1}	0.250	0.125	50.0#	99	0.00
10	JL6 AROCLOR 1016 {2}	0.250	0.214	14.4	100	0.00
11	JL6 AROCLOR 1016 {3}	0.250	0.212	15.2#	101	0.00
12	JL6 AROCLOR 1016 {4}	0.250	0.219	12.4	98	0.00
13	JL6 AROCLOR 1016 {5}	0.250	0.221	11.6	101	0.00
14	JL6 AROCLOR 1016 {6}	0.250	0.224	10.4	100	0.00
15	JL6 AROCLOR 1016 {7}	0.250	0.226	9.6	101	0.00
16	JL6 AROCLOR 1016 - TOTAL	0.250	0.206	17.6#	100	-5.00#
17	AS DCB (Surrogate)	0.020	0.025	-25.0#	98	0.00

FORM 10.7

BC LABORATORIES, INC. EXTRACTION LOGBOOK

Analysis _____ S W O **Extraction Solvent Used:** $MeCl_2$/Acetone EE Hexane $MeCl_2$ ACN R-_____

Ext. Method: 504 / 552 / 556 / 3510 / 3520 / 3550 / 3580 / 8330 / 548 / 549 **Reagent #1:** R-

Ext. Date/Time: _____ **Reagent #2:** R-

Extracted By: _____ **Reagent #3:** R-

Concentrated By: _____ **Reagent #4:** R-

Date Concentrated: _____ **Reagent #5:** R-

Concentration Technique: T-VAP / KD / Dilution / 504 / 552 / 556 / 3520 / 548 / 549 **Solvent Exch. Reag. #:** R-

Received by: _____ **Spike Witness:** _____

Date/Time: _____ **Spike ID:** EX-

LAB ID #	SAMPLE WT/ VOL. g / ml	BOTTLE ID	Surr	Spike	SURR. USED	FINAL VOLUME ml	Initial pH	Base mls pH > 10	Acid mls pH < 2	COMMENTS
_____MB					EX-					
_____MS										
_____MSD										
_____LCS										

S - Soil
W - Water
O - Oil
D - Dilution

EE - Ethyl Ether
$MeCl_2$ - Dichloromethane
ACN - Acetonitrile

Heating Block Temp:_____
T-Vap - Turbo Vap Temp:_____
KD - Kuderna Danish Temp _____
N - Evap Temp _____
Coliform Incubator Water Bath Temp_____

ELEMENT BATCH ID:_____

TRACKING ID: 462-_____

1

S:\WPDocs\WordPerfect\LAB_DOCS\LOGBOOKS\ELOGBOOK

FORM 10.8

REAGENT LOGBOOK - BC LABORATORIES, INC.

Reagent #: _____ **Date Opened:** _____
Reagent Name: _____ **Opened By:** _____
Reagent Lot #: _____ **Prepared By:** _____
Expiration Date: _____ **Date Prepared:** _____
Description of preparation: _____

Reagent #: _____ **Date Opened:** _____
Reagent Name: _____ **Opened By:** _____
Reagent Lot #: _____ **Prepared By:** _____
Expiration Date: _____ **Date Prepared:** _____
Description of preparation: _____

Reagent #: _____ **Date Opened:** _____
Reagent Name: _____ **Opened By:** _____
Reagent Lot #: _____ **Prepared By:** _____
Expiration Date: _____ **Date Prepared:** _____
Description of preparation: _____

Reagent #: _____ **Date Opened:** _____
Reagent Name: _____ **Opened By:** _____
Reagent Lot #: _____ **Prepared By:** _____
Expiration Date: _____ **Date Prepared:** _____
Description of preparation: _____

FORM 10.9

Sequence Example

1	IB
2	Laboratory Performance Checks (If application)
3	Continuing Calibration (Run dependent)
4	CCB
5	Method Blank
6	Laboratory Control Sample
7	Sample 1
8	Sample 1 Matrix Spike
9	Sample 1 Matrix Dupspike
10	IB
11	Sample 2
12	Sample 3
13	Sample 4
14	Sample 5
15	Sample 6
16	IB
17	CCV
18	CCB
19	Sample 7
20	Sample 8
21	Sample 9
22	Sample 10
23	Sample 11
24	Sample 12
25	Sample 13
26	Sample 14
27	Sample 15
28	Sample 16
29	IB
30	CCV
31	CCB

Blank may be required depending on sample matrix, and will be added at analyst's discretion.
Maximum 10 samples between CCV's

FORM 10.10

Injection Log

Directory: D:\INSTRMNT\GC-14\DATA\2013\FEB\FEB06

Line	Vial	FileName	Multiplier	SampleName	Misc Info	Injected
1	100	06feb000.d	1.	IB		06 Feb 2013 13:16
2	99	06feb001.d	1.	CCV		06 Feb 2013 13:27
3	100	06feb002.d	1.	IB		06 Feb 2013 13:43
4	91	06feb003.d	1.	IC-6		06 Feb 2013 13:54
5	92	06feb004.d	1.	IC-5		06 Feb 2013 14:05
6	99	06feb005.d	1.	IC-4		06 Feb 2013 14:16
7	93	06feb006.d	1.	IC-3		06 Feb 2013 14:27
8	94	06feb007.d	1.	IC-2		06 Feb 2013 14:38
9	95	06feb008.d	1.	IC-1		06 Feb 2013 14:49
10	99	06feb009.d	1.	ICV		06 Feb 2013 15:00
11	100	06feb010.d	1.	ICB		06 Feb 2013 15:11
12	1	06feb011.d	1.	B1-BLK1		06 Feb 2013 15:22
13	2	06feb012.d	1.	B1-BS1		06 Feb 2013 15:33
14	3	06feb013.d	1.	B1-MS1		06 Feb 2013 15:44
15	4	06feb014.d	1.	B1-MSD1		06 Feb 2013 15:55
16	5	06feb015.d	1.	1302462-01		06 Feb 2013 16:06
17	6	06feb016.d	1.	1302462-02		06 Feb 2013 16:17
18	7	06feb017.d	1.	1302462-03		06 Feb 2013 16:28
19	8	06feb018.d	1.	1302462-04		06 Feb 2013 16:39
20	9	06feb019.d	1.	1302462-05		06 Feb 2013 16:50
21	10	06feb020.d	1.	1302462-06		06 Feb 2013 17:01
22	99	06feb021.d	1.	CCV		06 Feb 2013 17:12
23	100	06feb022.d	1.	CCB		06 Feb 2013 17:23
24	11	06feb023.d	1.	1302463-01		06 Feb 2013 17:34
25	12	06feb024.d	1.	1302463-02		06 Feb 2013 17:45
26	13	06feb025.d	1.	1302463-03		06 Feb 2013 17:56
27	14	06feb026.d	1.	1302463-04		06 Feb 2013 18:08
28	15	06feb027.d	1.	1302464-01		06 Feb 2013 18:19
29	16	06feb028.d	1.	1302464-02		06 Feb 2013 18:30
30	17	06feb029.d	1.	1302464-03		06 Feb 2013 18:41
31	18	06feb030.d	1.	1302464-04		06 Feb 2013 18:52
32	19	06feb031.d	1.	1302464-05		06 Feb 2013 19:03
33	20	06feb032.d	1.	1302464-06		06 Feb 2013 19:14
34	99	06feb033.d	1.	CCV		06 Feb 2013 19:25
35	100	06feb034.d	1.	CCB		06 Feb 2013 19:36
36	21	06feb035.d	1.	1302464-07		06 Feb 2013 19:47
37	22	06feb036.d	1.	1302464-08		06 Feb 2013 19:58
38	23	06feb037.d	1.	B2-BLK1		06 Feb 2013 20:09
39	24	06feb038.d	1.	B2-BS1		06 Feb 2013 20:20
40	25	06feb039.d	1.	B2-MS1		06 Feb 2013 20:31
41	26	06feb040.d	1.	B2-MSD1		06 Feb 2013 20:42
42	27	06feb041.d	1.	1302465-01		06 Feb 2013 20:53
43	28	06feb042.d	1.	1302465-02		06 Feb 2013 21:04
44	29	06feb043.d	1.	1302465-03		06 Feb 2013 21:15
45	30	06feb044.d	1.	1302465-04		06 Feb 2013 21:26
46	99	06feb045.d	1.	CCV		06 Feb 2013 21:37
47	100	06feb046.d	1.	CCB		06 Feb 2013 21:48
48	31	06feb047.d	1.	1302465-05		06 Feb 2013 21:59
49	32	06feb048.d	1.	1302465-06		06 Feb 2013 22:10
50	33	06feb049.d	1.	1302465-07		06 Feb 2013 22:21
51	34	06feb050.d	1.	1302465-08		06 Feb 2013 22:32
52	35	06feb051.d	1.	1302477-01		06 Feb 2013 22:43
53	36	06feb052.d	1.	1302477-02		06 Feb 2013 22:54
54	37	06feb053.d	1.	1302477-03		06 Feb 2013 23:05
55	38	06feb054.d	1.	1302477-04		06 Feb 2013 23:16

Page 1 21 Mar 2013 11:39

Injection Log

Directory: D:\INSTRMNT\GC-14\DATA\2013\FEB\FEB06

Line	Vial	FileName	Multiplier	SampleName	Misc Info	Injected
56	39	06feb055.d	1.	1302477-05		06 Feb 2013 23:27
57	40	06feb056.d	1.	1302477-06		06 Feb 2013 23:38
58	99	06feb057.d	1.	CCV		06 Feb 2013 23:49
59	100	06feb058.d	1.	CCB		07 Feb 2013 00:00
60	41	06feb059.d	1.	1302477-07		07 Feb 2013 00:11
61	42	06feb060.d	1.	B3-BLK1		07 Feb 2013 00:22
62	43	06feb061.d	1.	B3-BS1		07 Feb 2013 00:33
63	44	06feb062.d	1.	B3-MS1		07 Feb 2013 00:44
64	45	06feb063.d	1.	B3-MSD1		07 Feb 2013 00:55
65	46	06feb064.d	1.	1302476-01		07 Feb 2013 01:06
66	47	06feb065.d	1.	1302476-02		07 Feb 2013 01:17
67	48	06feb066.d	1.	1302476-03		07 Feb 2013 01:28
68	49	06feb067.d	1.	1302476-04		07 Feb 2013 01:39
69	50	06feb068.d	1.	1302476-05		07 Feb 2013 01:50
70	99	06feb069.d	1.	CCV		07 Feb 2013 02:01
71	100	06feb070.d	1.	CCB		07 Feb 2013 02:12
72	51	06feb071.d	1.	1302476-06		07 Feb 2013 02:23
73	52	06feb072.d	1.	1302476-07		07 Feb 2013 02:34
74	53	06feb073.d	1.	1302476-08		07 Feb 2013 02:45
75	54	06feb074.d	1.	1302476-09		07 Feb 2013 02:56
76	55	06feb075.d	1.	1302476-10		07 Feb 2013 03:07
77	56	06feb076.d	1.	1302476-11		07 Feb 2013 03:18
78	57	06feb077.d	1.	1302476-12		07 Feb 2013 03:29
79	58	06feb078.d	1.	1302476-13		07 Feb 2013 03:40
80	59	06feb079.d	1.	1302476-14		07 Feb 2013 03:51
81	60	06feb080.d	1.	1302476-15		07 Feb 2013 04:03
82	99	06feb081.d	1.	CCV		07 Feb 2013 04:13
83	100	06feb082.d	1.	CCB		07 Feb 2013 04:24
84	61	06feb083.d	1.	1302476-16		07 Feb 2013 04:35
85	62	06feb084.d	1.	1302476-17		07 Feb 2013 04:46
86	63	06feb085.d	1.	1302476-18		07 Feb 2013 04:57
87	64	06feb086.d	1.	1302476-19		07 Feb 2013 05:09
88	65	06feb087.d	1.	B4-BLK1		07 Feb 2013 05:20
89	66	06feb088.d	1.	B4-BS1		07 Feb 2013 05:31
90	67	06feb089.d	1.	B4-MS1		07 Feb 2013 05:42
91	68	06feb090.d	1.	B4-MSD1		07 Feb 2013 05:53
92	69	06feb091.d	1.	1302478-01		07 Feb 2013 06:04
93	70	06feb092.d	1.	1302478-02		07 Feb 2013 06:15
94	99	06feb093.d	1.	CCV		07 Feb 2013 06:26
95	100	06feb094.d	1.	CCB		07 Feb 2013 06:37
96	71	06feb095.d	1.	1302478-03		07 Feb 2013 06:48
97	72	06feb096.d	1.	1302478-04		07 Feb 2013 06:59
98	73	06feb097.d	1.	1302478-05		07 Feb 2013 07:10
99	74	06feb098.d	1.	1302478-06		07 Feb 2013 07:21
100	75	06feb099.d	1.	1302478-07		07 Feb 2013 07:32
101	76	06feb100.d	1.	1302478-08		07 Feb 2013 07:43
102	77	06feb101.d	1.	1302478-09		07 Feb 2013 07:54
103	78	06feb102.d	1.	1302479-01		07 Feb 2013 08:05
104	79	06feb103.d	1.	1302479-02		07 Feb 2013 08:16
105	80	06feb104.d	1.	1302479-03		07 Feb 2013 08:27
106	99	06feb105.d	1.	CCV		07 Feb 2013 08:38
107	100	06feb106.d	1.	CCB		07 Feb 2013 08:49
108	81	06feb107.d	1.	1302479-04		07 Feb 2013 09:00
109	82	06feb108.d	1.	1302479-05		07 Feb 2013 09:11
110	83	06feb109.d	1.	1302479-06		07 Feb 2013 09:22

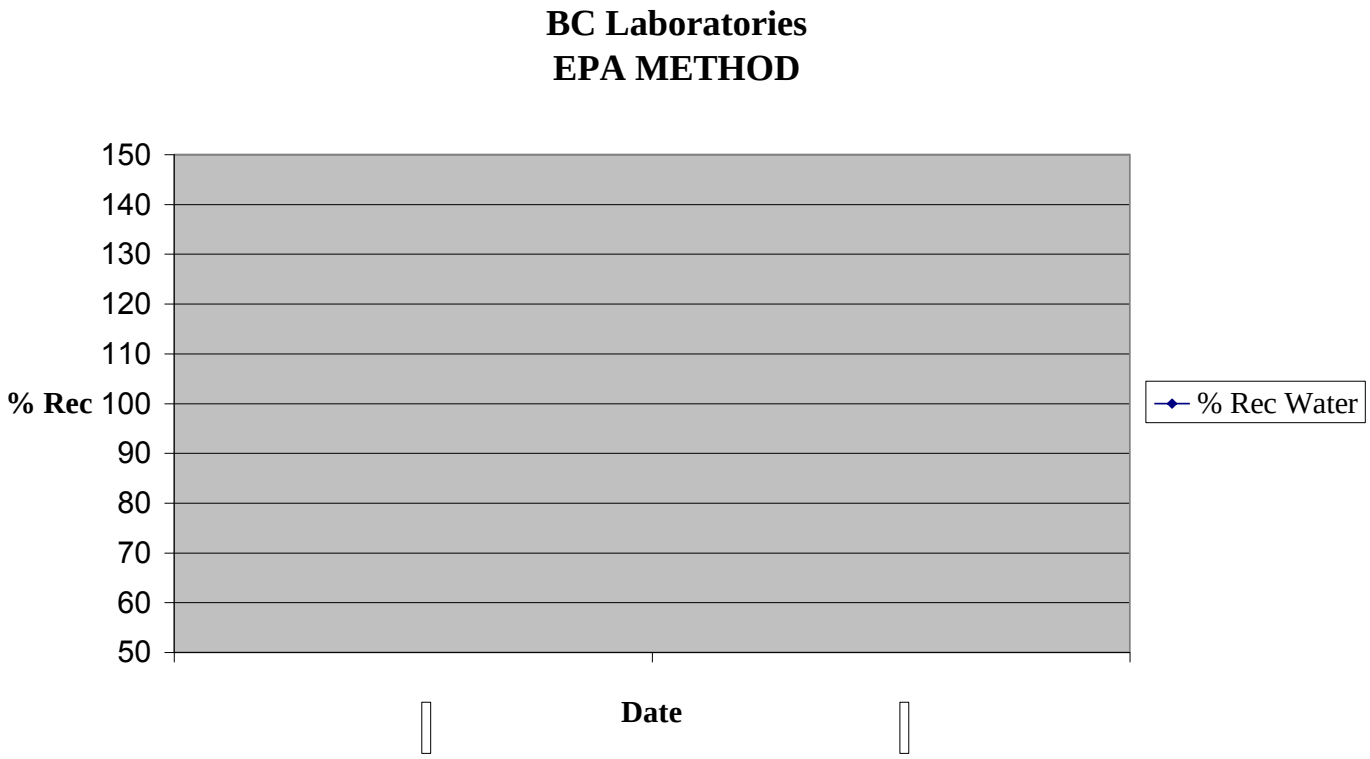
Page 2 21 Mar 2013 11:39

Injection Log

Directory: D:\INSTRMNT\GC-14\DATA\2013\FEB\FEB06

Line	Vial	FileName	Multiplier	SampleName	Misc Info	Injected
111	84	06feb110.d	1.	1302479-07		07 Feb 2013 09:33
112	99	06feb111.d	1.	CCV		07 Feb 2013 09:45
113	100	06feb112.d	1.	CCB		07 Feb 2013 09:56

10.11


BC Laboratories
EPA METHOD
150
140
130
120
110
% Rec 100
90
80
70
60
50
Date
% Rec Water

Form 10.11

Control Charts
New Limits

Analyst: VH1

Applicable Methods:

g608w	g608w UNTDW	g508w
g608w Full	g608w UNTDW priority	g508w Full
g608w Full2	g608w priority list	g508w Full2
g608w Full3	gm608w CTR	g508w Full3
g8081w	g8081w Full	g508w State
g8080w	g8080w Full	g508w CTR
g8081w Full2	g8080w Appendix 2 list	nSTLC g8080s full
gm8081w CTR	nMSTLC g8080s	nSTLC g8081s
nMSTLC g8081s	nMSTLC g8080s full	nSTLC g8081s full
nMSTLC g8081s full	nTCLP g8080s Full	nTCLP g8080s UNCLR
nTCLP g8081s Full		

Dates: 10/1/12-1/18/13

	Samples		
TCMX	40-140		
DBC	50-130		
	LCS	MS/MSD	RPD
Aldrin	60-130	60-130	30
Gamma-BHC	60-130	60-130	30
4,4'- DDT	60-130	60-130	30
Dieldrin	60-130	65-130	30
Endrin	60-130	60-130	30
Heptachlor	60-130	60-130	30

Approved by _____ **Date:** _____

Date limits given to QC : _____

FORM 10.12

11L207

GCO001

QC Approval: _____
Rev. Date: 08/31/2011
Page 1-10

BC Laboratories Inc.
MAINTENANCE LOGBOOK

BCL Instrument ID: GC-14

Methods: 508, 608, 8081

Department: Semi-Vol Organics

Location: 25

Log #: 1

From: _____ *To:* _____

Component	Manufacturer	Model	Serial#	Type	Date in Service
GC-14	HP	G1530A	US00003814	Interface	
AS72	HP	G1512A	3623A05389	Controller	
ADI30	HP	18596C	351A38582	Rotator	
ASTR12	HP	G1543A	US72602513	Samples	

Comments:

_____

_____

_____

C\MyDoCS\WordPerfect\LAB_DOCS\LOGBOOKS\GC14.MNTCV

FORM 10.13 **USER FLAGS**

Qualifiers	
*A	Absent
*P	Present
*R	[Custom Value]
<	<[Custom Value]
<=2	<= 2
<1	< 1
<1.1	< 1.1
<2	< 2
>	>[Custom Value]
> 140	>140
>23	> 23
A01	PQL's and MDL's are raised due to sample dilution.
A02	The difference between duplicate readings is less than the PQL.
A03	The sample concentration is more than 4 times the spike level.
A04	Method of Standard Additions used to calculate result.
A05	Unable to report specific MPN due to insufficient dilutions.
A06	The sample was preserved within 24 hours of the collection time.
A09	PQL's were raised due to high concentration of target analytes requiring sample dilution.
A10	PQL's and MDL's were raised due to matrix interference.
A11	PQL's and/or MDL's were raised due to inadequate sample size received.
A12	PQL's were raised due to high concentrations of hydrocarbons present requiring sample dilution.
A14	All phenolic compound results are affected due to low phenol surrogate recoveries caused by matrix.
A17	Surrogate not reportable due to sample dilution.
A18	Surrogate not reportable due to matrix interference.
A19	Surrogate is high due to matrix interference. Interferences verified through second extraction/analysis.
A20	Surrogate is low due to matrix interference. Interference verified through second extraction/analysis.
A22	Associated surrogate recovery is low.
A23	Associated surrogate recovery is high.
A26	Sample received past holding time.
A39	Sample received at pH greater than 2.
A40	Initial calibration linearity criteria not met.
A41	Results confirmed by GC/MS.
A43	Primary/Confirmation column ratios do not agree, results may be biased.
A48	Matrix spike interferences may be associated with this analyte.
A51	Chromatogram not typical of Diluent.
A52	Chromatogram not typical of diesel.
A53	Chromatogram not typical of gasoline.
A54	Chromatogram not typical of kerosene.
A55	Chromatogram not typical of crude oil.
A56	Chromatogram not typical of stoddard solvent.
A57	Chromatogram not typical of motor oil.

Qualifiers	
A58	Chromatogram not typical of hydraulic oil.
A59	Results calculated on a dry weight basis.
A61	Result is estimated a coeluting compound is also present at same retention time.
A66	Method blank for {%1} detected at {%2}.
A68	Presence of MTBE not confirmed by GC/MS.
A70	Surrogate recovery calculated from the confirmation column due to matrix interferences on the primary column.
A71	TBOS result subtracted from diesel range for final diesel result.
A72	PQL's and/or MDL's were raised due to high moisture content.
A74	A negative reading whose absolute value is greater than the MDL was obtained for the method blank.
A79	Prepared by EPA Method 5035.
A81	The result is below the calibration limit of the instrument. Due to the calibration technique used, a numerical result cannot be reported.
A83	Result based on tentatively identified compound search.
A84	Compound is a Non-Target Analyte
A85	Analyte is a Tentatively Identified Compound
A87	Carry over from a previously analyzed sample.
A88	Unable to report specific number. Insufficient dilutions to accommodate high concentration.
A89	TPH C4-C12
A90	TPPH does not exhibit a "gasoline" pattern. TPPH is entirely due to MTBE.
A91	TPH does not exhibit a "gasoline" pattern. TPH is entirely due to MTBE.
B	Analyte found in blank sample (CLP Flag)
B01	Analyte detected in the Continuing Calibration Blank (CCB) at a level greater than the PQL.
B02	Analyte detected in the Continuing Calibration Blank (CCB) at a level between the PQL and 1/2 the PQL.
B03	Analyte detected in the Continuing Calibration Blank (CCB) at a level between the PQL and the MDL.
B04	The batch size for the Continuing Calibration Blank (CCB) exceeds the control limit.
B05	The time interval between Continuing Calibration Blank exceeds the control limit.
B06	The number of consecutive analyses of the Continuing Calibration Blank exceeds the control limit.
B07	The analytical sequence did not contain a Continuing Calibration Blank at the end.
C01	The calibration curve did not contain the minimum number of standards.
C02	The relative standard deviation of the calibration curve response factors exceeds the control limit.
C03	The correlation coefficient for the calibration was below the minimum control limit.
C04	The standards for the calibration were not analyzed on the same day.
C05	The standards for the calibration were not analyzed consecutively.
C06	The average of the calibration curve response factors exceeds the control limit.
C07	The response factor for a System Performance Check Compound (SPCC) is below the acceptable limit.
C08	The relative standard deviation of the calibration curve response factors for a Calibration Check Compound (CCC) exceeds the control limit.
D	Dilution Used (CLP Flag)
D01	Recovery of a standard ath the PQL exceeded the control limit.
I1	Baseline adjustment
I2	Peak correction
I3	Rider removal
I4	Retention time

Qualifiers	
J	Estimated Value (CLP Flag)
L01	The Laboratory Control Sample Water (LCSW) recovery is not within laboratory established control limits.
L02	The Laboratory Control Sample Water (LCSW) recovery is not within method established control limits.
L03	The batch size for the Laboratory Control Sample Water (LCSW) exceeds the control limit.
L04	The matrix of the sample does not match the Laboratory Control Sample Water (LCSW)
L05	The Laboratory Control Sample Water (LCSW) was not analyzed prior to all the samples in the batch.
L06	The relative percent difference between the Laboratory Control Sample Water (LCSW) and the LCSW Duplicate exceeds the control limit.
L07	The Laboratory Control Sample (LCS) recovery is not within laboratory established control limits.
L08	The relative percent difference between the Laboratory Control Sample (LCS) and the LCS Duplicate exceeds the control limit.
L21	The Laboratory Control Sample Soil (LCSS) recovery is not within laboratory established control limits.
L22	The Laboratory Control Sample Soil (LCSS) recovery is not within method established control limits.
L23	The batch size for the Laboratory Control Sample Soil (LCSS) exceeds the control limit.
L24	The matrix of the sample does not match the Laboratory Control Sample Soil (LCSS)
L25	The Laboratory Control Sample Soil (LCSS) was not analyzed prior to all the samples in the batch.
L26	The relative percent difference between the Laboratory Control Sample Soil (LCSS) and the LCSS Duplicate exceeds the control limit.
M01	Analyte detected in the Method Blank at or above the PQL.
M02	Analyte detected in the Method Blank at a level between the PQL and 1/2 the PQL.
M03	Analyte detected in the Method Blank at a level between the PQL and the MDL.
M04	The batch size for the Method Blank exceeds the control limit.
M05	The Method Blank was not analyzed prior to all the samples in the batch.
M06	The internal standard on the Method Blank was not within the control limits.
M07	The surrogate recovery on the Method Blank for this compound was not within the control limits.
N01	This analyte exceeded the PQL in the beginning interference check standard.
N02	Recovery of this analyte in the beginning spiked interference check standard was not within the control limits.
N03	The beginning interference check standard was not analyzed prior to this sample.
N11	This analyte exceeded the PQL in the ending interference check standard.
N12	Recovery of this analyte in the ending spiked interference check standard was not within the control limits.
N13	The ending interference check standard was not analyzed after this sample.
ND	ND
NoObO	No Obs Odor
NR	Non-Reactive
NR2	Non-Reactive
NTA	Non Target Analyte
P01	Post spike recovery was not within the control limits.
P02	The batch size for the Post Spike exceeds the control limit.
P03	The relative percent difference between the duplicate Post Spikes exceeds the control limit.
PD	Sample container was preserved on [Custom Value]
pH1:1	pH result reported on a 1:1 dilution of sample
pH1:2	pH result reported on a 1:2 dilution of sample
pH1:3	pH result reported on a 1:3 dilution of sample

Qualifiers	
pHdil	pH result reported on a 1:[Custom Value] dilution of sample
pHsat	pH result reported on a saturated paste of sample
pHstr	pH result reported on a straight aliquot of sample
Q01	Sample precision is not within the control limits.
Q02	Matrix spike precision is not within the control limits.
Q03	Matrix spike recovery(s) is(are) not within the control limits.
Q04	The batch size for the QC set exceeds the control limit.
Q05	The matrix of the sample does not match that of the spike samples.
Q06	The dilutions of the quality control set are not consistent.
R01	The sample result is between the MDL and PQL.
R11	Per client request the reported PQL is less than the laboratory PQL but above the laboratory MDL.
S01	Sample result is not within the quantitation range of the method.
S02	The relative percent difference between duplicate instrument readings exceeds the control limit.
S03	A negative reading whose absolute value is greater than the PQL was obtained for the sample.
S04	The instrument reading for the sample was not a numeric value.
S05	The sample holding time was exceeded.
S06	There was an excessive amount of time between the prior sample and this sample in the analytical run.
S07	This sample result may contain carry over from the prior analytical sample.
S08	The internal standard on the sample was not within the control limits.
S09	The surrogate recovery on the sample for this compound was not within the control limits.
S10	The analyte in the Method Blank is greater than the laboratory PQL and the sample result is less than 10 times the Method Blank.
S11	The analyte in the Method Blank is greater than the laboratory PQL but the sample result is greater than 10 times the Method Blank.
S12	The Method Blank bias is greater than the PQL
U	Analyte Not Detected at or above the reporting limit (CLP Flag)
V01	The Initial Calibration Verification (ICV) recovery is not within established control limits.
V02	Not all of the calibration standards were analyzed prior to the Initial Calibration Verification (ICV).
V03	The internal standard on the Initial Calibration Verification (ICV) was not within the control limits.
V11	The Continuing Calibration Verification (CCV) recovery is not within established control limits.
V12	More than the acceptable numbers of samples were analyzed between Continuing Calibration Verification (CCV) standards.
V13	The time interval between Continuing Calibration Verification standards exceeds the control limit.
V14	The Continuing Calibration Verification (CCV) standard was reanalyzed more than the acceptable number of times.
V15	There was no Continuing Calibration Verification (CCV) at the end of the analytical sequence.
V16	The internal standard on the Continuing Calibration Verification (CCV) was not within the control limits.
V17	The percent deviation between the Continuing Calibration Verification (CCV) and the original calibration exceeds the control limit.
V18	The instrument response for a System Performance Check Compound (SPCC) on the Continuing Calibration Verification (CCV) is below the control limit.
V19	The relative standard deviation of the calibration curve response factors for a Calibration Check Compound (CCC) in the Continuing Calibration Verification (CCV) exceeds the control limit.
V20	For EPA 200.8 analyses the acceptable recovery is 85% - 115% for a CCV following sample analysis.
W1	Analysis performed by Weck Laboratories, Inc.

Qualifiers	
Z1	[Custom Value]
Z2	[Custom Value]
Z3	[Custom Value]

FORM 10.14

Analyst/Preparation Technician: _____

Initial Demonstration of Competency Form

BC Laboratories Inc.

IDC #: _____ Date _____ Method _____ Analyst Initials _____ Instrument

Standards

	Standard IDs								
	Initial Curve								
Date Stds Prepared	Std 1	Std 2	Std 3	Std 4	Std 5	Std 6	Reference/ICV	Spike Std.	Other

Reagents (if applicable)

Preparation Date	Reagent ID	Reagent ID	Reagent ID	Reagent ID	Reagent ID	Reagent ID

Analysis ☐ See Attached

			LCSW % Recoveries						
Instr ID	Date of Analysis	Correlation Coefficient (if applicable)	LCSW1	LCSW2	LCSW3	LCSW4	Avg.	%RSD	Acceptable Limits

Comments: _____

☐ Run log entries verified
☐ Maintenance Log entries verified
☐ Correction Techniques discussed
☐ Proper Integration Techniques
☐ Handling of matrix interferences discussed
☐ Reagent/Standard Log entries verified
☐ Control Charting Initiated
☐ Instrument QC acceptable
☐ Safety Issues Discussed
☐ Can navigate through instrument software
☐ Preparation Log entries verified
☐ SOP read and understood
☐ Reduction of results verified
☐ Waste Management Discussed

Analyst Signature	Trainer Signature	Supervisor Signature	QA Officer Signature
Date	Date	Date	Date

FILENAME: VisioDocument Rev 2 06/22/00

FORM 10.14

BC Laboratories Inc.

Initial Demonstration of Capability

Semi-Volatile Organics

Analyst: _____ **Matrix:** _____
Date(s) Analyzed: _____ **Units:** _____
EPA METHOD: _____ _____

Parameter	Spike Level	IDC 1	IDC 2	IDC 3	IDC 4	Ave	% RSD	% RSD Criteria	Ranges	
									Ave	% Rec
Compound 1										
Compound 2										
Etc...										

This form to be modified per method.

Filename: IDCFORM.xls Rev. 1 6/23/00 (GC-C0033)

FORM 10.15

4J01036

CPI INTERNATIONAL

5580 Skylane Blvd
Santa Rosa, CA 95403

(707)525-5788
(800)878-7654 Toll Free
(707)545-7901 Fax

Manufacturer's Quality System
Audited & Registered
by NSF-ISR to ISO 9001:2008

Date Received:_____

Certificate of Analysis

Rev 0 Page

Catalog No.:	Lot No.:	Storage:	Solvent:	Exp. Date:	Description:
Z-132220 -05-16PAK	234272	≤ -10 °C	Tol.:Hex. 1:1	9/7/2016	OEXT Pesticide Spiking Solution, 21-1, 2000 mg/L, 16 x 1 ml

Compound	CAS No.	Purity (%)	Compound Lot No.	Concentration, mg/L
aldrin	309-00-2	99.5	258.4.3.1P	2009 +/- 4.88
a-BHC	319-84-6	99.8	237.1.4P	1988 +/- 4.84
b-BHC	319-85-7	98.9	259.4.3P	1999 +/- 4.86
d-BHC	319-86-8	99.7	260.4.4.1P	2023 +/- 4.92
g-BHC	58-89-9	98.9	238.1.1P	1993 +/- 4.85
cis-chlordane	5103-71-9	99	264.4.2.2P	2001 +/- 10.94
trans-chlordane	5103-74-2	99	265.4.2.1P	1999 +/- 10.93
p,p'-DDD	72-54-8	97	234.1.1P	1998 +/- 30.29
p,p'-DDE	72-55-9	99	236.1.3.2P	1967 +/- 4.8
p,p'-DDT	50-29-3	98.3	233.1.1P	1983 +/- 4.82
dieldrin	60-57-1	91.8	240.1.1P	1998 +/- 4.81
endosulfan I	959-98-8	99.6	266.8.2.2P	1996 +/- 4.86
endosulfan II	33213-65-9	99.6	253.4.2.3P	2004 +/- 4.88
endosulfan sulfate	1031-07-8	96.6	254.8.2P	1988 +/- 4.82
endrin	72-20-8	99.3	255.8.1.2P	1988 +/- 4.84
endrin aldehyde	7421-93-4	99.6	256.4.3.3P	2035 +/- 4.94
endrin ketone	53494-70-5	99.9	257.115.2P	1984 +/- 4.84
heptachlor	76-44-8	99.7	261.4.2.1P	1994 +/- 4.86
heptachlor epoxide isomer B	1024-57-3	99.2	262.4.4P	1984 +/- 4.83
methoxychlor	72-43-5	94.3	241.1.1P	1983 +/- 4.79
mirex	2385-85-5	99	352.4.2.2P	2022 +/- 11.05

Certified By: Holly Tindal
Holly Tindal

All weights are traceable through N. I. S. T. Test No. 822/264157-00. Concentration (correct for purity) and uncertainty (95% confidence) values listed are determined gravimetricly.

TraceCERT®
Traceable Certified Reference Materials

SUPELCO
Solutions within.™
596 North Harrison Road · Bellefonte, PA
16823-0048 USA · Phone(814)359-3441

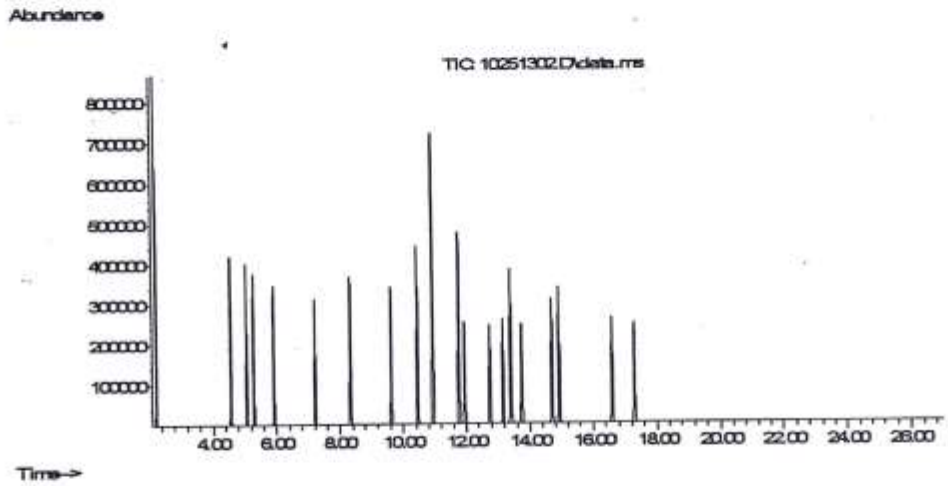
4J01035

Certificate of Analysis

Description: CLP Organochlorine Pesticide Mix, 1x1ml, 2000µg/ml in toluene:hexane (50:50)

Part Number: CRM47426
Lot Number: LC03823V
Expiration Date: October 2016
Storage: Refrigerate

Analytical Method Parameters:
Column: SLB-5ms 30m x 0.25mm x .25µm df
180°C for 2 min to 280°C (3 min)at 4°C/min
Detector: GCMS, 280°C
Injection Volume: 1µl



Elution	Analyte	Lot Number	CAS Number	Chromatographic Purity %	Certified Gravimetric Conc. µg/ml	Expanded Uncertainty µg/ml	Analytical Conc. µg/ml
	Internal Standard	N/A	N/A	N/A	N/A	N/A	N/A
2.	alpha-BHC	LB96973	319-84-6	99.9	1998.0	±53.3	2011.5
3.	gamma-BHC (Lindane)	LB78025	58-89-9	99.9	1998.0	±76.1	2026.0
4.	beta-BHC	LC03558	319-85-7	96.2	1924.0	±70.6	1975.0
5.	delta-BHC	LB87530	319-86-8	99.9	1998.2	±78.0	2000.0
6.	Heptachlor (Purified)	LB66483	76-44-8	99.9	1998.0	±76.4	1944.4
7.	Aldrin	LB87300	309-00-2	99.5	1990.0	±79.8	2000.0
8.	Heptachlorepoxide Isomer B	LB42066	1024-57-3	99.9	1998.0	±89.0	2000.0
9.	gamma-Chlordane	LB43792	5103-74-2	99.9	1998.2	±87.7	2000.0
10.	alpha-Chlordane	LB88778	5103-71-9	99.9	1998.0	±88.0	2006.7
11.	Endosulfan I (alpha)	LB27820	959-98-8	97.8	1956.2	±153.7	2000.0
12.	4,4'-DDE	LB27733	72-55-9	98.5	1970.4	±79.2	1969.4
13.	Dieldrin	LB31702	60-57-1	99.9	1998.0	±113.5	2000.0
14.	Endrin	LB84900	72-20-8	99.9	1997.8	±308.5	2000.0

ACLASS ACCREDITED TESTING Cert# AT-1607
ACLASS ACCREDITED REFERENCE MATERIAL PRODUCER Cert# AR-1606

Produced in double accredited laboratory fulfulling
ISO/IEC 17025 and
ISO Guide 34

Page 1 of 3

SIGMA-ALDRICH

Elution	Analyte	Lot Number	CAS Number	Chromatographic Purity %	Certified Gravimetric Conc. µg/ml	Expanded Uncertainty µg/ml	Analytical Conc. µg/ml
15.	Endosulfan II (Beta Isomer)	LB54647	33213-65-9	99.9	1998.2	±121.2	2000.0
16.	4,4'-DDD	LB63713	72-54-8	97.4	1948.2	±61.9	1987.1
17.	Endrin Aldehyde	LB45459	7421-93-4	98.4	1968.2	±65.5	1928.6
18.	Endosulfan Sulfate	LB41863	1031-07-8	99.4	1988.2	±67.0	2000.0
19.	4,4'-DDT	LA83013	50-29-3	96.0	1920.1	±77.1	2047.0
20.	Endrin Ketone	LB47822	53494-70-5	99.5	1990.0	±67.6	1871.0
21.	Methoxychlor	LB89865	72-43-5	99.9	1998.0	±107.3	1977.8

Absolute Standards, Inc.
800-368-1131
www.absolutestandards.com

Certified Reference Material CRM

ISO 9001 QS Registered
ISO 17025-34-35-43 Accredited
Scopes: http://AbsoluteStandards.com

CERTIFIED WEIGHT REPORT

Part Number: 43130
Lot Number: 091014
Description: Pesticide Decomposition Standard
2 components
Expiration Date: 091019
Recommended Storage: Refrigerate (4 °C)
Nominal Concentration (µg/mL): 500

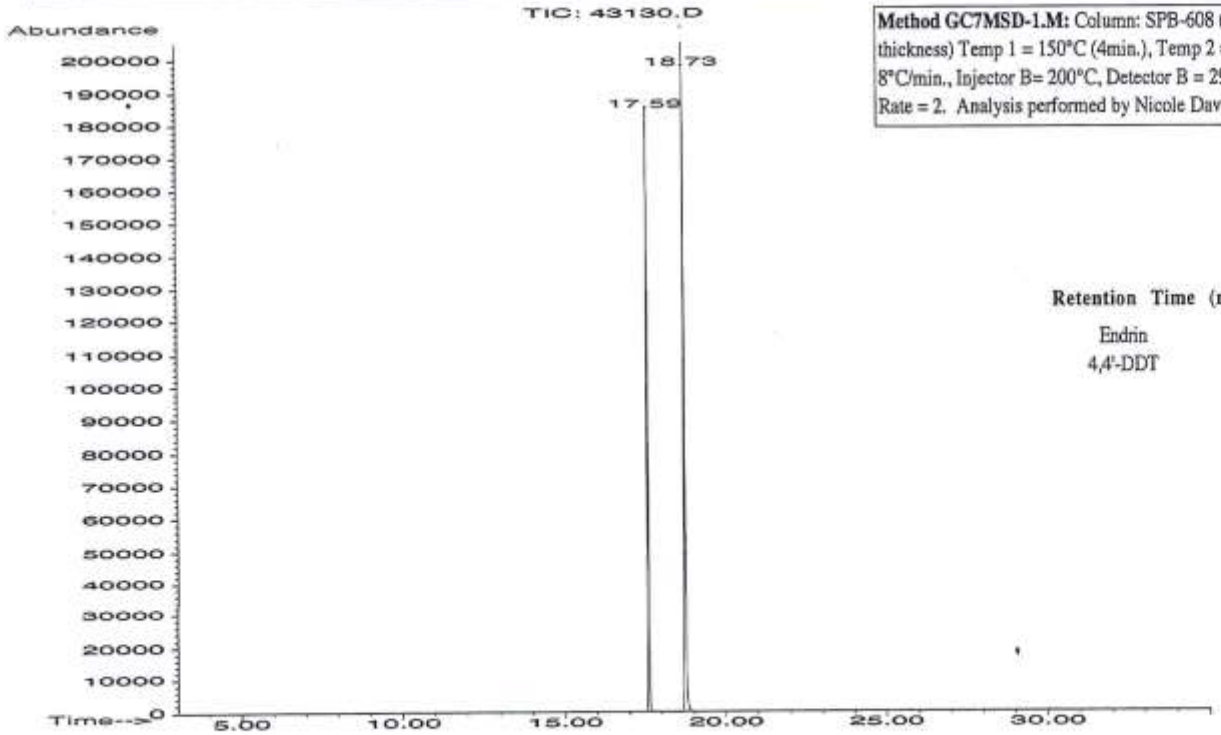
Solvent(s): Lot # DK010 Methanol

Formulated By: Paul Barron 091014 DATE
Reviewed By: Pedro L. Rentas 091014 DATE

Weight(s) shown below were combined and diluted to: 25.0 5E-05 Balance Uncertainty 0.006 Flask Uncertainty

MSDS Information (Solvent Safety Info. On Attached pg.)

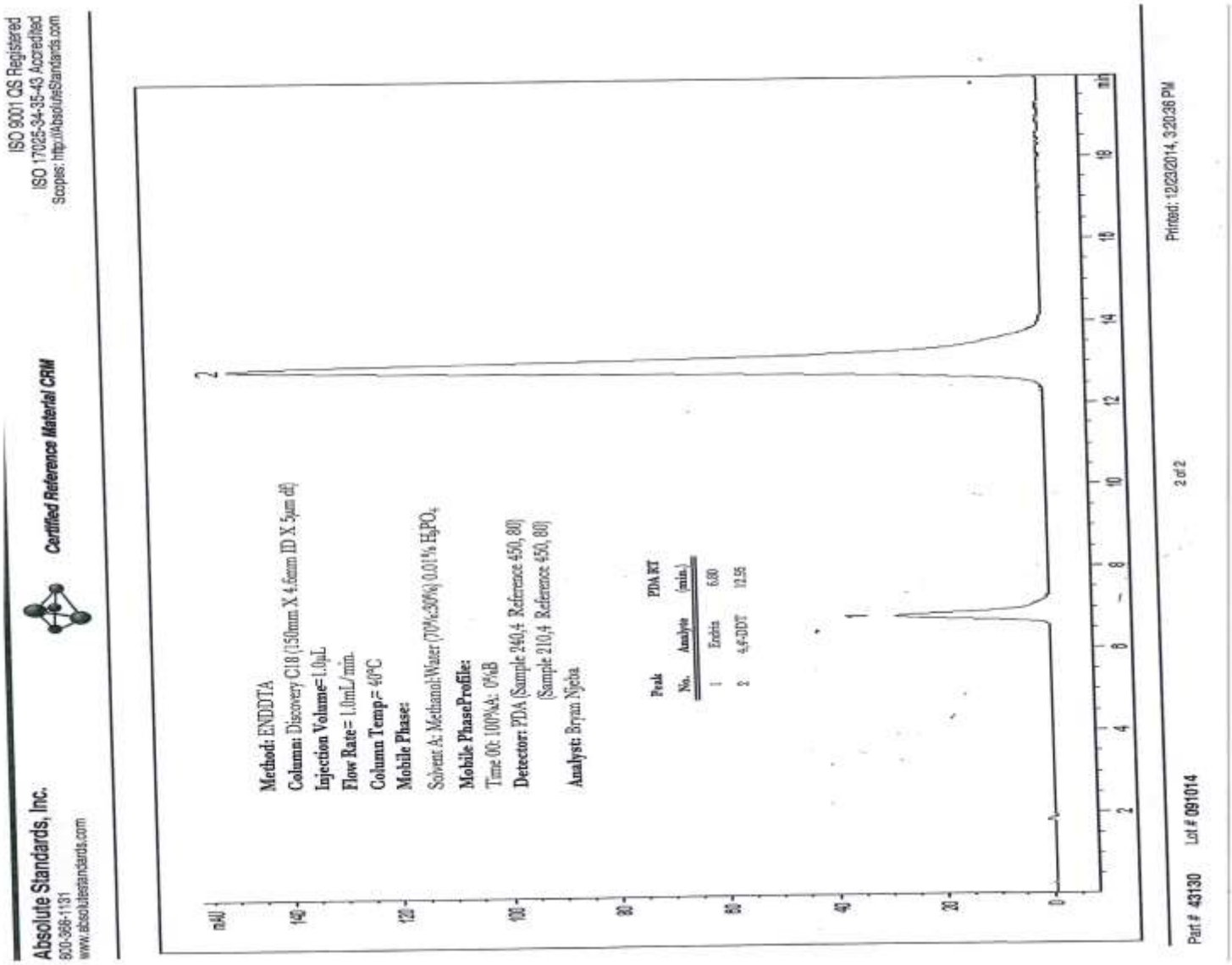
Compound	RM#	Lot Number	Nominal Conc (µg/mL)	Purity (%)	Uncertainty Purity	Target Weight(g)	Actual Weight(g)	Actual Conc (µg/mL)	Expanded Uncertainty	CAS#	OSHA PEL (TWA)	LD50
1. 4,4'-DDT	101	ER012306-03	500	99	0.2	0.01263	0.01264	500.5	0.0089	00050-29-3	N/A	orl-rat 87mg/kg
2. Endrin	170	110-146A	500	98	0.2	0.01276	0.01278	500.9	0.0088	00072-20-8	0.1mg/m3 (skin)	orl-rat 7mg/kg



Method GC7MSD-1.M: Column: SPB-608 (30m X 0.25mm ID X 0.25µm film thickness) Temp 1 = 150°C (4min.), Temp 2 = 290°C (13.5 min.), Rate = 8°C/min., Injector B= 200°C, Detector B = 290°C. Split Ratio = 100:1, Scan Rate = 2. Analysis performed by Nicole Davis.

Retention Time (min.)

Endrin	17.59
4,4'-DDT	18.73


Absolute Standards, Inc.
800-368-1131
www.absolutestandards.com
Certified Reference Material CRM
ISO 9001 QS Registered
ISO 17025-94-35-43 Accredited
Scopes: http://AbsoluteStandards.com
Method: ENDDTA
Column: Discovery C18 (150mm X 4.6mm ID X 5µm dl)
Injection Volume=1.0µL
Flow Rate= 1.0mL/min.
Column Temp= 40°C
Mobile Phase:
Solvent A: Methanol:Water (70%:30%) 0.01% H_3PO_4
Mobile PhaseProfile:
Time 00: 100%A: 0%B
Detector: PDA (Sample 240,4 Reference 450, 80)
(Sample 210,4 Reference 450, 80)
Analyst: Bryan Njeba
Peak No. Analyte PDA RT (min.)
1 Endrin 6.80
2 4,4-DDT 12.95
mAU
140
120
100
80
60
40
20
0
1
2
2
4
6
8
10
12
14
16
18
min
Part # 43130 Lot # 091014
2 of 2
Printed: 12/23/2014, 3:20:36 PM

Absolute Standards, Inc.
800-368-1131
www.absolutestandards.com

Analytical Reference Material ARM

ISO 9001 QS Registered
ISO 17025-34-35-43 Accredited
Scopes: http://AbsoluteStandards.com

CERTIFIED WEIGHT REPORT

		Lot #	Solvent(s):
		L03N76	MTBE

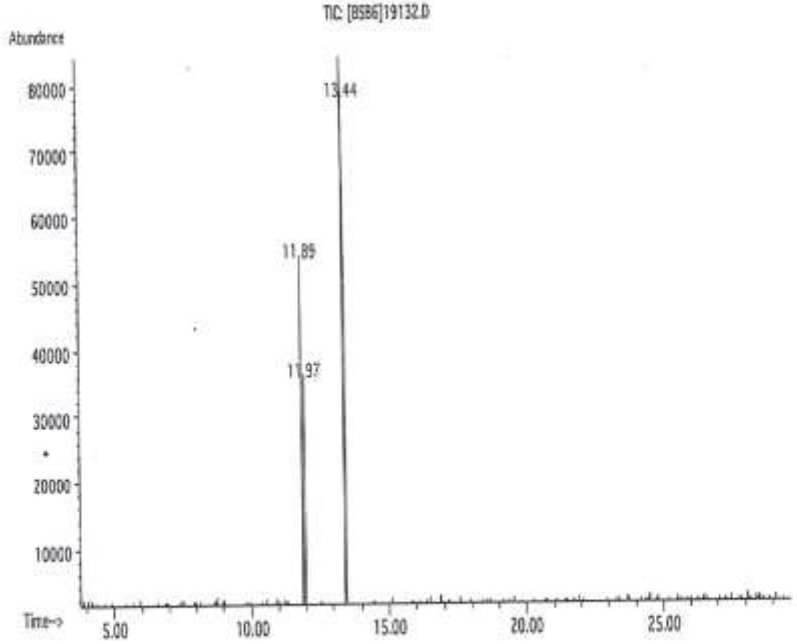
Part Number: 19132
Lot Number: 082013
Description: EPA Method 508 - Performance Check Solution
4 components
Expiration Date: 082018
Recommended Storage: Refrigerate (4 °C)
Nominal Concentration (µg/mL): Varied

Formulated By: Paul Barron 082013 DATE

Reviewed By: Pedro L. Rentas 082013 DATE

Volume(s) shown below were combined and diluted to: 100.0 0.002 Flask Uncertainty; 5E-05 Balance Uncertainty

Compound	Part Number	Lot Number	Dil. Factor	Initial Vol. (mL)	Uncertainty Pipette	Initial Conc.(ug/mL)	Final Conc.(ug/mL)	Expanded Uncertainty (+/-) (µg/mL)	MSDS Information (Solvent Safety Info. On Attached pg.) CAS#	OSHA PEL (TWA)	LD50
1. d-BHC	19133	062510	0.10	10.00	0.006	201.2	20.1	0.00637	00319-86-8	N/A	ori-rat 1000mg/kg
2. Chlorothalonil	79307	031213	0.025	2.50	0.025	1001.5	25.0	0.01012	01897-45-6	N/A	ori-rat 9000mg/kg
3. Chlorpyrifos (Dursban)	19135	081913	0.01	1.00	0.002	100.2	1.0	0.01413	02921-88-2	0.2mg/m3 (skin)	ori-rat 82mg/kg
4. Dacthal	19136	082510	0.10	10.00	0.006	252.0	25.2	0.01092	01861-32-1	N/A	ori-rat 3000mg/kg



Method GC7MSD-1.M: Column: SPB-608 (30m X 0.25mm ID X 0.25µm film thickness) Temp 1 = 150°C (4min.), Temp 2 = 290°C (13.5 min.), Rate = 8°C/min., Injector B= 200°C, Detector B = 290°C. Split Ratio = 100:1, Scan Rate = 2. Analysis performed by Candice Warren.

Name	MSD RT (min.)
Chlorothalonil	11.88
d-BHC	11.97
Chlorthal (Dacthal)	13.43
Chlorpyrifo	13.43

7

Part # 19132 Lot # 082013 1 of 1 Printed: 12/23/2014, 3:20:35 PM

FORM 10.16

508 Laboratory Performance Checks

File ID:

Chromatographic Performance - Peak Gaussian Factor

PGF = (1.83 x W1/2) / W1/10 — W1/2 = Peak width at half height; W1/10 = Peak width at tenth height

Primary Column
PGF = 0.92 — W1/2: 2 — W1/10: 4

Confirmation Column
PGF = 0.92 — W1/2: 5 — W1/10: 9.9

0.80 < PGF < 1.15

Column Performance - Resolution

R = t / W — t = difference in elution time; W = Average peak width in min.

Primary Column
R = 2.12 — t: 0.4 — W: 0.1888889

Confirmation Column
R = 1.33 — t: 0.11 — W: 0.0826923

Resolution > 0.50

	RT	Peak Width	
Peak 1	3.58	20	0.2222222
Peak 2	3.98	14	0.1555556
0.1min. In mm		9	

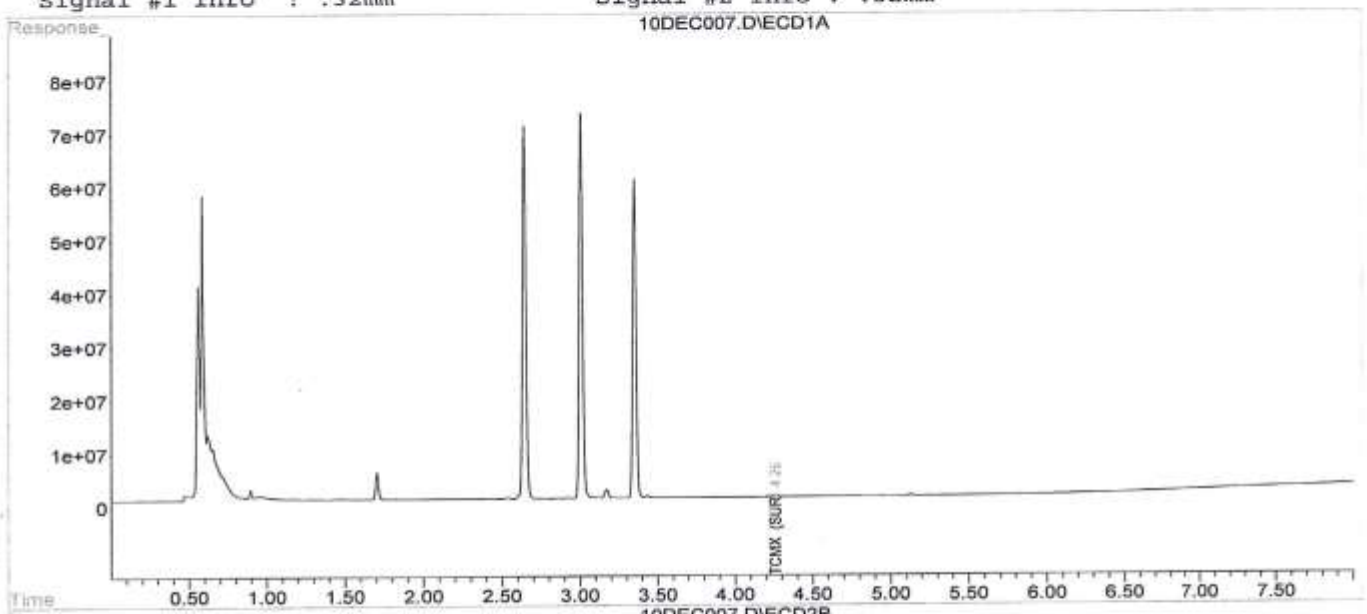
	RT	Peak Width	
Peak 1	4.23	21	0.0807692
Peak 2	4.34	22	0.0846154
0.1min in mm		26	

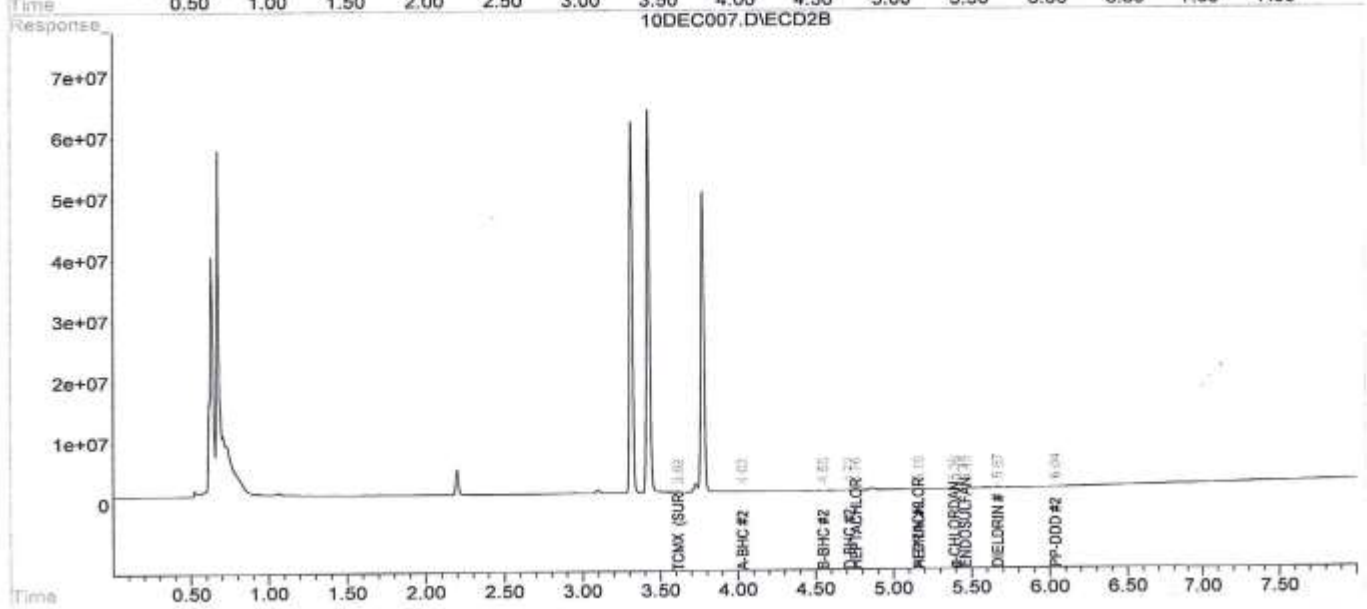
FORM 10.17

```
Signal #1 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC10\10DEC007.D\ECD1A.CH Vial: 95
Signal #2 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC10\10DEC007.D\ECD2B.CH
Acq On    : 10 Dec 2014   8:28 am                    Operator: VH1
Sample    : 508                                      Inst    : GC-17
Misc      :                                          Multiplr: 1.00
IntFile Signal #1: autoint1.e     IntFile Signal #2: autoint2.e
Quant Time: Dec 10  8:36 2014  Quant Results File: 608.RES

Quant Method : C:\HPCHEM\4\METHODS\608.M (Chemstation Integrator)
Title        : EPA 608 Pesticides
Last Update  : Wed Jan 16 14:53:10 2013
Response via : Multiple Level Calibration
DataAcq Meth : 608.M

Volume Inj.      : 3uL
Signal #1 Phase  : Rtx-440 30M x .32 Signal #2 Phase: Rtx CLPesticides2  30M x .32mm
Signal #1 Info   : .32mm              Signal #2 Info : .32mm
```





10DEC007.D 8080.M Sat Dec 13 17:49:47 2014 Page 2

FORM 10.18

```
Signal #1 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC11\11DEC041.D\ECD1A.CH Vial: 99
Signal #2 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC11\11DEC041.D\ECD2B.CH
Acq On    : 12 Dec 2014  12:07 am                    Operator: VH1
Sample    : CCV                                      Inst    : GC-17
Misc      :                                          Multiplr: 1.00
IntFile Signal #1: autoint1.e     IntFile Signal #2: autoint2.e
Quant Time: Dec 12 10:39 2014  Quant Results File: 8080.RES

Quant Method : C:\HPCHEM\4...\8080.M (Chemstation Integrator)
Title        : EPA 608 Pesticides
Last Update  : Fri Dec 12 09:45:34 2014
Response via : Initial Calibration
DataAcq Meth : 608.M

Volume Inj.      : 3uL
Signal #1 Phase : Rtx-440 30M x .32 Signal #2 Phase: Rtx CLPesticides2  30M x .32mm
Signal #1 Info  : .32mm              Signal #2 Info : .32mm
```

	Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
	System Monitoring Compounds						
1) S	TCMX (SURROGATE	1.74	2.21	628.0E6	510.6E6	30.332	30.385
	Spiked Amount 30.000			Recovery	=	101.11%	101.28%
3) S	DCB (SURROGATE)	5.11	5.90	599.9E6	421.8E6	75.471	75.142
	Spiked Amount 75.000			Recovery	=	100.63%	100.19%
	Target Compounds						
2) T	A-BHC	2.12	2.67	455.8E6	364.7E6	16.357	16.253
3) T	LINDANE	2.33	2.92	409.9E6	326.5E6	16.086	15.907
4) T	B-BHC	2.39	2.99	179.9E6	145.2E6	14.875	14.762
5) T	D-BHC	2.51	3.19	350.2E6	281.3E6	15.929	16.020
6) T	HEPTACHLOR	2.65	3.21	379.0E6	300.1E6	15.406	15.566
7) T	ALDRIN	2.83	3.42	374.5E6	303.4E6	15.426	15.935
8) T	HEPTACHLOR EPOXI	3.21	3.79	354.8E6	276.5E6	15.026	15.446
9) T	g-CHLORDANE	3.29	3.91	365.0E6	285.9E6	15.317	15.451
0) T	a-CHLORDANE	3.37	4.00	368.0E6	284.0E6	15.213	15.444
1) T	ENDOSULFAN I	3.45	4.03	680.0E6	253.3E6	15.682	15.441
2) T	PP-DDE	3.45	4.11	680.0E6	249.9E6	15.579	15.843
3) T	DIELDRIN	3.59	4.19	343.0E6	262.4E6	15.460	15.652
4) T	ENDRIN	3.72	4.37	235.2E6	183.8E6	15.170	15.580
5) T	PP-DDD	3.80	4.46	261.5E6	205.6E6	15.609	15.828
6) T	ENDOSULFAN II	3.85	4.50	287.0E6	234.2E6	15.172	15.216
7) T	PP-DDT	3.96	4.64	220.9E6	165.5E6	15.203	15.687
8) T	ENDRIN ALDEHYDE	4.09	4.70	205.9E6	146.8E6	15.448	15.446
9) T	ENDOSULFAN SULFA	4.28	4.86	584.7E6	181.5E6	15.710	15.306
0) T	METHOXYCHLOR	4.28	5.06	584.7E6	97788721	15.705	15.629
1) T	ENDRIN KETONE	4.49	5.15	310.4E6	590.3E6	15.391	14.998
2) T	MIREX	4.33	5.15	246.0E6	590.3E6	15.344	14.935

```
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25%  (m)=manual int.
11DEC041.D  8080.M      Sat Dec 13 17:47:10 2014
```

Page 1

FORM 10.19

```
Signal #1 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC05\05DEC003.D\ECD1A.CH Vial: 91
Signal #2 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC05\05DEC003.D\ECD2B.CH
Acq On    :  5 Dec 2014   1:22 pm                    Operator: VH1
Sample    : 8080 BREAKDOWN                           Inst     : GC-17
Misc      :                                          Multiplr: 1.00
IntFile Signal #1: autoint1.e     IntFile Signal #2: autoint2.e
Quant Time: Dec  5 13:47 2014  Quant Results File: 8080.RES

Quant Method : C:\HPCHEM\4...\8080.M (Chemstation Integrator)
Title        : EPA 608 Pesticides
Last Update  : Thu Dec 04 14:48:28 2014
Response via : Initial Calibration
DataAcq Meth : 608.M

Volume Inj.      : 3uL
Signal #1 Phase : Rtx-440 30M x .32 Signal #2 Phase: Rtx CLPesticides2  30M x .32mm
Signal #1 Info  : .32mm             Signal #2 Info : .32mm
```

		Compound	RT#1	RT#2	Resp#1	Resp#2	ng#1	ng#2
System Monitoring Compounds								
Target Compounds								
2)	T	PP-DDE	3.90	4.55	24107920	18341837	0.497m	1.052m#
4)	T	ENDRIN	4.19	4.84	339.2E6	247.8E6	17.205m	17.566m
5)	T	PP-DDD	4.25	4.90	12199408	9572333	0.615m	0.667m
7)	T	PP-DDT	4.41	5.09	298.0E6	203.2E6	18.023m	18.300m
8)	T	ENDRIN ALDEHYDE	4.56	5.17	14988243	10196575	0.974m	0.974m
1)	T	ENDRIN KETONE	4.97	5.65	27455875	20299975	1.156m	0.475m#

```
(f)=RT Delta > 1/2 Window (#)=Amounts differ by > 25%  (m)=manual int.
05DEC003.D  8080.M      Sat Dec 13 17:43:47 2014
```

Page 1

Form 10.19

DDT and Endrin Breakdown: 05DEC003

File ID =

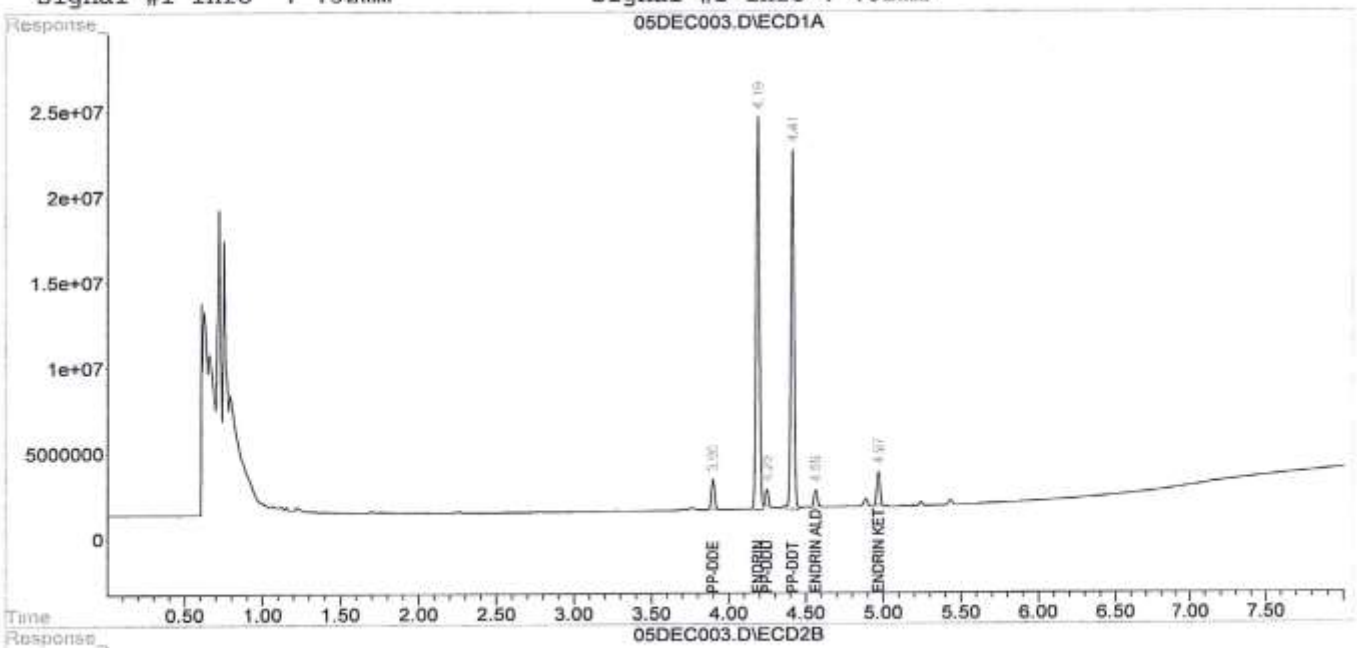
	Primary	*Confirmation*
% Breakdown of Endrin =	11.1%	11.0%
% Breakdown of DDT =	10.9%	12.1%
Area Count of Endrin:	3.39E+08	2.48E+08
Area Count of Endrin Aldehyde:	14988243	10196575
Area Count of Endrin Ketone:	2.75E+07	20299975
Area Count of DDT:	2.98E+08	2.03E+08
Area Count of DDE:	2.41E+07	18341837
Area Count of DDD:	1.22E+07	9572333

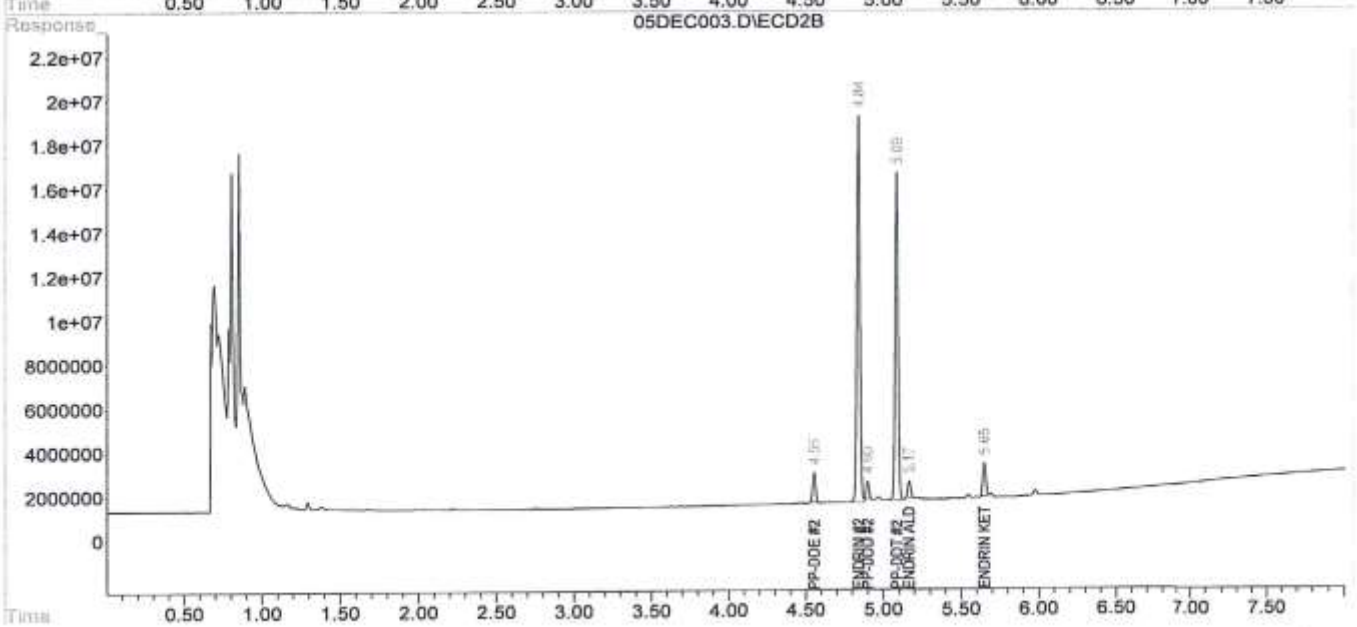
% Breakdown of DDT and Endrin, each must be less than 15%.

```
Signal #1 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC05\05DEC003.D\ECD1A.CH Vial: 91
Signal #2 : D:\INSTRMNT\GC-17\DATA\2014\DEC\DEC05\05DEC003.D\ECD2B.CH
Acq On    :  5 Dec 2014   1:22 pm                    Operator: VH1
Sample    : 8080 BREAKDOWN                           Inst    : GC-17
Misc      :                                          Multiplr: 1.00
IntFile Signal #1: autoint1.e     IntFile Signal #2: autoint2.e
Quant Time: Dec  5 13:47 2014  Quant Results File: 8080.RES

Quant Method : C:\HPCHEM\4...\8080.M (Chemstation Integrator)
Title        : EPA 608 Pesticides
Last Update  : Thu Dec 04 14:48:28 2014
Response via : Multiple Level Calibration
DataAcq Meth : 608.M

Volume Inj.      : 3uL
Signal #1 Phase : Rtx-440 30M x .32 Signal #2 Phase: Rtx CLPesticides2  30M x .32mm
Signal #1 Info  : .32mm             Signal #2 Info : .32mm
```



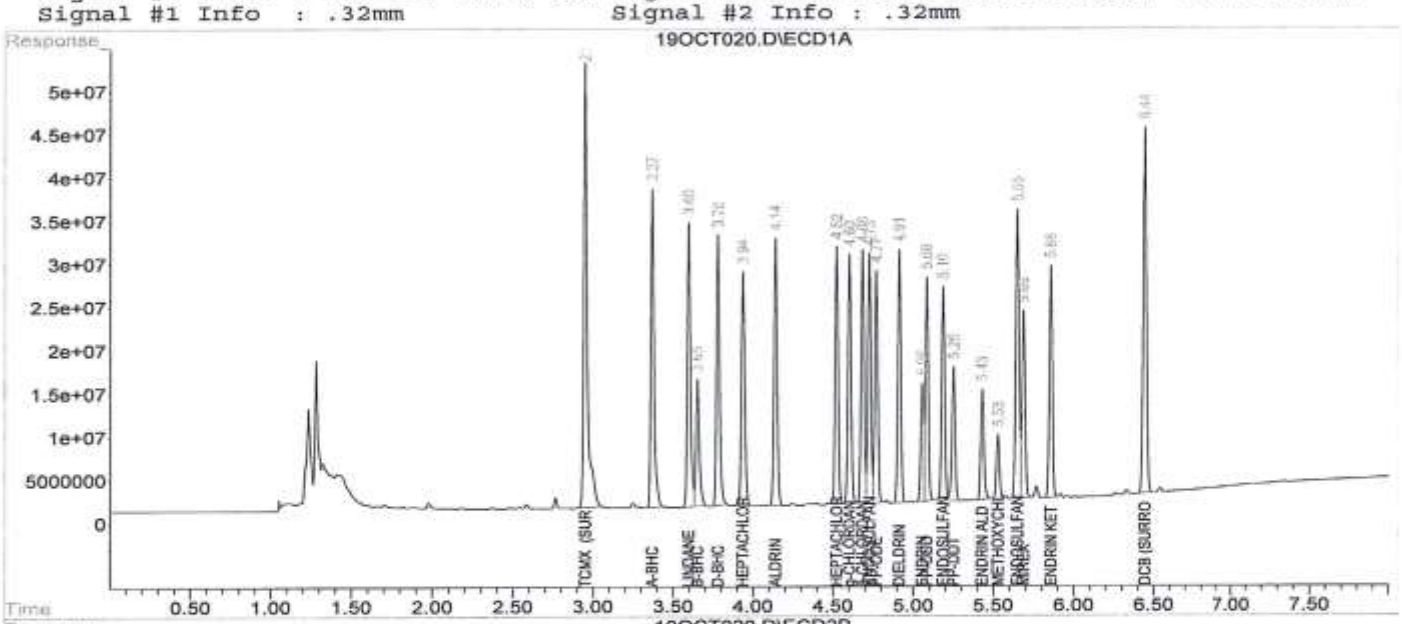


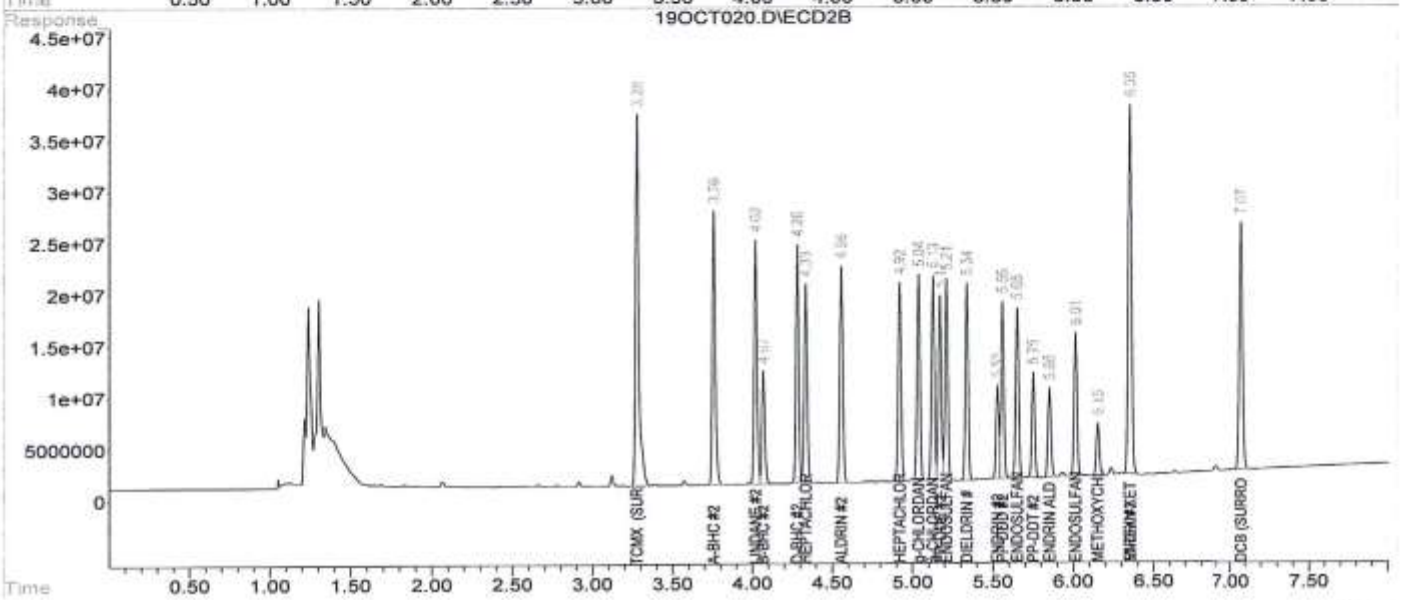
05DEC003.D 8080.M Sat Dec 13 17:43:47 2014 Page 2

```
Signal #1 : D:\INSTRMNT\GC-17\DATA\2014\OCT\OCT19\19OCT020.D\ECD1A.CH Vial: 99
Signal #2 : D:\INSTRMNT\GC-17\DATA\2014\OCT\OCT19\19OCT020.D\ECD2B.CH
Acq On    : 20 Oct 2014  11:39 am                    Operator: VH1
Sample    : CCV                                      Inst    : GC-17
Misc      :                                          Multiplr: 1.00
IntFile Signal #1: autoint1.e     IntFile Signal #2: autoint2.e
Quant Time: Oct 20 11:36 2014  Quant Results File: 608.RES

Quant Method : C:\HPCHEM\4...\608.M (Chemstation Integrator)
Title        : EPA 608 Pesticides
Last Update  : Sun Oct 19 22:04:18 2014
Response via : Multiple Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3uL
Signal #1 Phase  : Rtx-440 30M x .32 Signal #2 Phase: Rtx CLPesticides2  30M x .32mm
Signal #1 Info   : .32mm              Signal #2 Info : .32mm
```





19OCT020.D 608.M Sat Dec 13 17:40:27 2014 Page 2

UnControlled Copy:
Issued To:
Approved By: Semi Volatiles Supervisor
Approval Date: 01/21/2016
Effective Date: 01/23/2017
Printed Date:
Location:
Printed By:

1.0 SCOPE

1.1 This method is used to determine the concentrations of Polychlorinated Biphenyls (PCB's) in a variety of matrices. This method is based on Gas Chromatographic (GC) procedures. Following are the seven different types of PCB's and their detection limits.

1.2

Component	Water MDL µg/L	Soil MDL mg/kg
PCB 1016	0.2	0.01
PCB 1221	0.2	0.01
PCB 1232	0.2	0.01
PCB 1242	0.2	0.01
PCB 1248	0.2	0.01
PCB 1254	0.2	0.01
PCB 1260	0.2	0.01

PCB 1262 and 1268 can be run at client's request.

2.0 APPLICATION

This method is used for wastewater, soil, solid waste, transformer oil, and auto shredder waste.

3.0 SUMMARY OF METHOD

3.1 5 µl of the top hexane layer of the extracted sample is introduced into the Gas Chromatograph by direct injection via an autosampler. The PCB's are separated by the Gas Chromatograph and a Chromatogram is obtained through an integrator. All the PCB's have a different pattern of elution. A minimum of seven peaks is used in the standard and the same peaks are used for the quantitation of PCB's in the sample. The peaks are identified by the retention time comparison with the standard peaks. The particular PCB is then quantitated individually. The chromatographic conditions and operation procedures will be given later.

4.0 INSTRUMENT

4.1 Gas Chromatograph: The Gas Chromatograph used is Hewlett Packard HP 6890 Series GC System and GC Injector/Autosampler.

4.2 Columns: The primary column is Zebron CLPesticies, 30m x 0.32mm ID, 0.32µm *df* or Restek Rtx 440

The confirmation columns is Zebron CLPesticidies-1 -2, 30m x 0.32mm ID, 0 .25µm *df*
The Guard column is Zebron 5m x 0.32 mm ID or Restek Rtx-CLP Pesticides and 0 .25

GC/MS SIM mode may also be an alternative confirmation method.

4.3 Data System: HP Chemstation with GC Enviroquant software, HP CD writer for data storage.

4.4 Conditions:

Initial Oven Temp.	140°C
Initial hold time	0.5 min
Inlet Temp.	250°C
Detector Temp.	340°C
Prog.1 Final col.	330°C

5.0 STANDARD PREPARATION

5.1 Stock Solutions for PCB's: The polychlorinated biphenyls are purchased individually from different sources. The individual PCB's are listed in Table 1, with their suppliers, primary concentration and solvent used.

TABLE 1

PCB	Supplier	Primary Stock Conc. (µg/ml)	Solvents Used
AR1268	Absolute Std.	1000	MeOH
AR1262	Absolute Std.	1000	Isooctane
AR1260	Absolute Std.	1000	Hexane
AR1254	Absolute Std.	1000	Isooctane
AR1248	Absolute Std.	1000	Isooctane
AR1242	Absolute Std.	1000	Isooctane
AR1232	Absolute Std.	1000	Isooctane
AR1221	Absolute Std.	1000	Isooctane
AR1016	Absolute Std.	1000	Hexane
AR1260 ICV	RESTEK	1000	Hexane
AR1016 ICV	Supelco	1000	Isooctane
DCB Surrogate	RESTEK	200	Acetone
TCMX Surrogate	RESTEK	100	Acetone

* Hexane may also be used.

6.0 PREPARATION OF CALIBRATION STANDARDS

6.1 Curve Standards for PCB's: The final stock solution required for preparation of working standards is prepared by diluting primary stocks of PCB's.

TABLE 2 Preparation of calibration standards

Arochlor	Compound	Stock Conc. µg/ml	Aliquot Added (mls)						Final Concentration (µg/ml)					
			#1	#2	#3	#4	#5	#6	#1	#2	#3	#4	#5	#6
AR1260/1016 `	PCB's	10	0.2	0.1	0.15	0.25	0.35	0.5	0.02	0.1	0.15	0.25	0.35	0.5
	DCB Surrogate	3	0.04	0.06	0.08	0.1	0.12	0.14	0.012	0.018	0.024	0.03	0.036	0.042
	TCMX Surrogate	6	0.04	0.06	0.08	0.1	0.12	0.14	0.024	0.036	0.048	0.06	0.072	0.084

The PCB stock standard concentration used to prepare std. # 1 is a 2 µg/ ml solution. Aroclor 1254,1248,1242,1232, 1221, 1262 and 1268 are prepared at the #4 std for single point calibration as needed.

A seventh point may also be added to increase linear range.

6.2 Reference Standards for PCB's: The reference standards or ICV standards for all the PCB's are prepared from different sources at the midpoint concentration.

6.3 Matrix Spike Standard: 2.5 ml of 100 µg/ml of PCB stock solution is added to 100 mls of Hexane (for oil sample only) or Acetone (for soil and H_2O Samples only). Spike level =2.5 ug/ml in 10ml final extract = 0.25 µg per 1L or 30g of sample.

7.0 INITIAL CALIBRATION FOR THE GC

7.1 Prior to the analysis of any sample, 5 µl of hexane is introduced into the GC by direct injection to make sure that there is no instrument contamination of any kind.

7.2 Each of the standards is injected in the GC for AR1260/1016.

7.3 The instrument must be calibrated to assure stable response and adequate sensitivity. At least a 5 point curve must be generated using the five calibration standards listed in section 6.1. If the RF relative standard deviation is less than 20% then an Average of Response Factors curve fit is used. If the % RSD is greater than 20 and the coefficient of determination (r^2) is greater than 0.990 then a Linear Regression curve fit can be used. If the % RSD is greater than 20 and the coefficient of determination is greater than 0.990 then a Quadratic Regression curve fit can be used provided six standards are run for calibration. The Chemstation software reports the r^2 value. The requirements for Department of Defense work is a correlation coefficient (r) greater than 0.995 for both a Linear Regression and Quadratic Regression curve fit. For reference, an r value of 0.995 corresponds to an r^2 value of 0.990. The curve, once generated, must have its accuracy verified by the reference standard (ICV).

7.4 After running the curve, an ICV standard is run to check calibration. The percent difference must be ± 15%. This criterion must be met before the initial calibration is to be used.

8.0 DAILY GC CALIBRATION

8.1 The initial calibration must be checked and verified daily. This is accomplished by analyzing a calibration standard that is at the midrange concentration of the working range (0.25 µg/ml). The % RSD should be a percent difference of ± 15%.

9.0 GC ANALYSIS

9.1 Screening the sample by visible inspection is necessary to provide guidance on whether a sample will need to be diluted before initial analysis. Use good judgment, if the sample appears to be highly contaminated it is better to start with high dilution and brings the dilution down, than to overload the column and necessitate the running of hexane blanks to clean the system.

9.2 If dilution is needed, use a volumetric flask and add the appropriate amount of the sample to make the required dilution.

9.3 Transfer about 2 ml of the diluted sample with a transferring pipette into an autosampler vial. Set the vial in the rack and let it run.

9.4 If upon initial analysis of a sample or a dilution of a sample a concentration of analyte greater than the initial calibration range is found, the sample must be reanalyzed at a higher dilution. A hexane blank should be run after a sample of high concentration is run.

10.0 DATA INTERPRETATION

10.1 Qualitative Analysis - The PCB is identified by the comparison of the retention times and pattern recognization of the peaks of interest with those from the daily calibration run.

10.2 The sample retention time (RT) must compare with the RT of the standard. For reference the daily calibration run RT is used.

10.3 Quantitative Analysis - When a PCB is identified quantification will take place.

$$Conc.(ug/L) or (mg/kg) = \frac{ax}{rf} \; x \; \frac{fv}{vs} \; x \; dilution \;\; factor.$$

The concentration of the particular PCB is calculated as follows:

Where :	ax	=	Sum of the area of the seven peaks.
	rf	=	Average response factor for that PCB.
	fv	=	Final volume of the sample.
	vs	=	Volume of the sample extracted.

Since the computer software calculates the conc. of PCB in µg, we have to divide the conc. of Total PCB Arochlor by sample volume (liters) or weight (grams).

$$eg = \frac{8.0233}{30.0} = 0.267 \text{ mg/kg for soil}$$

$$= \frac{8.0233}{0.940} = 8.535 \text{ µg/L for water}$$

(Example for 30 grams sample or 940 ml sample).

10.4 All positive results are to be confirmed by 2nd column analysis.

10.5 When reporting positive results for Department of Defense samples, the analyst must report the value from the higher of the two columns.

10.6 When manual integrations are performed on Department of Defense sample chromatograms, the analyst is required to provide a chromatogram of the peak before and after integration. These should be initialed, dated and a given a brief explanation for the manual integration.

Note: For DOD work, DOD QSM requirement version 5.0 must be followed. DOD compliance has been documented in BCL SOP BCDOD001 in section 3.0 thru section 8.0 to be followed. A copy of BCL SOP BCDOD001 is available for reference with Department Supervisors.

11.0 QUALITY CONTROL

11.1 All analysts new to this method must first undergo an official training period before actual analysis can begin. The training must be performed by the supervisor, the team leader, the prior analyst, or a combination of the three. The period will be deemed appropriate for new analysts to become competent to perform this method. Once the training is complete, an IDC (Initial Demonstration of Capability) must be generated by the new analyst before he/she can perform the analysis and report results. A copy of this IDC and all the raw data associated with it, will be kept by the supervisor. The information related to the length of training and who performed the training, also is kept with the supervisor. Continued training will take place as long as needed for the analyst to become proficient in running this method.

11.1.1 Each analyst must undergo a yearly demonstration of capability. This can be accomplished by passing a yearly audit sample. If a given analyst does not run an annual audit sample then they can perform an IDC to satisfy this requirement.

11.2 Before analysis begins a Hexane blank is run in order to ascertain that interferences from the analytical system are under control (i.e., below detection limit). Each time a set of samples is run or there is a change of reagents, a Hexane blank must be run in order to evaluate contamination problems.

11.3 Each day that analysis is performed, the daily midpoint calibration standard is run to evaluate the initial calibration curve and to ensure that the GC system is working properly. The analysis judgments and experience is crucial. Certain judgments must be made by the analyst. Does the

Chromatography look correct? Is the response obtained comparable to that obtained in the past? Have the retention times shifted substantially? Is there any background contamination? If any changes to the analytical system are made, recalibration of the system must take place.

11.4 Required Instrument Q.C.

11.4.1 There must be an initial calibration of the GC system follow by initial calibration verification (ICV) from a different source.

11.4.2 On each working day a Hexane blank must be run to verify that no contamination is present.

11.4.3 On each working day the initial calibration must be verified by running a calibration standard after every 12 hour shift or every 10 samples.

11.4.4 For each analytical batch, up to 20 samples per batch, a laboratory control sample (LCS) must be run. The LCS is used to confirm method performance.

11.4.5 For each analytical batch, up to 20 samples per batch, a matrix spike and matrix spike duplicate must be run on the matrix analyzed.

11.4.6 The analyst, on an ongoing basis, must analyze a reagent blank, a LCS, a matrix spike and a matrix spike duplicate for each analytical batch.

11.4.7 To determine acceptable accuracy and precision limits for LCS, spike, and spike duplicate recovery, the following procedure is used:

11.4.7.1 For each LCS, spikes, and spike duplicate analyzed, calculate the percent recovery of Aroclor 1260.

11.4.7.2 Once a minimum of 30 Q.C. sets of the same matrix are analyzed, the average percent recovery is calculated and the standard deviation of the percent recovery is also calculated.

11.4.7.3 For a given matrix the upper and lower control limits are calculated as follows:

Upper Control Limits (UCL) = Ave + 3S
Lower Control Limits (UCL) = Ave - 3S

11.4.8 <u>Method Detection Limit (MDL)</u> – This is defined as the minimum concentration of a compound that can be qualitatively reported with a 99% confidence that the analyte concentration is greater than zero for a given matrix. The concentration is important since a concentration which is too low might not be subject to quantitation. Likewise, a concentration too high may provide a relatively small standard deviation, thereby producing an unusually low method detection limit. These spikes are extracted and processed in exactly the same manner as any sample. The final results are recorded and

the standard deviation is calculated for each analyte. MDL studies for water and soil are performed on an annual basis.

The MDL is then calculated as:

$$MDL = t * sd$$

Where: sd = standard deviation
t = Student's t-value @ 99% confidence level
(t_{n-1} = 3.14 for n = 7)

11.4.8.1 A method detection limit (MDL) verification sample must be run on the instrument immediately following an MDL study. This check sample is spiked approximately two times the current reported MDL. It is determined to be successful if it yields a response that is three times above the instruments noise level.

11.4.9 Practical Quantitation Limit (PQL) – This is a limit which this laboratory specifies is the concentration which will be quantitated and reported. It is approximately 3-5 times the MDL. It is chosen such that it is above the method detection limit, but below the MCL (Maximum Contamination Limit) for a particular analyte. For those levels which confirm between the MDL and the PQL, a level of "Trace" will be reported for specific clients.

11.4.9.1 A limit of quantitation (LOQ) verification sample must be run on the instrument immediately following an MDL study. This check sample is spiked at approximately, but no higher than, two times the currently reported PQL. It is determined to be successful if it yields a recovery within the limits specified in Appendix DoD-D of the Department of Defense Quality Systems Manual for Environmental Laboratories for laboratory control samples.

11.5 QC Failure (If applicable)

11.5.1 The following is a list of possible QC failures that can occur:

A. Initial calibration (Linearity, % RSD)
Initial calibration verification (% D)
Continuing calibrations (%D)
Laboratory control sample
MS and MSD % Recovery or Precision not within established criteria (Same origin or Batch specific)
MB positive above the PQL (in all cases of positive compounds)
MB positive above ½ the PQL (in all cases of positive compounds for Navy related projects)
Sample precision (Same origin or Batch specific)

Sample holding time exceeded
Sample extract holding time exceeded
Surrogate(s) not within established criteria

B. Laboratory Performance Checks (If applicable)
Tuning criteria (GC/MS only)
Internal Standard incompliance (If applicable)
Sample frequency (CCV frequency)
SPCC or CCC criteria (GC/MS only)

11.5.2 For situations involving category A above, re-extract, re-run the incompliant samples, or note with appropriate flags. For situations involving category B, the analysis must stop immediately, and the analyst must evaluate possible causes and initiate corrective action. Maintenance of the instrument or the remaking of stock standard solutions may be the cure for both categories.

11.5.3 In instances where the MB, LCS, MS, or MSD is outside of established limits the following is the protocol:

1) Re-run the incompliant sample to confirm extraction or instrument error.

2) If the sample is within holding time, and there is enough samples to re-extract, it will be re-extracted.

3) If the sample is not within holding time, and there is enough sample to re-extract, the client service representative will be asked to notify the client of their options. Expired samples will be extracted only at clients request or with the permission of the supervisor or team leader.

4) If there is insufficient sample for re-extraction, the original result is reported with appropriate flags.

11.5.4 For further information refer to the current revision of the Quality Assurance Program Plan Appendix D.

11.5.5 For Navy related projects, Department of Defense Quality Systems Manual limits must also be met. In cases where spike and surrogate recoveries fall outside of DoD QSM limits the LCS and/or samples must be re-run to confirm recoveries.

12.0 INSTRUMENT LOGS

12.1 Each analyst is expected to keep up to date the following instrument logs.

12.1.1 The <u>analysis run logbook</u> contains all the sample, spikes, blanks and standards run on the particular instrument involved.

12.1.2 Maintenance log – All instruments also have maintenance logbooks which must be maintained including routine service and repairs. Detailed descriptions and drawings, if helpful, should also be included. Each entry in this log should include, at a minimum, identification of problems, their corrective actions and the results of those actions. One may be surprised later that very detailed notes may help solve future problems. Often, suspicious components may be exempt from repair because they were replaced at an earlier time.

12.1.3 Reagent Logbook - Contains all pertinent information regarding reagent prep and expiration dates.

12.2 Binder—Analyst's are required to keep a binder by each workstation that contains the following information:

1) A current controlled copy of the SOP.
2) A current copy of the MDL study report (Soil and Water where applicable). The originals with all the pertinent raw data is to be kept with the supervisor.
3) Control chart information including current limit, LCS, MS, and MSD QC reports..
4) A copy of the current Retention Time Report (if applicable).

12.3 Certificate of Analysis Logbook—This book contains the Certificate of Analysis for each standard, neat, and solution purchased from chemical supplies. Information pertaining to compound concentration, lot numbers, part numbers, and expiration dates are located here. When standard are prepared, an Element number and the date the standard was opened are assigned to each Certificate of Analysis. When standards are discarded, that date is placed into the Extractables Standard Logbook and the associated Certificate of Analysis is taken out and placed into a separate folder.

13.0 GENERAL MAINTENANCE

The maintenance of the equipment and apparatus is essential to the integrity of results generated by this method. The many components of the instrument work together much like the components of a fine watch. If one component is not able to perform its function, then the entire system will not perform correctly.

13.1 Septa Changes - The septum is the silicon based component which seal off the injection port after the sample syringe introduces its 5 µl aliquot. It is located just under the sample injection port nut on the top of the instrument. This should be replaced after every 100 sample injections, or when there is a noticeable change in the chromatography (i.e., significant response changes, septa bleed, etc.). To change the septum, simply remove the injection nut, replace the septum, and carefully replace the nut and tighten slowly until the column head pressure returns.

13.2 Injection Insert and Guard Column - Occasionally, the septum change may not be sufficient to restore the system's integrity and performance. The glass injection insert and the guard column are particularly prone to contamination by permanently retained compounds and general contaminants. These deposits can significantly hinder component resolution and column

performance. The injection insert is located just under the septum and should be removed with forceps; but be careful because this insert is very hot! The insert should then be immersed in sulfuric acid to dissolve the residue. Finally, the guard column should be clipped or replaced to restore its proper function. The guard column must then be setup to be connected to the injection port. The nut and graphite/vespel ferrul will first be placed over the column to be ready for installation. Next, this instrument requires the column to be inserted into the injection insert in a tapered closure arrangement. To assure gas-tight seal, the insert must first be wetted with methanol, and the column pressed into the tapered end of the glass insert. The nut and ferrel are then placed over the injector tip and moderately tightened to assure a gas-tight seal.

13.3 Column Change - The column is the heart of the analytical system. If properly cared for, it should provide at least six months of trouble free service. The worst enemies to these columns are oxidants and extreme temperatures. The most fatal enemy to the column is the combination of these two. The most prevalent oxidant is oxygen found in the atmosphere. It is therefore crucial that the column temperature be reduced prior to opening the system to the atmosphere. By participating this one rule, the system will be assured to be protected from the most damaging conditions. Likewise, the injection of samples which are acidic or known to be oxidants should never be injected onto the column. Dark or foul smelling extracts can also result in column performance. When possible, inject high dilutions of these type samples to avoid destruction of the column performance.

13.3.1 Periodically, the column performance will suffer to the point that it is no longer acceptable. This is the indication that a new column is necessary to restore the system performance. This method requires the two columns mentioned earlier. One or both columns may need to be changed as necessary. The two columns are connected to the guard column via a "Y" connector. This allows the carrier gas and injection components to be distributed equally between the two columns. The column will first be removed from its end of the Y. If this removal is clean, and there are no visible pieces of the column in the Y, then the new column may be inserted into this void. Again, as mentioned above, a small amount of CH_3OH should be placed in the Y to allow for the smooth insertion of the column. If, however, the old column does not come out of the Y cleanly, then a new Y must be installed. This required the removal of both column heads and the guard column. All ends must then be cut smoothly with an appropriate cutting tool. Always check the column end with a magnifying glass to assure a right angle cut. The column end will then be inserted into the electron capture detector and will extend 115 mm from the button of the detector nut to the tip of the column. Maintain this length while carefully securing the nut to the bottom of the detector body.

13.3.2 With the column installed, it will then be necessary to allow the atmospheric gas to be displaced by the nitrogen carrier gas. Allow the column to sit for about a half an hour at room temperature before heating.

13.4 When documenting maintenance log for non-routine instrument problems, certain information is necessary.

1. List the symptoms.

2. Document what you think is wrong.

3. Document what you did to correct the problem.

4. Document if the corrective action worked.

5. Document when instrument was returned to control, initial and date.

6. Ask supervisor to check maintenance log for correct information, initial and date.

14.0 FORMS

14.1 Example of Initial Calibration Report
14.2 Example of ICV Report
14.3 Example of CCV Report
14.4 Example of QT Review Report
14.5 Example of Chromatogram of LCS
14.6 Example Chromatogram of 1221
14.7 Example Chromatogram of 1232
14.8 Example Chromatogram of 1242
14.9 Example Chromatogram of 1248
14.10 Example Chromatogram of 1254
14.11 Example Chromatogram of 1262
14.12 Example Chromatogram of 1268
14.13 PCB Disposal Log. Cradle to grave documentation.
14.14 GC Sequence example
14.15 System Improvement Form (SIF)
14.16 Initial Demonstration of Capability Form
14.17 Control Charts
14.18 Maintenance Logbook
14.19 User Flags
14.20 Analytical Standard Record
14.21 Instrument: GC:6 Run Log Schedule
14.22 Extraction Logbook

15.0 SAFETY

15.1 Safety of the employees is of primary concern at BC Laboratories. Perhaps the most effective means of securing the safety of employees is through the process of education and training. Ideally, the analyst should follow the chain of thought to assure safe practice:

15.1.1 What is my objective? How will I complete my objective?

15.1.2 What are the potential hazards involved while performing the procedures necessary to obtain this objective?

15.1.3 Can the hazards involved be eliminated or minimized by hardware (i.e. safety goggles, gloves, respirators) or behavioral modifications (i.e. waiting for the oven to cool, or avoiding the high voltage section of the instrument.)?

15.1.4 Where may I obtain the necessary hardware to protect myself and/or others from the potential hazards?

15.1.5 How will I employ the hardware? Do I need special training?

Once the above questions have been answered and satisfied, the goal will be to begin the procedure.

15.2 The hazards associated with this method can be classified as chemical, physical, or radioactive. These may be further classified as chronic or acute hazards. Specific chemical hazards include the solvents and the preparative reagents. The solvents hexane is used extensively in this method for dissolving sample extracts, cleaning preparation and instrument syringes, and making standard solutions. Exposure to this and all other solvents in this method should be avoided. Skin contact can be minimized by using vinyl or nitrile gloves. The exposure to the respiratory system should be avoided by using the solvents under a fume hood when necessary. Preparation of the standards, spikes, etc. should also be performed under a hood if solvent exposure is expected to be extensive.

15.3 The analytes of this method also pose another potential hazard to health. Again, minimization of the exposure hazard is required. Neat compounds and stock solutions have the greatest potential for acute poisoning. For this reason these should be handled the most carefully. The MSDS sheet for each compound may be found in the MSDS library for any or all solvents and analytes. The MSDS will designate the physical and chemical properties as well as the health hazards. The physical hazards involved with this method can be encountered while preparing samples and performing instrument repairs or maintenance. The column oven, injector, and detectors all have the potential to inflict major burns. Be extra careful when working around these hot surfaces to avoid burns.

15.4 The detectors for this method are the electron detectors. These detectors will be inspected semi-annually for radiation leaks as required by federal law. If a leak is discovered, the detector will be removed and replaced immediately. If no leaks are discovered, then the exposure to radiation is not a threat to the analyst or lab personnel. In any case, the detector should never be disassembled except by qualified personnel. Never disassemble the detectors.

15.5 Safety meetings are conducted to educate employees, solicit input from the employee on job hazards, and provide a forum for discussions of the Health and Safety Program. For further information consult the Employee Safety Manual.

16.0 POLLUTION PREVENTION

16.1 The laboratory pollution prevention practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are characterized and disposed of in the proper manner. The laboratory minimizes all releases from hoods and bench chemistries, complying with all solid and hazardous waste regulations.

16.2 The responsibility of each and every analyst or technician to monitor and minimize the waste and the disposal cost of unused materials. Analysts only prepare volumes of reagents and standards to reflect their anticipated usage and reagent stability. These include all stock, initial calibration, and continuing calibration standards, spike and surrogate solution, and any waste generated in their preparation.

16.3 Laboratory is concerned about pollution prevention, and will therefore employ any technique found to be effective in its reduction; provided its use does not compromise data quality, integrity, or defensibility.

17.0 WASTE MANAGEMENT

17.1 Waste streams from all laboratory operations are identified, segregated, and characterized. They are also profiled for disposal, drummed, and transfer by licensed hazardous waste haulers to licensed facilities.

17.2 All extracts received from the semi-volatile extractions department are kept by the analyst for 30-90 days, whereupon they are disposed of into the proper waste stream. Autosampler vials used during the analysis phase are also kept by each analyst. These are placed into boxes, sealed, labeled according, and given to our sample disposal custodian. At no time is any waste placed into any trash receptacle intended for land disposal.

17.3 Any disposable glassware used by the analysts, technicians, or preparation departments are kept in labeled boxes or trash bins. All syringes containing needles are placed in appropriate sharp containers. This is to ensure safety in their handling.

17.4 It is required that all water waste left over from the extractions department be placed in five gallons properly labeled containers. These containers are then emptied into drums in the waste disposal area. Only the sample disposal custodian or personnel trained in the disposal of hazardous waste are allowed into the sample disposal area. This disposal area is to remain locked at all times.

17.5 All glassware apparatus used in the preparation of semi-volatile organic analysis is stripped with a chlorinated solvent, followed by a through rinsing with acetone. They are then given to the glassware technician for washing. Acetone must be the last solvent used in the pre-cleaning stage to ensure no residual methylene chloride is placed into any sink.

17.6 Refer to the Standard Operation Procedure for Waste Disposal Practices and Emergency Response Plan for further information.

18.0 REFERENCES

18.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update III. EPA Method 8082, Rev. 2, December 1996.

18.2 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Update III. EPA Method 8000 B, Rev. 2, December 1996

18.3 USEPA Contract Laboratory Program, Statement of Work of Organics Analysis.

18.4 USEPA 40 CFR Part 136, Guidelines Establishing Procedures for the Analysis of Pollutants Under the CWA, Method 608, July 1, 1994.

18.5 Methods for the Determination of Organic Compounds in Drinking Water, Supplement III, USEPA, EPA Method 508, August 1995.

18.6 Department of Defense Quality Systems Manual for Environmental Laboratories, Version 2, DoD Environmental Data Quality Workshop, Department of Navy, Lead Service, June 2002.

APPENDIX

FORM 14.1

Response Factor Report GC-6

Method : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title : EPA 8080 PCB
Last Update : Wed Apr 13 08:27:56 2011

Calibration Files
.02 =12APR09.D .1 =12APR08.D .15 =12APR07.D
.25 =12APR06.D .35 =12APR05.D .5 =12APR04.D

	Compound	.02	.1	.15	.25	.35	.5	Avg		%RSD
8)	AML1AROCLOR 1260 - TOTA	2.119	2.628	2.808	2.950	3.329	3.441	2.879	E9	16.79
16)	JL6 AROCLOR 1016 - TOTA	1.106	1.197	1.230	1.222	1.360	1.418	1.256	E9	9.07
17)	AS DCB (Surrogate)	4.797	4.281	4.735	5.089	4.973	5.217	4.849	E9	6.82

Signal #2 Calibration Files
.02 =12APR09.D .1 =12APR08.D .15 =12APR07.D
.25 =12APR06.D .35 =12APR05.D .5 =12APR04.D

	Compound	.02	.1	.15	.25	.35	.5	Avg		%RSD
8)	AML1AROCLOR 1260 - TOTA	1.780	2.132	2.244	2.293	2.532	2.577	2.260	E9	12.86
16)	JL6 AROCLOR 1016 - TOTA	5.660	5.534	5.371	5.036	5.462	5.171	5.372	E8	4.33
17)	AS DCB (Surrogate)	4.158	3.772	4.041	4.309	4.059	4.024	4.061	E9	4.35

(#) = Out of Range
(*) = Linear regression (**) = Quadratic regression
8082PCB.M Wed Apr 13 15:08:08 2011 RPT1

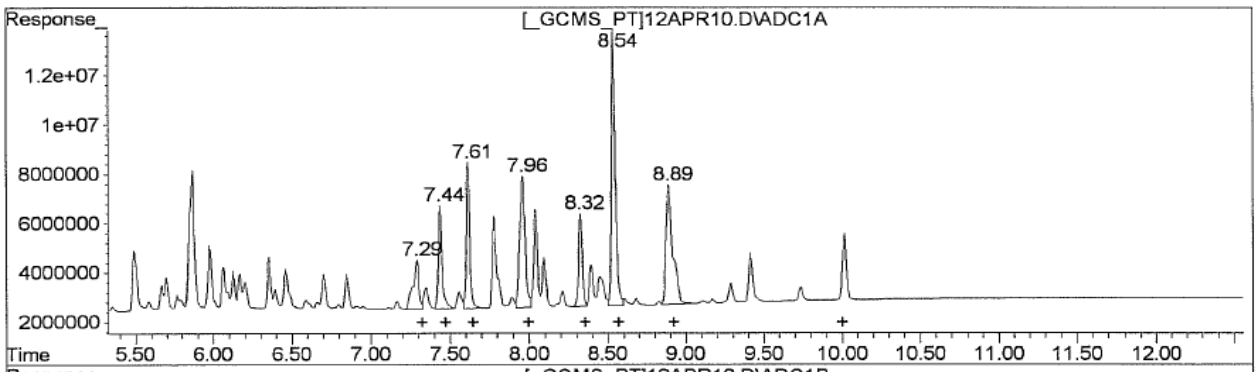
FORM 14.2 ICV Report

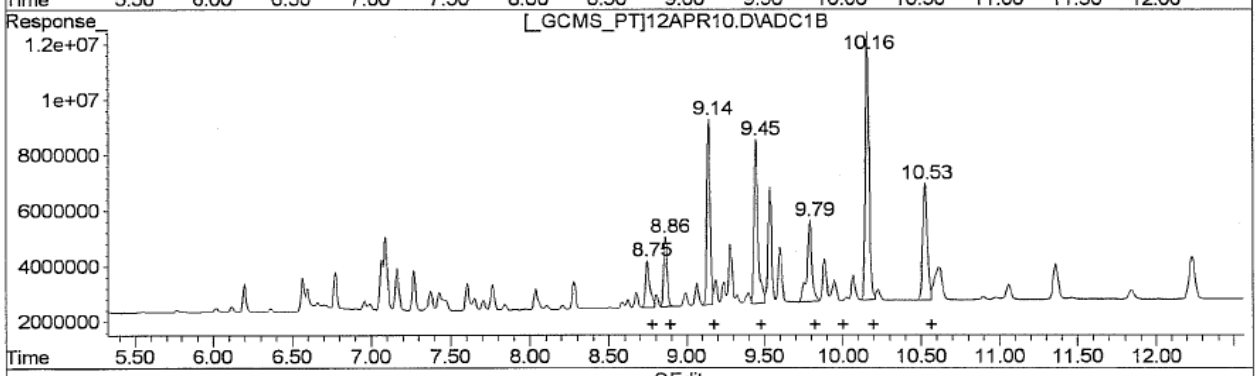
Quantitation Report

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR10.D\ADC1A.CH Vial: 10
Acq On    : 12 Apr 2011  10:12 pm                    Operator: VH1
Sample    : ICV1                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR10.D\ADC1B.CH Vial: 10
Acq On    : 12 Apr 2011  10:12 pm                    Operator: VH1
Sample    : ICV1                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : AUTOINT2.E
Quant Time: Apr 13  8:29 2011  Quant Results File: 8082PCB.RES


Method       : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Wed Apr 13 08:27:56 2011
Response via : Multiple Level Calibration
```





QEdit

(1) AROCLOR 1260 (1) (AML1)

R.T.	Response	Conc
7.29	51720408	0.26
7.44	59088853	0.24
7.62	54970043	0.25
7.96	128260383	0.25
8.32	62369502	0.25
8.54	196196071	0.27
8.89	143881827	0.25

(1) AROCLOR 1260 (1) #2 (AML1)

R.T.	Response	Conc
8.75	31322972	0.25
8.86	36812590	0.24
9.14	94256044	0.25
9.45	102230688	0.25
9.79	64867478	0.24
10.16	160045016	0.26
10.53	84003133	0.26

(+) = Expected Retention Time

12APR10.D 8082PCB.M Thu Apr 14 08:47:28 2011 RPT1

FORM 14.3

Evaluate Continuing Calibration Report

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1A.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1B.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : AUTOINT2.E

Method       : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Wed Apr 13 08:27:56 2011
Response via : Multiple Level Calibration

Min. RRF     :   0.000  Min. Rel. Area :  50%  Max. R.T. Dev  0.50min
Max. RRF Dev :  15%     Max. Rel. Area : 150%
```

Compound	Amount	Calc.	%Dev	Area%	Dev(Min)
8 AML1AROCLOR 1260 - TOTAL	0.250	0.264	-5.6	103	-10.00#
16 JL6 AROCLOR 1016 - TOTAL	0.250	0.251	-0.4	103	-3.00#
17 AS DCB (Surrogate)	0.010	0.011	-10.0	103	-0.03
Signal #2					
8 AML1AROCLOR 1260 - TOTAL	0.250	0.257	-2.8	101	-10.00#
16 JL6 AROCLOR 1016 - TOTAL	0.250	0.260	-4.0	111	-3.00#
17 AS DCB (Surrogate)	0.010	0.011	-10.0	102	-0.04

(#) = Out of Range SPCC's out = 0 CCC's out = 0

(*) = Linear regression (**) = Quadratic regression

12APR06.D 8082PCB.M Wed Apr 13 15:06:57 2011 RPT1

FORM 14.3

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1A.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1B.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : AUTOINT2.E
Quant Time: Apr 13  8:44 2011  Quant Results File: 8082PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Wed Apr 13 08:27:19 2011
Response via : Initial Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3uL
Signal #1 Phase  : Rtx-440 30M x .32 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : .32mm             Signal #2 Info : .32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
System Monitoring Compounds						
17) AS DCB (Surrogate)	10.02	12.25	52471447	44098626	0.0108	0.0109
Spiked Amount 0.010 Range 38 - 135 Recovery =					108.00%	109.00%
Target Compounds						
1) AML1 AROCLOR 1260 {1}	7.30	8.76	51540274	31587963	0.2581	0.2539
2) AML1 AROCLOR 1260 {2}	7.45	8.87	71054343	38955637	0.2510	0.2573
3) AML1 AROCLOR 1260 {3}	7.62	9.15	96625867	96883058	0.2593	0.2603m
4) AML1 AROCLOR 1260 {4}	7.97	9.45	132.4E6	105.5E6	0.2597	0.2577
5) AML1 AROCLOR 1260 {5}	8.33	9.80	64231514	56438662	0.2558	0.2126
6) AML1 AROCLOR 1260 {6}	8.55	10.17	196.5E6	165.7E6	0.2858	0.2704
7) AML1 AROCLOR 1260 {7}	8.90	10.54	147.9E6	86045149	0.2572	0.2658
8) AML1 AROCLOR 1260 - T	0.00	0.00	760.2E6	581.2E6	0.2641m	0.2572m
9) JL6 AROCLOR 1016 {1}	5.15	6.21	23949865	14856682	0.2364	0.2500
10) JL6 AROCLOR 1016 {2}	5.49	6.57	51901133	19067424	0.2415	0.2484m
11) JL6 AROCLOR 1016 {3}	5.67	6.78	14906222	20675381	0.2524m	0.2455
12) JL6 AROCLOR 1016 {4}	5.87	7.08	126.2E6	29845380	0.2572	0.3076m
13) JL6 AROCLOR 1016 {5}	6.07	7.28	33656938	21810482	0.2644	0.2508
14) JL6 AROCLOR 1016 {6}	6.36	7.62	30721284	16661400	0.2531m	0.2497
15) JL6 AROCLOR 1016 {7}	6.47	7.78	34257558	16914230	0.2435	0.2559
16) JL6 AROCLOR 1016 - T	0.00	0.00	315.6E6	139.8E6	0.2514m	0.2603m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
12APR22.D 8082PCB.M Wed Apr 13 15:06:41 2011 RPT1 Page 1

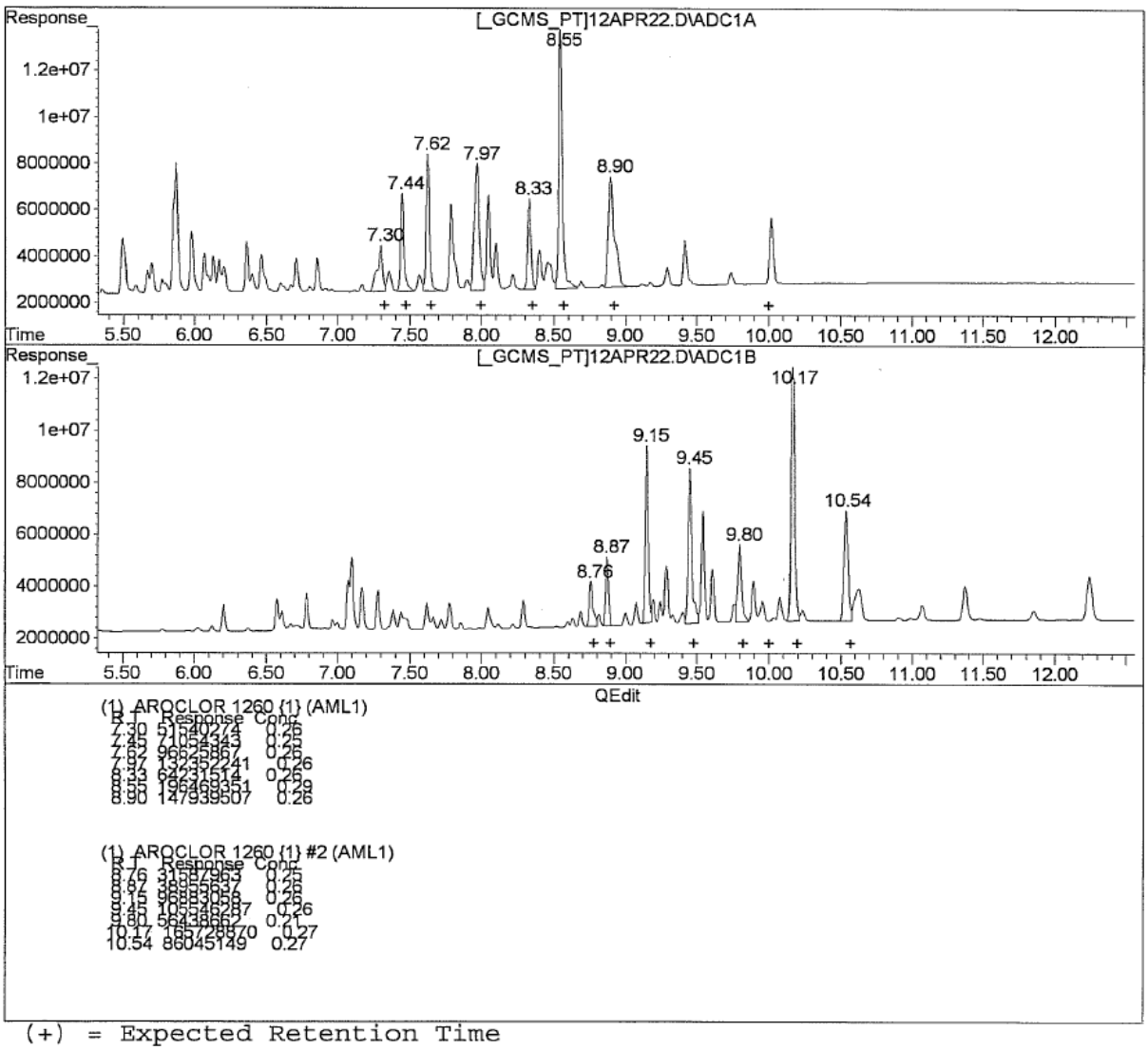
FORM 14.3

Quantitation Report

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1A.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR22.D\ADC1B.CH Vial: 22
Acq On    : 13 Apr 2011   1:32 am                    Operator: VH1
Sample    : CCV2                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13  8:44 2011  Quant Results File: 8082PCB.RES


Method       : C:\HPCHEM\3\METHODS\1268PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:03:43 2011
Response via : Multiple Level Calibration
```



(+) = Expected Retention Time

12APR22.D 1268PCB.M Wed Apr 13 15:04:51 2011 RPT1

FORM 14.4 QT Report

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR16.D\ADC1A.CH Vial: 16
Acq On    : 12 Apr 2011  11:52 pm                    Operator: VH1
Sample    : 1105356-02                               Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR16.D\ADC1B.CH Vial: 16
Acq On    : 12 Apr 2011  11:52 pm                    Operator: VH1
Sample    : 1105356-02                               Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : AUTOINT2.E
Quant Time: Apr 13  8:40 2011  Quant Results File: 8082PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Wed Apr 13 08:27:19 2011
Response via : Initial Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3uL
Signal #1 Phase : Rtx-440 30M x .32 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info  : .32mm             Signal #2 Info : .32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
System Monitoring Compounds						
17) AS DCB (Surrogate)	10.03	12.25	45553379	38715602	0.0094	0.0095
Spiked Amount 0.010	Range 38 - 135		Recovery =		94.00%	95.00%
Target Compounds						
1) AML1 AROCLOR 1260 {1}	0.00	0.00	0	0	N.D. d	N.D. d
2) AML1 AROCLOR 1260 {2}	0.00	0.00	0	0	N.D. d	N.D. d
3) AML1 AROCLOR 1260 {3}	0.00	0.00	0	0	N.D. d	N.D. d
4) AML1 AROCLOR 1260 {4}	0.00	0.00	0	0	N.D. d	N.D. d
5) AML1 AROCLOR 1260 {5}	0.00	0.00	0	0	N.D. d	N.D. d
6) AML1 AROCLOR 1260 {6}	0.00	0.00	0	0	N.D. d	N.D. d
7) AML1 AROCLOR 1260 {7}	0.00	0.00	0	0	N.D. d	N.D. d
8) AML1 AROCLOR 1260 - T	0.00	0.00	0	0	N.D. d	N.D. d
9) JL6 AROCLOR 1016 {1}	0.00	0.00	0	0	N.D. d	N.D. d
10) JL6 AROCLOR 1016 {2}	0.00	0.00	0	0	N.D. d	N.D. d
11) JL6 AROCLOR 1016 {3}	0.00	0.00	0	0	N.D. d	N.D. d
12) JL6 AROCLOR 1016 {4}	0.00	0.00	0	0	N.D. d	N.D. d
13) JL6 AROCLOR 1016 {5}	0.00	0.00	0	0	N.D. d	N.D. d
14) JL6 AROCLOR 1016 {6}	0.00	0.00	0	0	N.D. d	N.D. d
15) JL6 AROCLOR 1016 {7}	0.00	0.00	0	0	N.D. d	N.D. d
16) JL6 AROCLOR 1016 - T	0.00	0.00	0	0	N.D. d	N.D. d

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
12APR16.D 8082PCB.M Thu Apr 14 08:55:47 2011 RPT1 Page 1

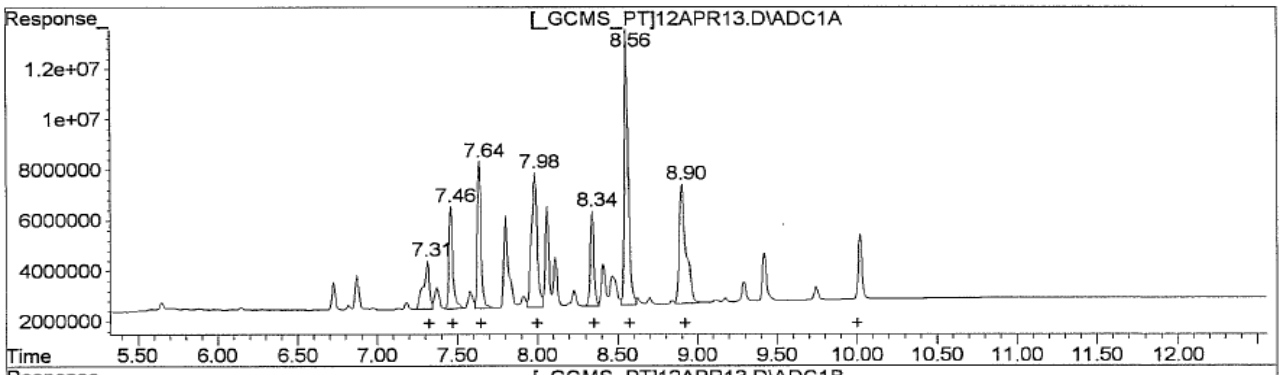
FORM 14.5 LCS

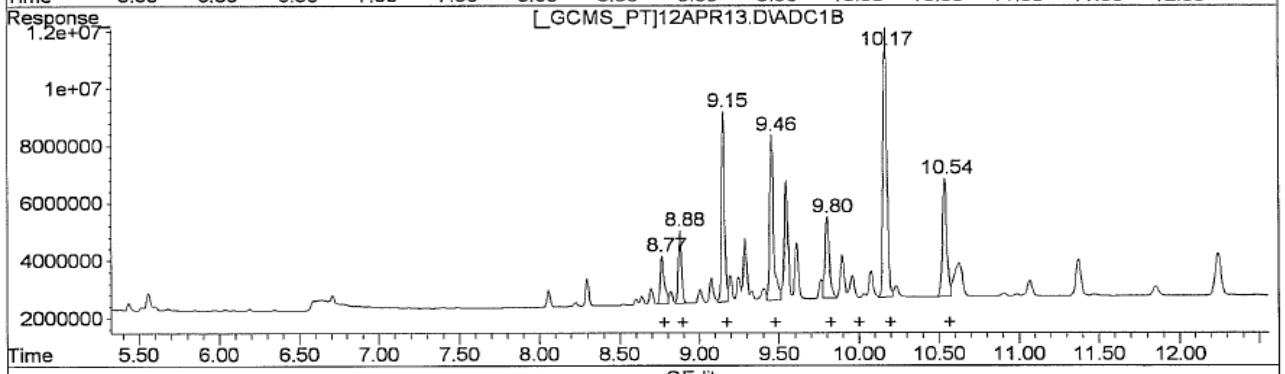
Quantitation Report

```
Data File : D:\DATA\GC6\APR2011\APR12A\12APR13.D\ADC1A.CH Vial: 13
Acq On    : 12 Apr 2011  11:02 pm                    Operator: VH1
Sample    : B1-BS1                                   Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\APR2011\APR12A\12APR13.D\ADC1B.CH Vial: 13
Acq On    : 12 Apr 2011  11:02 pm                    Operator: VH1
Sample    : B1-BS1                                   Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : AUTOINT2.E
Quant Time: Apr 13  8:38 2011  Quant Results File: 8082PCB.RES


Method       : C:\HPCHEM\3\METHODS\8082PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Wed Apr 13 08:27:56 2011
Response via : Multiple Level Calibration
```





QEdit

(1) AROCLOR 1260 (1) (AML1)

RT	Response	Conc
7.31	49319271	0.25
7.46	67881666	0.24
7.64	92424183	0.25
7.98	126713304	0.25
8.34	61400258	0.24
8.56	181943884	0.26
8.91	140466611	0.24

(1) AROCLOR 1260 (1) #2 (AML1)

RT	Response	Conc
8.77	30250266	0.24
8.88	37245659	0.25
9.16	93872765	0.25
9.46	101276422	0.25
9.81	54283735	0.25
10.17	158831456	0.26
10.54	82653930	0.26

(+) = Expected Retention Time

12APR13.D 8082PCB.M Thu Apr 14 08:46:50 2011 RPT1

FORM 14.6

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1A.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                    Operator: VH1
Sample    : 1221                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1B.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                    Operator: VH1
Sample    : 1221                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:27 2011  Quant Results File: 1221PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1221PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:32:32 2011
Response via : Continuing Cal File: D:\DATA\GC6\APR2011\APR02A\02APR03.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase : Rtx-440 30M x .32 Signal #2 Phase: Rtx-CLpesticides2 30
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1221 {1}	3.55f	4.74f	8586900	4459600	1.6421m	0.7429m#
2) AML1 AROCLOR 1221 {2}	4.26f	5.55f	13813704	7328722	0.2820m	0.2945m
3) AML1 AROCLOR 1221 {3}	4.38f	5.64f	8137660	6128970	0.6284m	1.0904m#
4) AML1 AROCLOR 1221 {4}	4.43f	5.72f	34803248	20835970	1.4116m	1.9441m
5) AML1 AROCLOR 1221 {5}	4.76f	6.21f	5166764	2392522	0.0829m	0.0668m
6) AML1 AROCLOR 1221 {6}	5.13f	6.56f	6440012	2810468	0.1923m	0.1119m#
7) AML1 AROCLOR 1221 {7}	5.23f	6.63f	3265878	2339916	0.0177m	0.0261m
8) AML1 AROCLOR 1221 - T	0.00	0.00	80214166	46296168	0.2153m	0.2341m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB19.D 1221PCB.M Wed Apr 13 14:27:11 2011 RPT1 Page 1

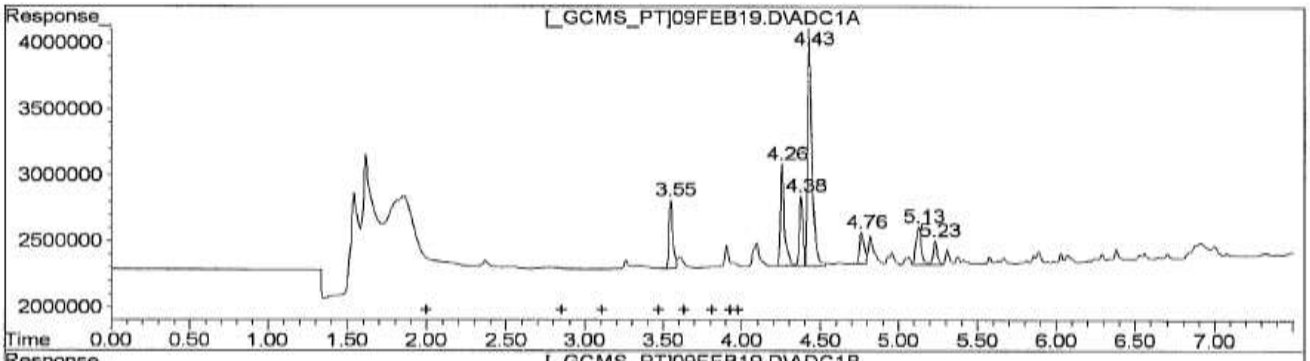
FORM 14.6

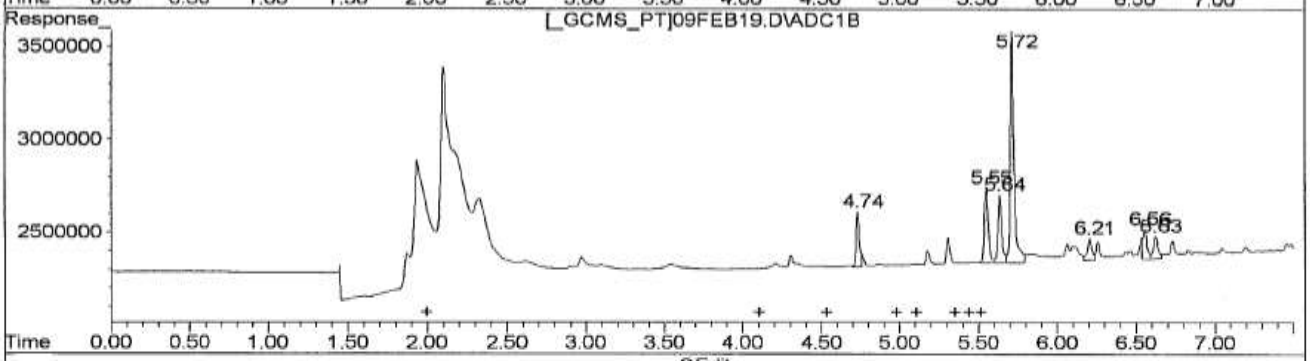
Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1A.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                        Operator: VH1
Sample    : 1221                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1B.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                        Operator: VH1
Sample    : 1221                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:23 2011  Quant Results File: 1221PCB.RES

Method       : C:\HPCHEM\3\METHODS\1221PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:32:32 2011
Response via : Single Level Calibration
```





QEdit

(1) AROCLOR 1221 (1) #2 (AML1)

R.T.	Response	Conc
3.55	8586900	1.64
4.26	13813704	0.28
4.38	8137660	0.63
4.43	34803248	1.41
4.76	5166764	0.08
5.13	6440012	0.19
5.23	3265878	0.02

(1) AROCLOR 1221 (1) #2 (AML1)

R.T.	Response	Conc
4.74	4458600	0.74
5.55	7328722	0.29
5.64	6128970	1.09
5.72	20835970	1.94
6.21	2392522	0.07
6.56	2810468	0.11
6.63	2339916	0.03

(+) = Expected Retention Time

09FEB19.D 1221PCB.M Wed Apr 13 14:27:03 2011 RPT1

FORM 14.6

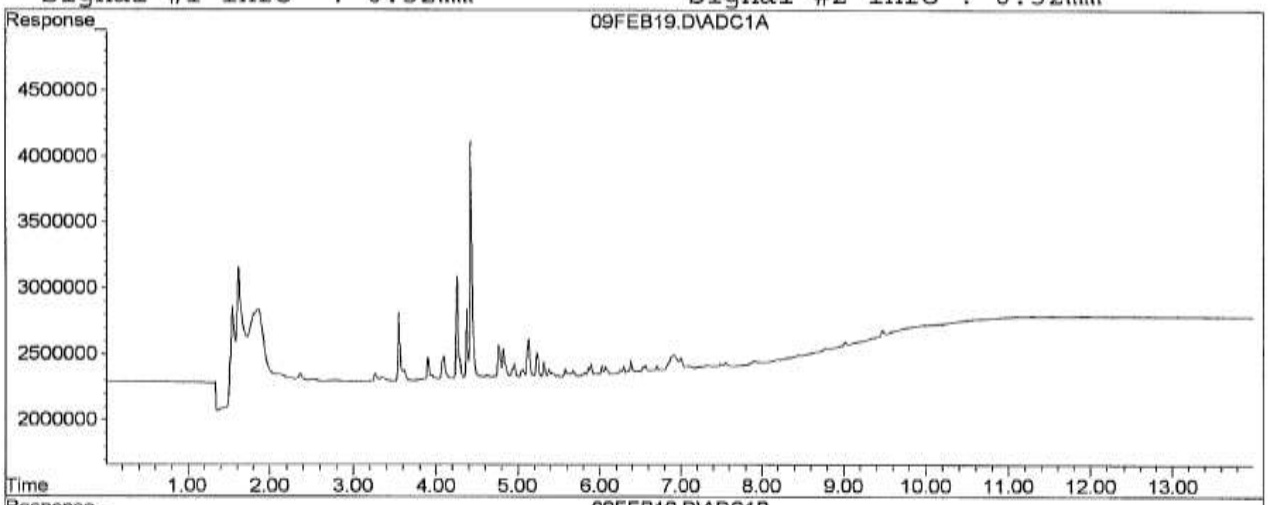
Quantitation Report

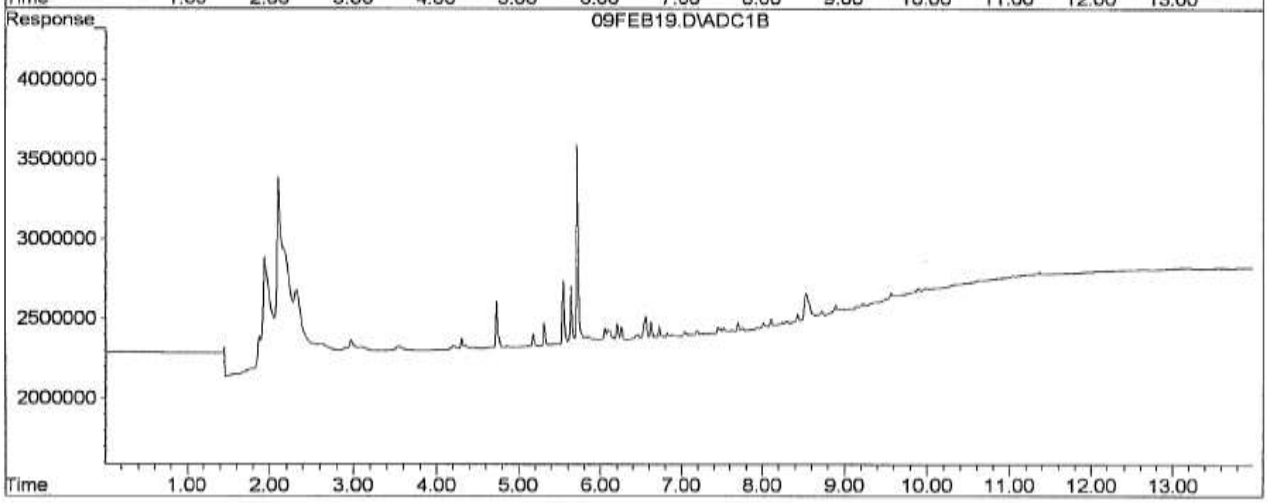
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1A.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                    Operator: VH1
Sample    : 1221                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB19.D\ADC1B.CH Vial: 19
Acq On    :  9 Feb 2011   1:28 pm                    Operator: VH1
Sample    : 1221                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:27 2011  Quant Results File: 1221PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1221PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:32:32 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30M x .32 Signal #2 Phase: Rtx-CLpesticides2
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```





09FEB19.D 1221PCB.M Wed Apr 13 14:27:13 2011 RPT1 Page 2

FORM 14.7

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1A.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                    Operator: VH1
Sample    : 1232                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1B.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                    Operator: VH1
Sample    : 1232                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:35 2011  Quant Results File: 1232PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1232PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 11:29:16 2011
Response via : Continuing Cal File: D:\DATA\GC6\MAR2011\MAR28A\28MAR37.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1232 {1}	4.39f	5.68f	23505316	12640810	0.1932m	0.2559m
2) AML1 AROCLOR 1232 {2}	4.73f	6.22f	21161546	6865100	0.2478m	0.1827m
3) AML1 AROCLOR 1232 {3}	5.10f	6.53f	43548556	21898190	0.2697m	0.2509m
4) AML1 AROCLOR 1232 {4}	5.55f	7.01f	14605586	6921292	0.1172m	0.2200m#
5) AML1 AROCLOR 1232 {5}	5.64f	7.16f	17315858	8167158	0.2395m	0.3093m
6) AML1 AROCLOR 1232 {6}	5.83f	7.50f	13963368	7871574	0.0885m	0.1592m#
7) AML1 AROCLOR 1232 {7}	6.04f	7.67f	19099484	7584486	0.1983m	0.2668m
8) AML1 AROCLOR 1232 - T	0.00	0.00	153.2E6	71948610	0.1870m	0.2321m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB20.D 1232PCB.M Wed Apr 13 14:35:13 2011 RPT1 Page 1

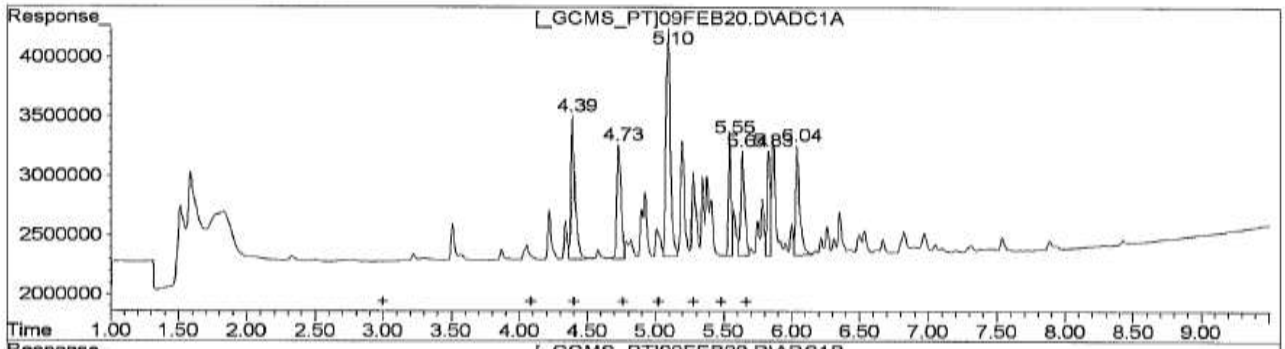
FORM 14.7

Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1A.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                        Operator: VH1
Sample    : 1232                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1B.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                        Operator: VH1
Sample    : 1232                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:29 2011  Quant Results File: 1232PCB.RES

Method        : C:\HPCHEM\3\METHODS\1232PCB.M (Chemstation Integrator)
Title         : EPA 8080 PCB
Last Update   : Sat Apr 02 11:29:16 2011
Response via  : Single Level Calibration
```



(1) AROCLOR 1232 (1) #2 (AML1)

R.T.	Response	Conc.
4.39	23505316	0.19
4.73	21161546	0.25
5.10	43548556	0.27
5.55	14605586	0.12
5.84	17315968	0.24
5.83	13963368	0.09
6.04	19099484	0.20

(1) AROCLOR 1232 (1) #2 (AML1)

R.T.	Response	Conc.
5.68	12640810	0.26
6.22	6865100	0.18
6.53	21898190	0.25
7.01	6921292	0.22
7.16	8167158	0.31
7.50	7871574	0.16
7.67	7584486	0.27

(+) = Expected Retention Time

09FEB20.D 1232PCB.M Wed Apr 13 14:35:02 2011 RPT1

FORM 14.7

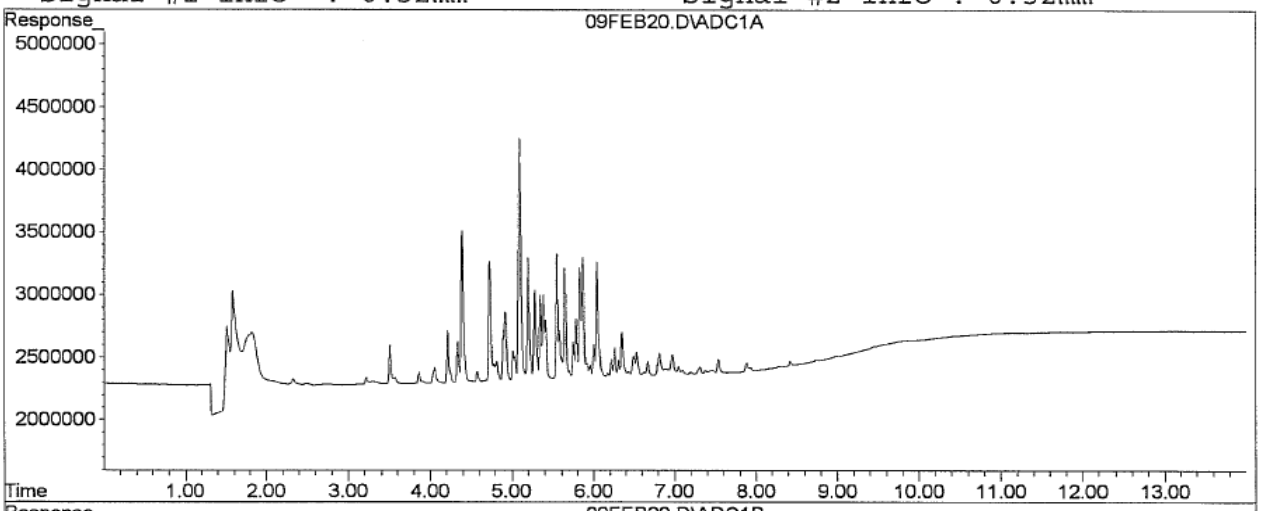
Quantitation Report

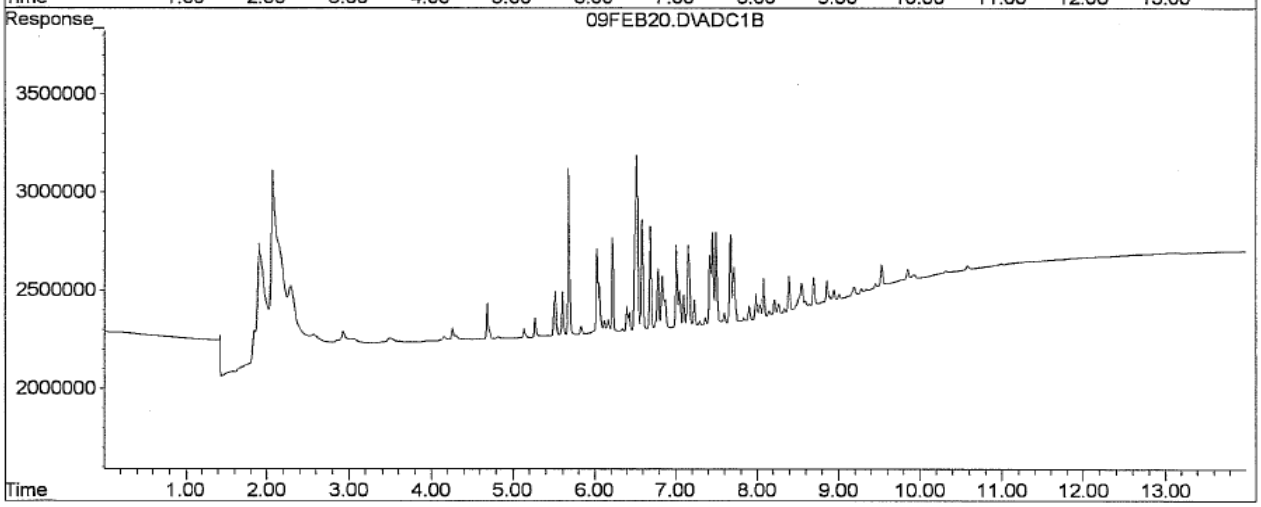
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1A.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                    Operator: VH1
Sample    : 1232                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB20.D\ADC1B.CH Vial: 20
Acq On    :  9 Feb 2011   1:45 pm                    Operator: VH1
Sample    : 1232                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:35 2011  Quant Results File: 1232PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1232PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 11:29:16 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.     : 3UL
Signal #1 Phase : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 3
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```





09FEB20.D 1232PCB.M Wed Apr 13 14:35:14 2011 RPT1 Page 2

FORM 14.8

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1A.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                        Operator: VH1
Sample    : 1242                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1B.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                        Operator: VH1
Sample    : 1242                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:40 2011  Quant Results File: 1242PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1242PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Mon Apr 11 15:05:07 2011
Response via : Continuing Cal File: D:\DATA\GC6\APR2011\APR11A\11APR04.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1242 {1}	4.39f	5.67f	20514822	11107294	0.2502m	0.2344m
2) AML1 AROCLOR 1242 {2}	4.73f	6.22f	40183912	12735812	0.2593m	0.2109m
3) AML1 AROCLOR 1242 {3}	5.09f	6.52f	92200068	42575182	0.2696m	0.6835m#
4) AML1 AROCLOR 1242 {4}	5.27f	6.69f	28111260	14806032	0.3131m	0.2386m
5) AML1 AROCLOR 1242 {5}	5.54f	7.00f	25788038	12490814	0.2819m	0.2533m
6) AML1 AROCLOR 1242 {6}	5.64f	7.15f	32092812	14352686	0.2643m	0.2363m
7) AML1 AROCLOR 1242 {7}	6.04f	7.67f	38367488	13018294	0.4105m	0.1885m#
8) AML1 AROCLOR 1242 - T	0.00	0.00	277.3E6	121.1E6	0.2844m	0.2945m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB21.D 1242PCB.M Wed Apr 13 14:40:29 2011 RPT1 Page 1

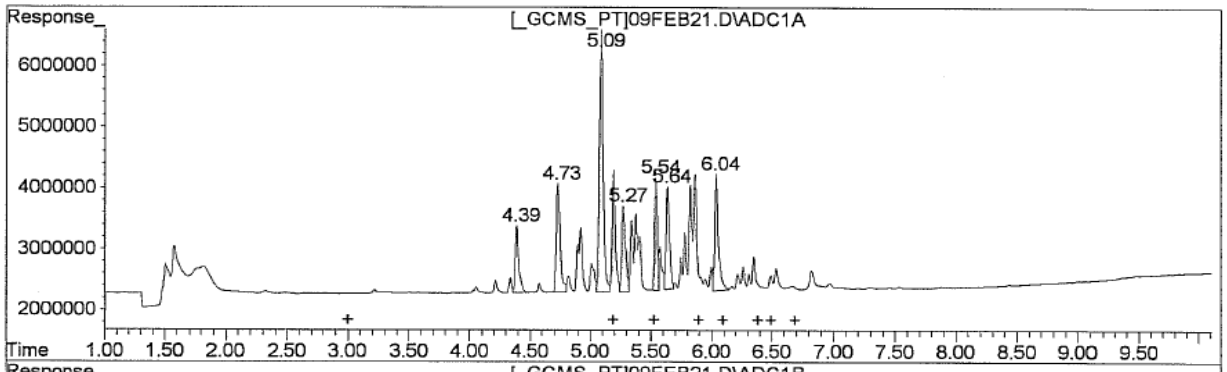
FORM 14.8

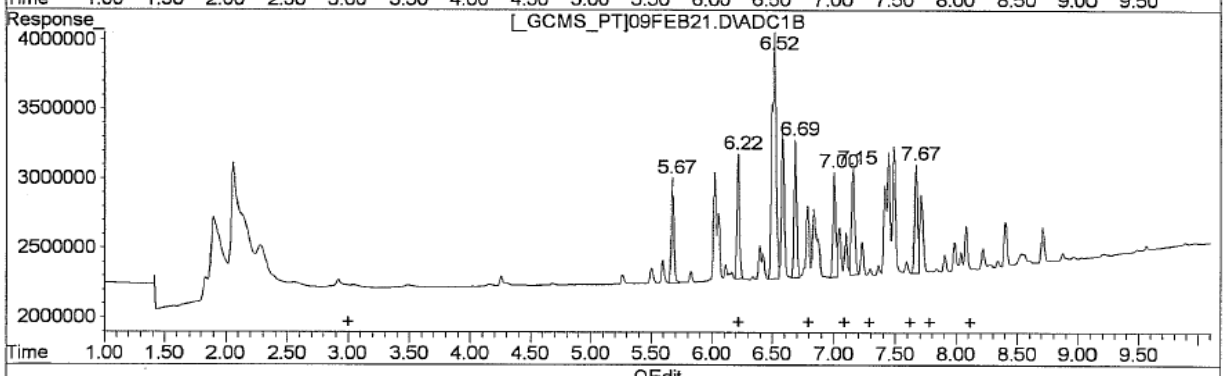
Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1A.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                       Operator: VH1
Sample    : 1242                                        Inst    : GC-6
Misc      :                                             Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1B.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                       Operator: VH1
Sample    : 1242                                        Inst    : GC-6
Misc      :                                             Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:37 2011  Quant Results File: 1242PCB.RES


Method       : C:\HPCHEM\3\METHODS\1242PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Mon Apr 11 15:05:07 2011
Response via : Single Level Calibration
```





QEdit

(1) AROCLOR 1242 (1) #2 (AML1)

R.T.	Response	Conc
4.39	20574827	0.25
4.73	40183912	0.26
5.09	92200068	0.27
5.27	28111260	0.31
5.54	25788038	0.28
5.64	32092812	0.26
6.04	38367488	0.41

(1) AROCLOR 1242 (1) #2 (AML1)

R.T.	Response	Conc
5.67	11107294	0.23
6.22	12735512	0.21
6.52	42575182	0.68
6.69	14806032	0.24
7.00	12390814	0.25
7.15	14356886	0.24
7.67	13018294	0.19

(+) = Expected Retention Time

09FEB21.D 1242PCB.M Wed Apr 13 14:40:17 2011 RPT1

FORM **14.8**

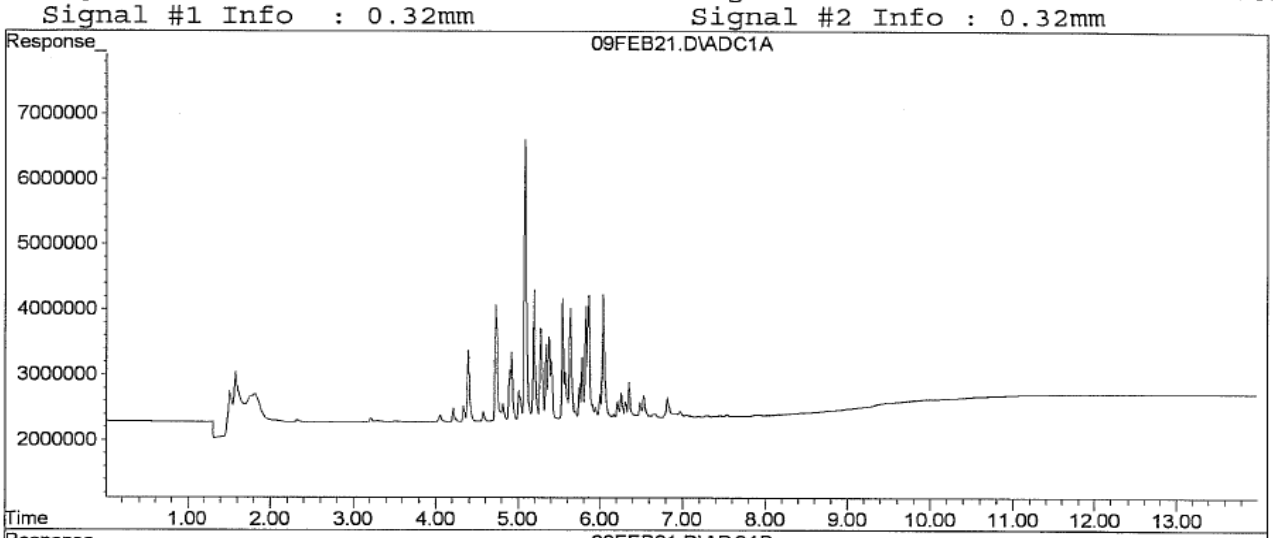
Quantitation Report

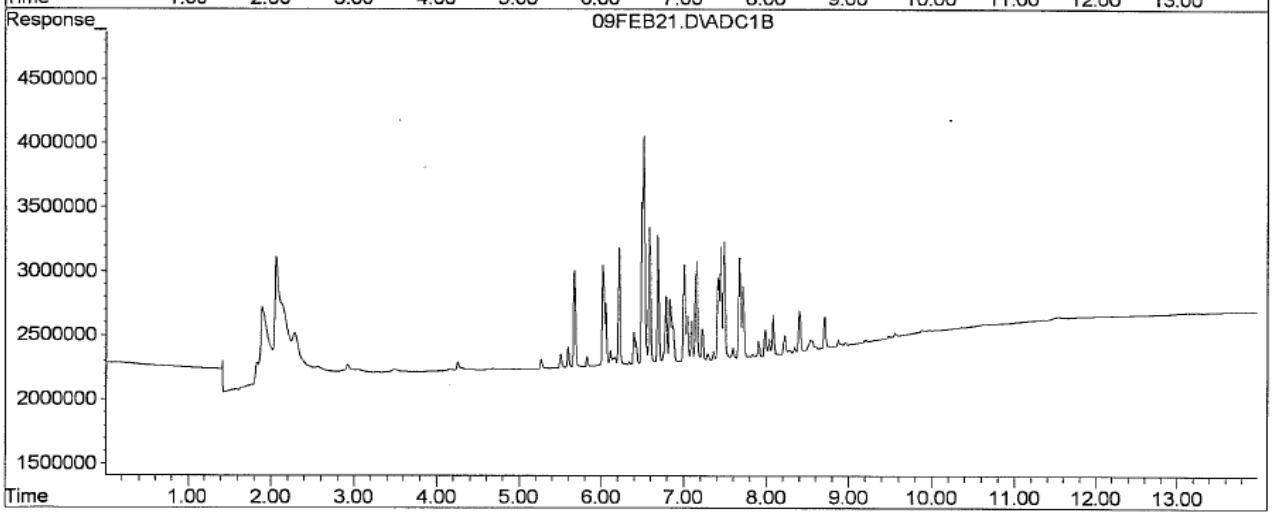
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1A.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                    Operator: VH1
Sample    : 1242                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB21.D\ADC1B.CH Vial: 21
Acq On    :  9 Feb 2011   2:02 pm                    Operator: VH1
Sample    : 1242                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:40 2011  Quant Results File: 1242PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1242PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Mon Apr 11 15:05:07 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 3
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```





)9FEB21.D 1242PCB.M Wed Apr 13 14:40:30 2011 RPT1 Page 2

FORM **14.9**

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1A.CH Vial: 22
Acq On    :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample    : 1248                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1B.CH Vial: 22
Acq On    :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample    : 1248                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:47 2011  Quant Results File: 1248PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1248PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 12:34:56 2011
Response via : Continuing Cal File: D:\DATA\GC6\MAR2011\MAR30A\30MAR10.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1248 {1}	4.74	6.04f	19313262	6444172	0.0871m	0.0456m#
2) AML1 AROCLOR 1248 {2}	5.11f	6.52f	53105000	13518172	0.1294m	0.1827m
3) AML1 AROCLOR 1248 {3}	5.56f	7.03f	44850328	19695154	0.1761m	0.2045m
4) AML1 AROCLOR 1248 {4}	5.65f	7.18f	51398178	20221904	0.0916m	0.2012m#
5) AML1 AROCLOR 1248 {5}	5.84f	7.44f	48548098	18695766	0.1435m	0.0822m#
6) AML1 AROCLOR 1248 {6}	6.06f	7.69f	69541592	26440608	0.4646m	0.2022m#
7) AML1 AROCLOR 1248 {7}	6.37f	8.10f	27600228	15108632	0.2740m	0.2031m
8) AML1 AROCLOR 1248 - T	0.00	0.00	314.4E6	120.1E6	0.1543m	0.1422m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB22.D 1248PCB.M Wed Apr 13 14:47:47 2011 RPT1 Page 1

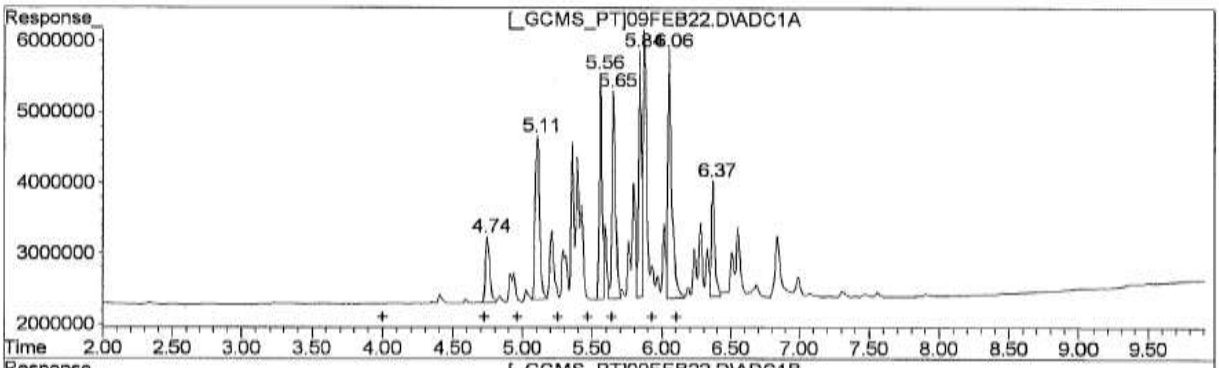
FORM **14.9**

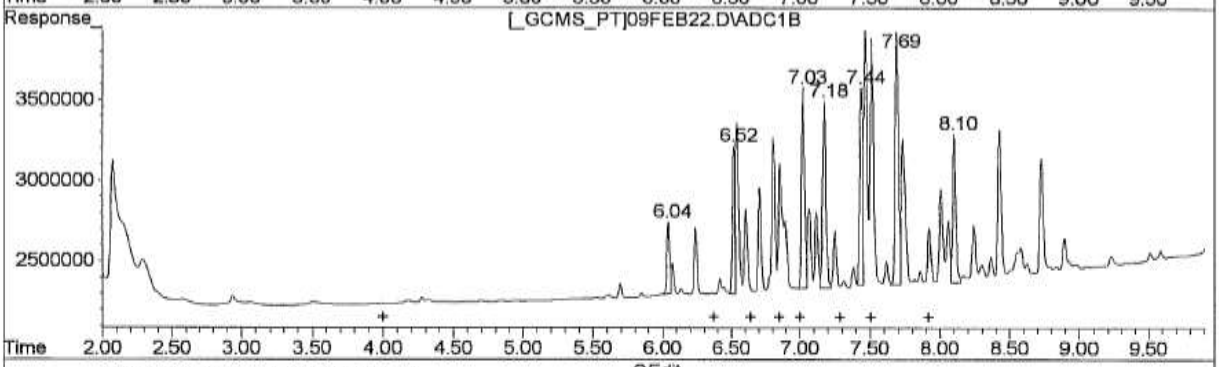
Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1A.CH Vial: 22
Acq On    :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample    : 1248                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1B.CH Vial: 22
Acq On    :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample    : 1248                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:42 2011  Quant Results File: 1248PCB.RES


Method       : C:\HPCHEM\3\METHODS\1248PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 12:34:56 2011
Response via : Single Level Calibration
```





QEdit

(1) AROCLOR 1248 (1) #2 (AML1)

R.T.	Response	Conc
4.74	19313252	0.09
5.11	53105000	0.13
5.56	44850328	0.18
5.65	51398178	0.09
5.84	48548098	0.14
6.06	69541592	0.46
6.37	27600228	0.27

(1) AROCLOR 1248 (1) #2 (AML1)

R.T.	Response	Conc
6.04	5444172	0.05
6.52	13518172	0.18
7.03	18695154	0.20
7.18	20221904	0.20
7.44	18695766	0.08
7.69	26440608	0.20
8.10	15108632	0.20

(+) = Expected Retention Time

09FEB22.D 1248PCB.M Wed Apr 13 14:47:39 2011 RPT1

FORM **14.9**

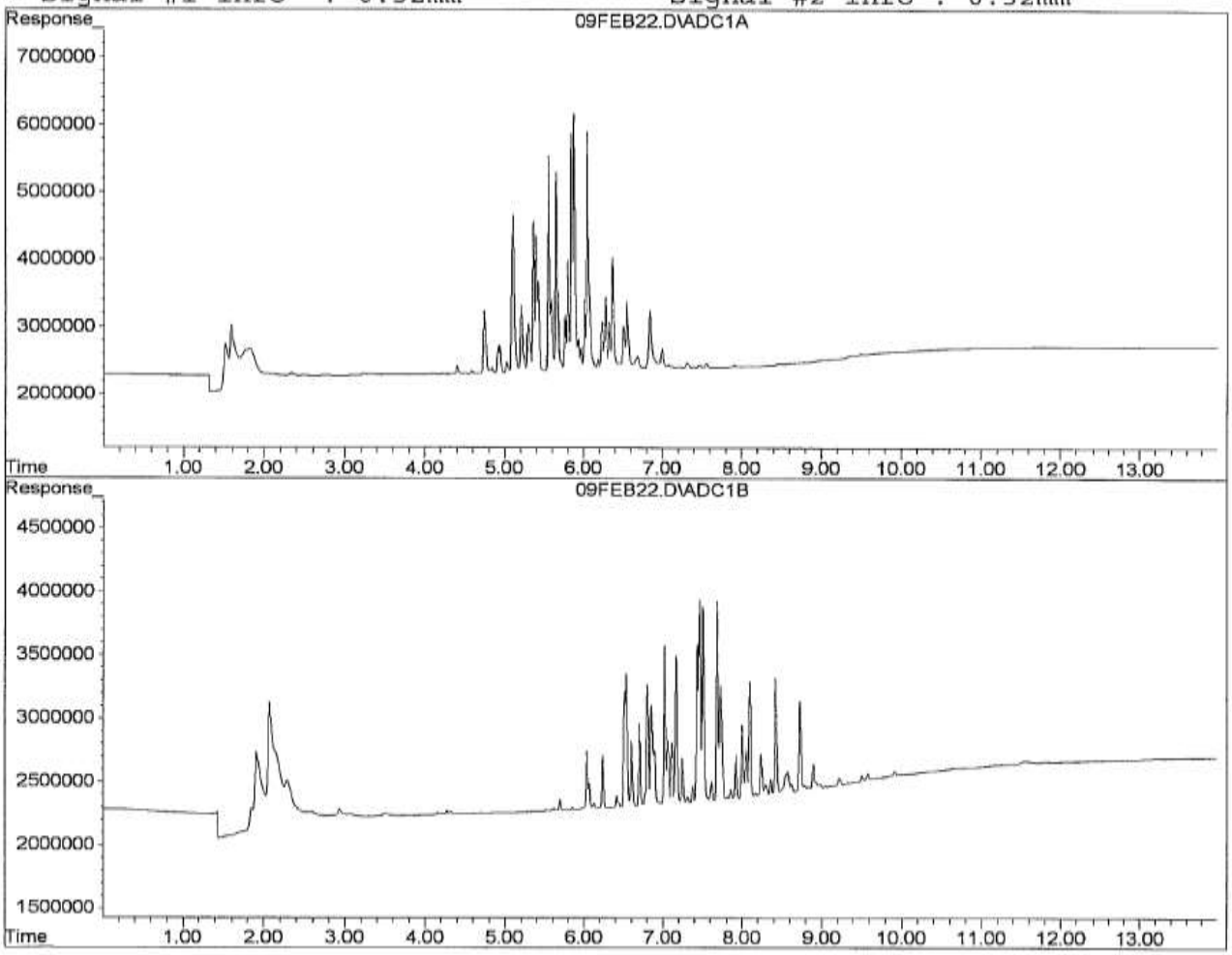
Quantitation Report

```
Data File  : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1A.CH Vial: 22
Acq On     :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample     : 1248                                      Inst     : GC-6
Misc       :                                           Multiplr: 1.00
IntFile    : 8080PCB.E

Data File  : D:\DATA\GC6\FEB2011\FEB09\09FEB22.D\ADC1B.CH Vial: 22
Acq On     :  9 Feb 2011   2:19 pm                    Operator: VH1
Sample     : 1248                                      Inst     : GC-6
Misc       :                                           Multiplr: 1.00
IntFile    : autoint2.e
Quant Time: Apr 13 14:47 2011  Quant Results File: 1248PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1248PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 12:34:56 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 3
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```



)9FEB22.D 1248PCB.M Wed Apr 13 14:47:48 2011 RPT1 Page 2

FORM **14.10**

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1A.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                    Operator: VH1
Sample    : 1254                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1B.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                    Operator: VH1
Sample    : 1254                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:53 2011  Quant Results File: 1254PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1254PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 12:41:58 2011
Response via : Continuing Cal File: D:\DATA\GC6\MAR2011\MAR30A\30MAR11.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1254 {1}	5.36f	6.82f	25394370	11070336	0.1756m	0.0714m#
2) AML1 AROCLOR 1254 {2}	5.88f	7.45	72109938	32425886	0.2068m	0.1693m
3) AML1 AROCLOR 1254 {3}	6.02f	7.70f	58594892	37424764	0.2374m	0.1569m#
4) AML1 AROCLOR 1254 {4}	6.29f	8.11f	44811414	45443052	0.0972m	0.1609m#
5) AML1 AROCLOR 1254 {5}	6.38f	8.43	103.3E6	49298994	0.2176m	0.2331m
6) AML1 AROCLOR 1254 {6}	6.56f	8.59	68055382	38041104	0.2303m	0.2202m
7) AML1 AROCLOR 1254 {7}	7.00f	8.91f	103.2E6	62436514	0.2114m	0.1790m
8) AML1 AROCLOR 1254 - T	0.00	0.00	475.5E6	276.1E6	0.1933m	0.1725m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB23.D 1254PCB.M Wed Apr 13 14:54:00 2011 RPT1 Page 1

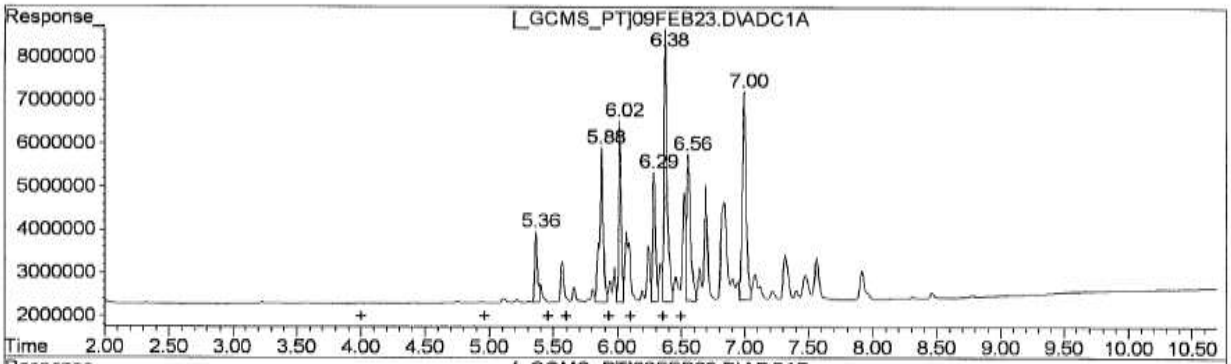
FORM **14.10**

Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1A.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                    Operator: VH1
Sample    : 1254                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1B.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                    Operator: VH1
Sample    : 1254                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:48 2011  Quant Results File: 1254PCB.RES


Method        : C:\HPCHEM\3\METHODS\1254PCB.M (Chemstation Integrator)
Title         : EPA 8080 PCB
Last Update   : Sat Apr 02 12:41:58 2011
Response via  : Single Level Calibration
```



(1) AROCLOR 1254 (1) #2 (AML1)

R.T.	Response	Conc
5.36	25394370	0.18
5.88	72109938	0.21
6.02	58594892	0.24
6.29	44811414	0.10
6.38	103325490	0.22
6.56	68055382	0.23
7.00	103238872	0.21

(1) AROCLOR 1254 (1) #2 (AML1)

R.T.	Response	Conc
6.82	11070336	0.07
7.45	32425886	0.17
7.70	37424764	0.16
8.11	45443052	0.16
8.43	49298994	0.23
8.59	38041104	0.22
8.91	62436514	0.18

(+) = Expected Retention Time

09FEB23.D 1254PCB.M Wed Apr 13 14:53:51 2011 RPT1

FORM **14.10**

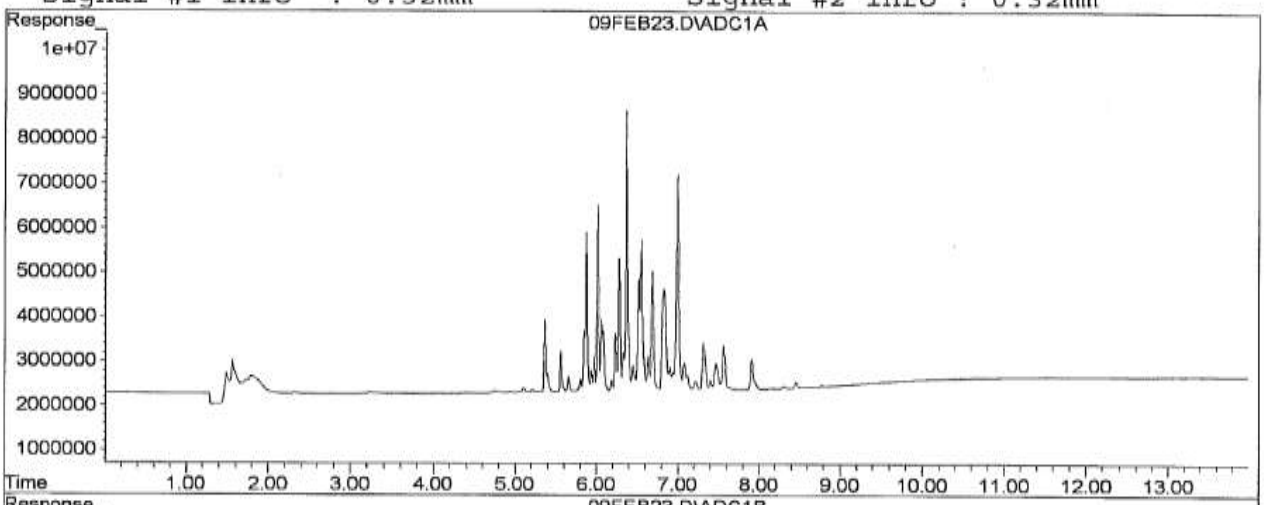
Quantitation Report

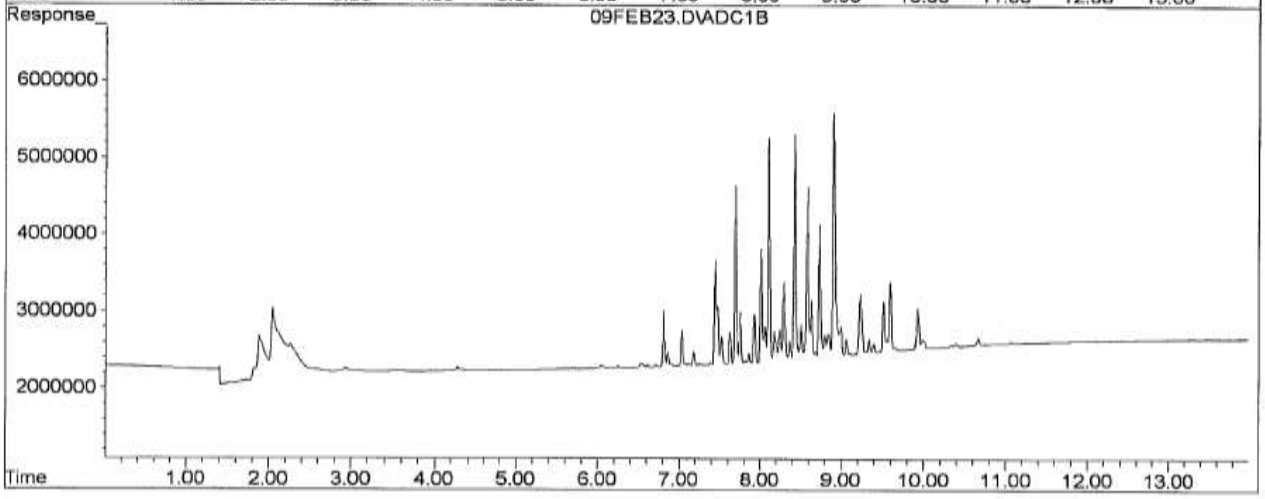
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1A.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                      Operator: VH1
Sample    : 1254                                       Inst    : GC-6
Misc      :                                            Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB23.D\ADC1B.CH Vial: 23
Acq On    :  9 Feb 2011   2:35 pm                      Operator: VH1
Sample    : 1254                                       Inst    : GC-6
Misc      :                                            Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:53 2011  Quant Results File: 1254PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1254PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 12:41:58 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 3
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```





)9FEB23.D 1254PCB.M Wed Apr 13 14:54:01 2011 RPT1 Page 2

FORM **14.11**

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1A.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                    Operator: VH1
Sample    : 1262                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1B.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                    Operator: VH1
Sample    : 1262                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:58 2011  Quant Results File: 1262PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1262PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 09:34:57 2011
Response via : Continuing Cal File: D:\DATA\GC6\APR2011\APR01A\01APR11.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1262 {1}	6.52f	8.57f	56024546	55424994	0.4257m	0.4056m
2) AML1 AROCLOR 1262 {2}	6.68f	8.88f	71435404	49511686	0.3173m	0.3537m
3) AML1 AROCLOR 1262 {3}	7.06f	8.97f	116.3E6	96893982	0.2292m	0.3696m#
4) AML1 AROCLOR 1262 {4}	7.32f	9.22f	95642310	62990442	0.2371m	0.1517m#
5) AML1 AROCLOR 1262 {5}	7.55f	9.55f	247.6E6	174.7E6	0.2351m	0.1756m
6) AML1 AROCLOR 1262 {6}	7.89f	9.87f	157.2E6	103.8E6	0.1343m	0.1943m
7) AML1 AROCLOR 1262 {7}	8.44f	10.61f	75679940	49626668	0.2261m	0.2014m
8) AML1 AROCLOR 1262 - T	0.00	0.00	819.8E6	592.9E6	0.2143m	0.2173m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB24.D 1262PCB.M Wed Apr 13 14:58:34 2011 RPT1 Page 1

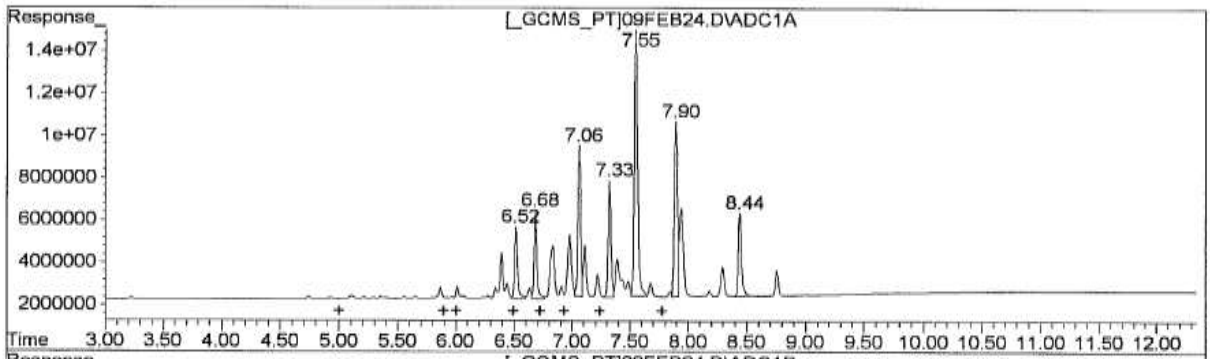
FORM **14.11**

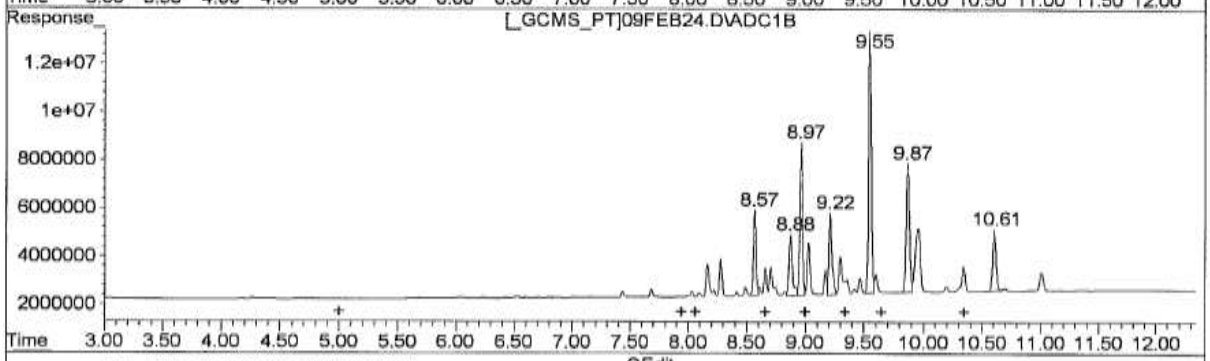
Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1A.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                      Operator: VH1
Sample    : 1262                                       Inst    : GC-6
Misc      :                                            Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1B.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                      Operator: VH1
Sample    : 1262                                       Inst    : GC-6
Misc      :                                            Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:55 2011  Quant Results File: 1262PCB.RES

Method       : C:\HPCHEM\3\METHODS\1262PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 09:34:57 2011
Response via : Single Level Calibration
```





QEdit

(1) AROCLOR 1262 (1) #2 (AML1)

R.T.	Response	Conc
6.52	56024546	0.43
6.68	71435404	0.32
7.06	116255674	0.23
7.33	95623100	0.24
7.55	247591872	0.24
7.89	157194334	0.13
8.44	75679940	0.23

(1) AROCLOR 1262 (1) #2 (AML1)

R.T.	Response	Conc
8.57	55072694	0.34
8.88	39417886	0.35
8.97	96893982	0.37
9.22	62990442	0.75
9.55	174552224	0.18
9.87	103774093	0.19
10.61	49626668	0.20

(+) = Expected Retention Time

09FEB24.D 1262PCB.M Wed Apr 13 14:58:25 2011 RPT1

FORM **14.11**

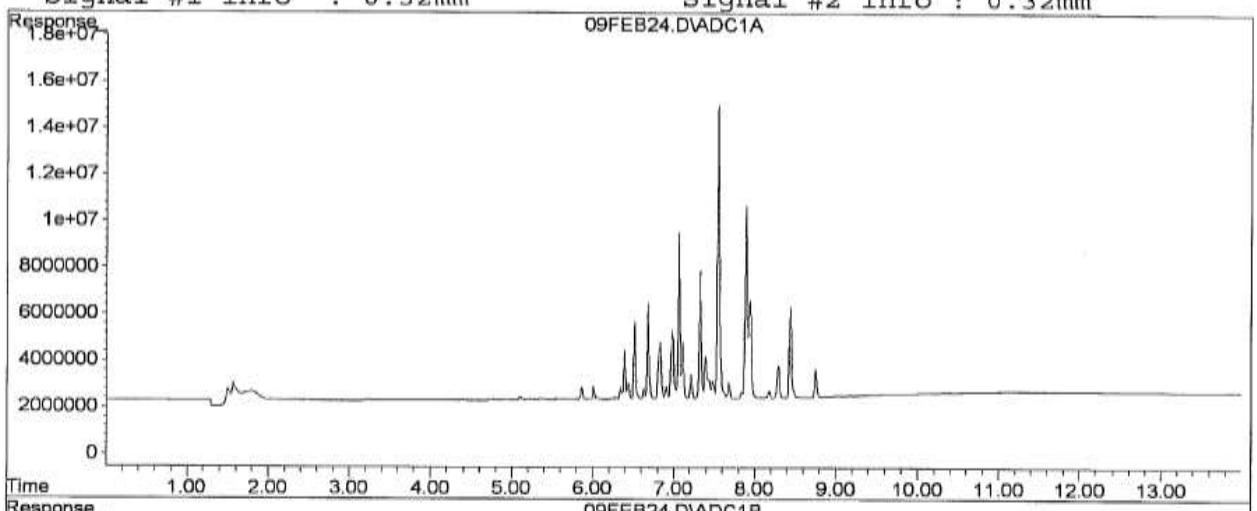
Quantitation Report

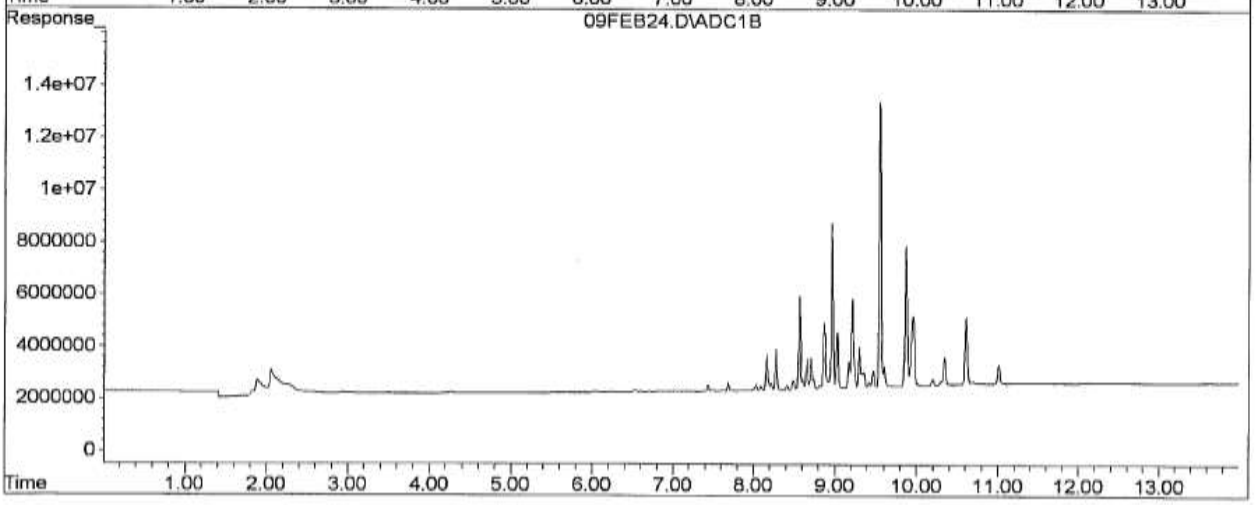
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1A.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                    Operator: VH1
Sample    : 1262                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB24.D\ADC1B.CH Vial: 24
Acq On    :  9 Feb 2011   2:52 pm                    Operator: VH1
Sample    : 1262                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:58 2011  Quant Results File: 1262PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1262PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 09:34:57 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 3(
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```





)9FEB24.D 1262PCB.M Wed Apr 13 14:58:35 2011 RPT1 Page 2

FORM **14.12**

Quantitation Report (QT Reviewed)

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1A.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                    Operator: VH1
Sample    : 1268                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1B.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                    Operator: VH1
Sample    : 1268                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 15:03 2011  Quant Results File: 1268PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1268PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:03:43 2011
Response via : Continuing Cal File: D:\DATA\GC6\APR2011\APR01A\01APR12.D
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase  : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info   : 0.32mm            Signal #2 Info : 0.32mm
```

Compound	RT#1	RT#2	Resp#1	Resp#2	Conc#1	Conc#2
Target Compounds						
1) AML1 AROCLOR 1268 {1}	7.05f	8.95f	51554854	43712602	0.2290m	0.2021m
2) AML1 AROCLOR 1268 {2}	7.32f	9.22f	66448684	52531764	0.2545m	0.2008m
3) AML1 AROCLOR 1268 {3}	7.88f	9.85f	322.4E6	223.1E6	0.1156m	0.1908m#
4) AML1 AROCLOR 1268 {4}	8.17f	10.18f	216.9E6	146.7E6	0.2159m	0.1975m
5) AML1 AROCLOR 1268 {5}	8.43f	10.59f	81132982	57975420	0.4314m	0.3474m
6) AML1 AROCLOR 1268 {6}	8.74f	10.99f	627.3E6	420.3E6	1.7956m	1.5873m
7) AML1 AROCLOR 1268 {7}	8.99f	11.31f	80823846	58458196	0.0286m	0.0276m
8) AML1 AROCLOR 1268 - T	0.00	0.00	1446.6E6	1002.7E6	0.1893m	0.2030m

(f)=RT Delta > 1/2 Window (#)=Amts. Percent Difference > 40% (m)=manual int.
09FEB25.D 1268PCB.M Wed Apr 13 15:03:32 2011 RPT1 Page 1

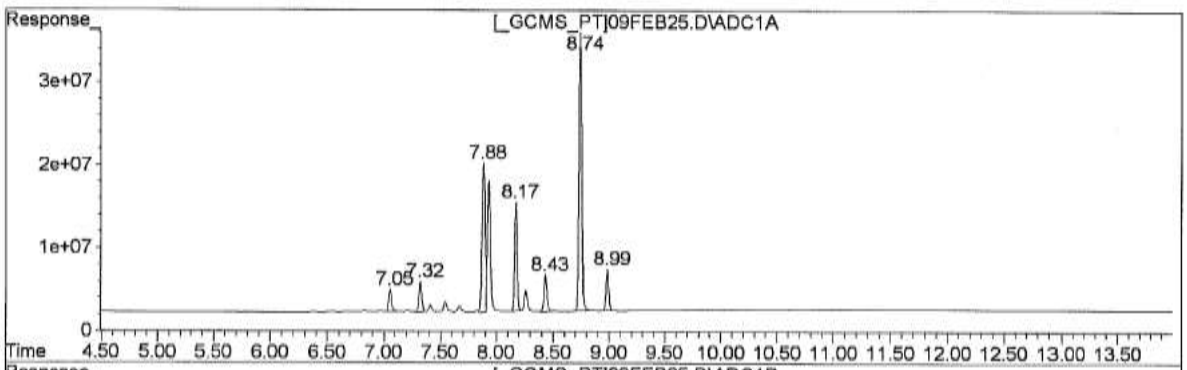
FORM **14.12**

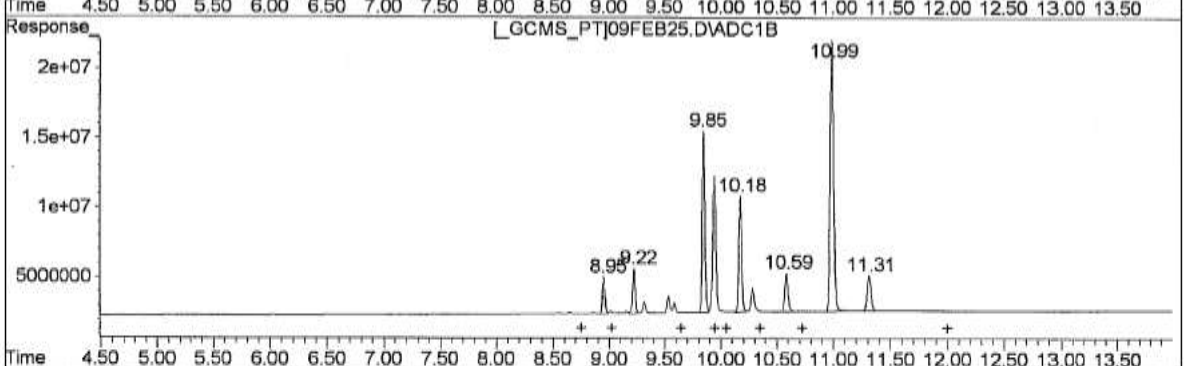
Quantitation Report

```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1A.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                        Operator: VH1
Sample    : 1268                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1B.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                        Operator: VH1
Sample    : 1268                                         Inst    : GC-6
Misc      :                                              Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 14:59 2011  Quant Results File: 1268PCB.RES


Method       : C:\HPCHEM\3\METHODS\1268PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:03:43 2011
Response via : Single Level Calibration
```





(1) AROCLOR 1268 (1) #2 (AML1)

R.T.	Response	Conc.
7.05	51554854	0.23
7.32	56448684	0.25
7.88	322406414	0.12
8.17	216898678	0.22
8.43	81132982	0.43
8.74	627344954	1.80
8.99	80823846	0.03

(1) AROCLOR 1268 (1) #2 (AML1)

R.T.	Response	Conc.
8.95	43772607	0.20
9.22	52531764	0.20
9.85	223052328	0.19
10.18	146739760	0.20
10.59	57975420	0.35
10.99	420256746	1.59
11.31	58458196	0.03

(+) = Expected Retention Time

09FEB25.D 1268PCB.M Wed Apr 13 15:02:58 2011 RPT1

FORM **14.12**

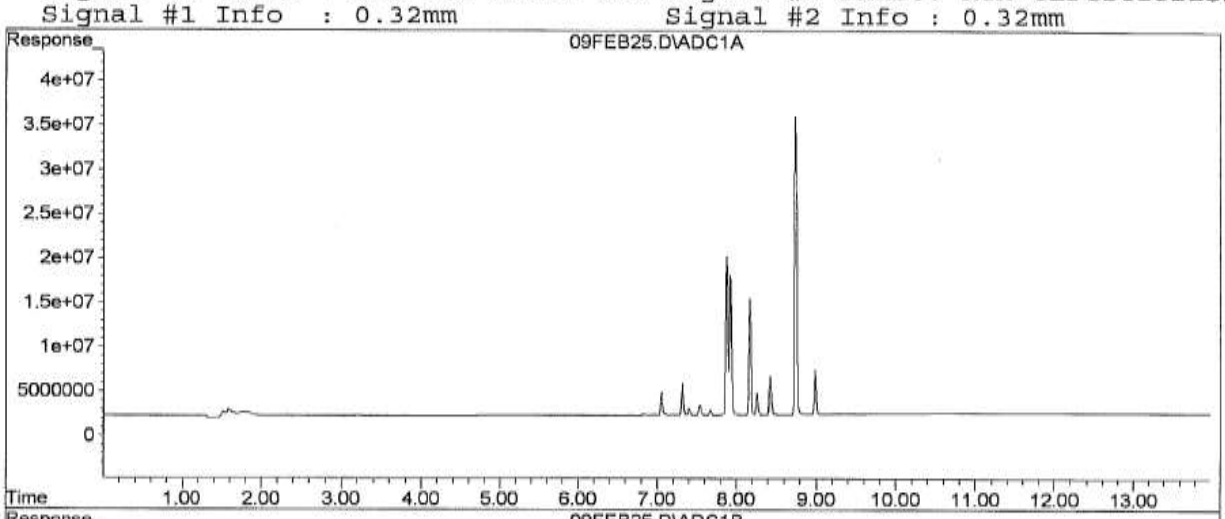
Quantitation Report

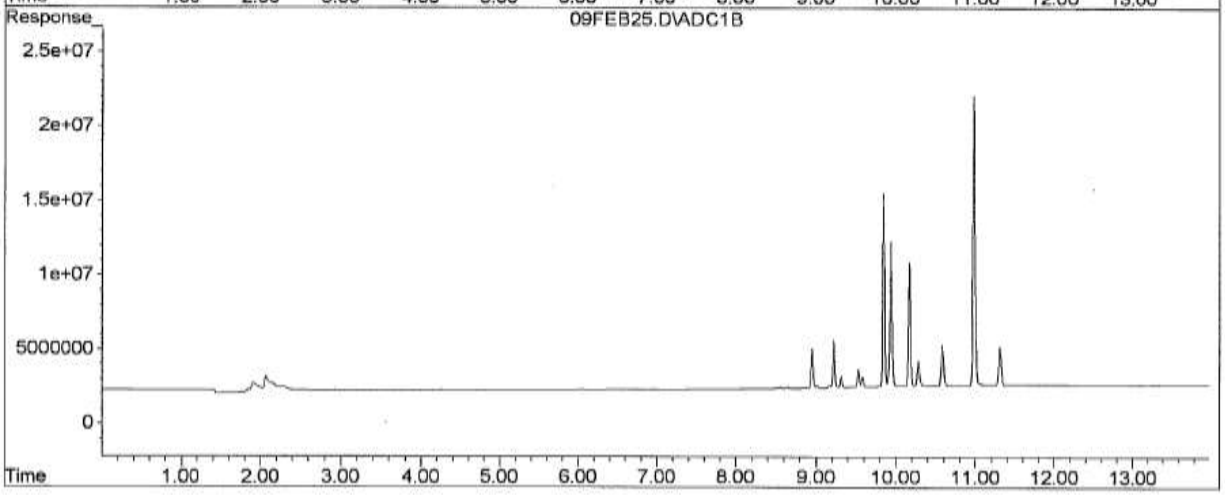
```
Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1A.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                    Operator: VH1
Sample    : 1268                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : 8080PCB.E

Data File : D:\DATA\GC6\FEB2011\FEB09\09FEB25.D\ADC1B.CH Vial: 25
Acq On    :  9 Feb 2011   3:09 pm                    Operator: VH1
Sample    : 1268                                     Inst    : GC-6
Misc      :                                          Multiplr: 1.00
IntFile   : autoint2.e
Quant Time: Apr 13 15:03 2011  Quant Results File: 1268PCB.RES

Quant Method : C:\HPCHEM\3\METHODS\1268PCB.M (Chemstation Integrator)
Title        : EPA 8080 PCB
Last Update  : Sat Apr 02 13:03:43 2011
Response via : Single Level Calibration
DataAcq Meth : 8082PCB.M

Volume Inj.      : 3UL
Signal #1 Phase : Rtx-440 30m x 0.3 Signal #2 Phase: Rtx-CLPesticides2 30
Signal #1 Info  : 0.32mm            Signal #2 Info : 0.32mm
```





09FEB25.D 1268PCB.M Wed Apr 13 15:03:33 2011 RPT1 Page 2

FORM 14.13
BC Laboratories, Inc.
Standard Operating Procedure (BCSAF005): Cradle to Grave Documentation
Sample Containing Polychlorinated Biphenyls – PCB's

Analyst Splitter Collector Disposer

BC Laboratories #'s	Mg/Kg µg/Litter	#Split	# PCB Vessel Labeled	Location Code*	Date Initials	#PCB Vessels Collected	Date Initials	#PCB Vessels Disposed	# Date Initials

Custody Chain for Disposal Document

1 Analyst: Report Lab ID if above MDL
2 Sample Splitter: Label all split samples
3 PCB Sample Collector: Harvest all and give to Disposer
4 PCB Sample Disposer: Place into acceptable container and sign disposal form

*Lab Location Code Legend
1 Walk-In refrigerator
2 Reach-In refreigerator

Sample collector will verify with login dept. before sending samples to disposal.

Enter the information requested and the date/initials for the procedure performed.
Upon completion by the sample disposer, please return the form to the PCB Analyst.
Your cooperation is greatly appreciated.

FORM 14.14

Sequence Example
GC

1	IB
2	Laboratory Performance checks (If applicable
3	Continuing calibrations (Run Dependent)
4	CCB
5	Method Blank
6	Laboratory Control Sample
7	Sample 1
8	Sample 1 Matrix Spike
9	Sample 1 Matrix Dupspike
10	Sample 2
11	Sample 3
12	Sample 4
13	Sample 5
14	Sample 6
15	CCV
16	CCB
17	Sample 7
18	Sample 8
19	Sample 9
20	Sample 10
21	Sample 11
22	Sample 12
23	Sample 13
24	Sample 14
25	Sample 15
26	Sample 16
27	CCV
28	CCB

Blank may be required depending on sample matrix, and will be added at analyst's discretion.
Maximum 10 samples between CCV's

Filename SEQUENCE.xlx Rev. 1 6/23/00 (GC-C0033)

FORM 14.15

BC LABORATORIES, INC.

System Improvement Form (SIF)

Non Conformance Type (Circle One) _____

001-Audit
002-Equipment
003-LIMS
004-Policy
005-Procedure
006-Supply
007-Health and Safety
008-Other (Specify) _____

Specify _____

Dept. Affected: _____

SIF ID SIF-000
SIF-mmddyyyy-000

Initiated By _____

Initiated Date _____

Responsible Party for Restoring System

Schedule Completion Date _____

Actual Date of Completion _____

Stopped Work? Yes / No

NCR Description

Cause

Corrective Action

Verification of Corrective Procedure

Client Notification Required? Yes / No

Company Name: _____ *Date* _____

Contact Name: _____

How was client work impacted?

Comments

Department Manager Signature _____ *Date* _____

QC Officer Signature _____ *Date* _____

Wednesday, January 11, 2012 *H:\QCData\QC Data Entry\SIF DB Tracking\...SIF Report* *Page 1 of 319*

FORM 14.16

Analyst/Preparation Technician:_____

Initial Demonstration of CompetencyForm
BC Laboratories Inc.

IDC #:_____ Date _____ Method _____ Analyst Initials _____ Instrument

Standards

Date Stds Prepared	Standard IDs Initial Curve								
	Std 1	Std 2	Std 3	Std 4	Std 5	Std 6	Reference/ICV	Spike Std.	Other

Reagents (if applicable)

Preparation Date	Reagent ID	Reagent ID	Reagent ID	Reagent ID	Reagent ID	Reagent ID

Analysis ☐ See Attached

Instr ID	Date of Analysis	Correlation Coefficient (if applicable)	LCSW % Recoveries				Avg.	%RSD	Acceptable Limits
			LCSW1	LCSW2	LCSW3	LCSW4			

Comments: _____

☐ Run log entries verified
☐ Maintenance Log entries verified
☐ Correction Techniques discussed
☐ Proper Integration Techniques
☐ Handling of matrix interferences discussed
☐ Reagent/Standard Log entries verified
☐ Control Charting Initiated
☐ Instrument QC acceptable
☐ Safety Issues Discussed
☐ Can navigate through instrument software
☐ Preparation Log entries verified
☐ SOP read and understood
☐ Reduction of results verified
☐ Waste Management Discussed

Analyst Signature _____ Date _____

Trainer Signature _____ Date _____

Supervisor Signature _____ Date _____

QA Officer Signature _____ Date _____

FILENAME: TPH418_1.DOC Rev 2 06/22/00

FORM 14.16

BC Laboratories Inc.

Initial Demonstration of Capability

Semi-Volatile Organics

Analyst: _____ **Matrix:** _____
Date(s) Analyzed: _____ **Units:** _____
EPA METHOD: _____ _____

Parameter	Spike Level	IDC 1	IDC 2	IDC 3	IDC 4	Ave	% RSD	% RSD Criteria	Ranges	
									Ave	% Rec
Compound 1										
Compound 2										
Etc...										

This form to be modified per method.

Filename: IDCFORM.xls Rev. 1 6/23/00 (GC-C0033)

Form 14.17 Control Limits

Control Charts
New Limits

Analyst: VH1
Applicable Methods: g8082w
g8082w Appendix 2 Li
g8082w full
g8082w LWRNH A
g508w PCBs only
g8080w PCBs only
g608w PCBs only

Dates: 4/1/2010-6/30/2010

Limits

	Samples
Decachlorobiphenyl (Surr.):	48-135

	LCS		MS/MSD	RPD
PCB 1260	73-119		64-125	23

Approved by: _____ Date: 10-7-2010

Date Limits given to QC Dept.: 10-7-2010
Date limits in use: _____

Form 14.18

QC Log ID: *GCF003* 09L371

QC Approval: _____
Rev. Date: *11/25/2009*
Total Pages: 1-10

BC Laboratories, Inc.
MAINTENANCE LOGBOOK

BCL Instrument Identification: **GC-6**
Methods: 8082
Department: Semi-Volatiles-Organic
Location: 25
Log #: 3
From: 11-30-09 To: _____

Component	*Manufacturer*	*Model*	*Serial #.*	*Type*
ADI ØØ8	HP	3590ØE	US81301966	Interface
GC-6	Varian	3400	8247	GC-ECD
AS-17	Varian	8100	147Ø	Auto Sampler

Comments:

S:\WPDoc\WordPerfect\Lab_Docs\Logbook\GC6MNTCV

Form 14.18

BC LABORATORIES, INC.

Maintenance Record
Instrument GC-6

DATE	Trouble Observed/Service performed/Down Time	Init.	Approval	Date

S:\WPDoc\WordPerfect\Lab_Docs\Logbook\GC6MNTLG

FORM 14.19

USER FLAGS

FLAGS	COMMENTS	isRetain
A01	PQL's and MDL's are raised due to sample dilution.	
A02	The sample concentration between duplicate readings is less than the PQL	
A03	The sample concentration is more thatn 4 times the spike level	
A04	Method of Standard Additions used to calculate result.	
A09	PQL's were raised due to high concentration of target analytes requiring sample dilution.	
A10	PQL's and MDL's were raised due to matrix interference.	
A11	PQL's and/or MDL's were raised due to inadequate sample size received.	
A12	PQL's were raised due to high concentrations of hydrocarbons present requiring sample dilution.	
A14	All phenolic compound results are affected due to low phenol surrogate recoveries caused by matrix.	
A17	Surrogate not reportable due to sample dilution.	
A18	Surrogate not reportable due to matrix interference.	
A19	Surrogate is high due to matrix interference. Interferences verified through second extraction/analysis.	
A20	Surrogate is low due to matrix interference. Interference verified tthrough second extraction/analysis.	
A22	Associated surrogate recovery is low	
A23	Associated surrogate recovery is high	
A26	Sample received past holding time	
A39	Sample received at pH greater than 2	
A40	Initial calibration linearity not met	
A41	Results confirmed by GC/MS.	
A43	Primary/Confirmation column ratios do not agree, results may be biased.	
A48	Matrix spike interferences may be associated with this analyte.	
A51	Chromatogram not typical of Diluent.	
A52	Chromatogram not typical of diesel.	
A53	Chromatogram not typical of gasoline.	
A54	Chromatogram not typical of kerosene.	
A55	Chromatogram not typical of crude oil.	
A56	Chromatogram not typical of stoddard solvent.	
A57	Chromatogram not typical of motor oil.	
A58	Chromatogram not typical of hydraulic oil.	
A59	Results calculated on a dry weight basis.	
A61	Result is estimated a coeluting compound is also present at same retention time.	
A66	Method Blank for {%1} detected at {%2}	
A68	Presence of MTBE not confirmed by GC/MS.	
A70	Surrogate recovery calculated from the confirmation column due to matrix interferences on the primary column.	
A71	TBOS result subtracted from diesel range for final diesel result.	
A72	PQL's and/or MDL's were raised due to high moisture content.	
A74	A negative reading whose absolute value is greater than the MDL was obtained for the method blank.	
A79	Prepared by EPA Method 5035.	
A81	The result is below the calibration limit of the instrument. Due to the calibration tecnique used, a numerical result cannot be reported.	
A83	Result based on tentatively identified compound search.	
A84	Compound is a Non-Target Analyte	
A85	Analyte is a Tentavely Identified Compound	
A87	Carry over from a previously analyzed sample.	
A88	Unable to report specific number. Insufficient dilution to accomodate high concentration	
A89	TPH C4-C12	
B01	Analyte detected in the Continuing Calibration Blank (CCB) at a level greater than the PQL.	
B02	Analyte detected in the Continuing Calibration Blank (CCB) at a level between the PQL and ½ the PQL.	
B03	Analyte detected in the Continuing Calibration Blank (CCB) at a level between the PQL and the MDL.	
B04	The batch size for the Continuing Calibration Blank exceeds the control limit.	
B05	The time interval between Continuing Calibration Blank exceeds the control limit.	
B06	The number of consecutive analyses fo the Continuing Calibration Blank exceeds the control limit.	
B07	The analytical sequence did not contain a Continuing Calibration Blank at the end.	

FLAGS	COMMENTS	isRetain
C01	The calibration curve did not contain the minimum number of standards.	
C02	The relative standard deviation of the calibration curve response factors exceeds the control limit.	
C03	The correlation coefficient for the calibration was below the minimum control limit.	
C04	The standards for the calibration were not analyzed on the same day.	
C05	The standards for the calibration were not analyzed consecutively.	
C06	The average of the calibration curve response factors exceeds the control limit.	
C07	The response factor for a System Performance Check Compound (SPCC) is below the acceptable limit.	
C08	The relative standard deviation of the calibration curve response factors for a Calibration Check Compound (CCC) exceeds the control limit.	
D01	Recovery of a standard ath the PQL exceeded the control limit.	
L01	The Laboratory Control Sample Water (LCSW) recovery is not within laboratory established control limits.	
L02	The Laboratory Control Sample Water (LCSW) recovery is not within method established control limits.	
L03	The batch size for the Laboratory Control Sample Water (LCSW) exceeds the control limit.	
L04	The matrix of the sample does not match the Laboratory Control Sample Water (LCSW).	
L05	The Laboratory Control Sample Water (LCSW) was not analyzed prior to all the samples in the batch.	
L06	The relative percent difference between the Laboratory Control Sample Water (LCSW) and the LCSW Duplicate exceeds the control limit.	
L21	The Laboratory Control Sample Soil (LCSS) recovery is no within Laboratory established control limits.	
L22	The Laboratory Control Sample Soil (LCSS) recovery is not within method established control limits.	
L23	The batch size for the Laboratory Control Sample Soil (LCSS) exceeds the control limit.	
L24	The matrix of the sample does not match the Laboratory Control Sample Soil (LCSS).	
L25	The Laboratory Control Sample Soil (LCSS) was not analyzed prior to all the samples in the batch.	
L26	The relative percent difference between the Laboratory Control Sample Soil (LCSS) and the LCSS Duplicate exceeds the control limit.	
M01	Analyte detected in the Method Blank at a level above the PQL.	
M02	Analyte detected in the Method Blank at a level between the PQL and ½ the PQL.	
M03	Analyte detected in the Method Blank at a level between the PQL and MDL.	
M04	The batch size for the Method Blank exceeds the control limit.	
M05	The Method Blank was not analyzed prior to all the samples in the batch.	
M06	The internal standard on the Method Blank was not within the control limits.	
M07	The surrogate recovery on the Method Blank for this compound was not within the control limits.	
N01	This analyte exceeded the PQL in the beginning interference check standard.	
N02	Recovery of this analyte in the beginning spiked interference check standard was not within the control limits.	
N03	The beginning interference check standard was not analyzed prior to this sample.	
N11	This analyte exceeded the PQL in the ending interference check standard.	
N12	Recovery of this analyte in the ending spiked interference check standard was not within the control limits.	
N13	The ending interference check standard was not analyzed after this sample.	
ND	ND	X
NoObO	No Obs Oder	
NR	Non-Reactive	X
NR2	Non-Reactive	
NTA	Non Target Analyte	
P01	Post spike recovery was not within the control limits.	
P02	The batch size for the Post Spike exceeds the control limit.	
P03	The relative percent difference between the duplicate Post Spikes exceeds the control limit.	
pH1:1	pH result reported on a 1:1 dilution of sample	
pHsat	pH result reported on a saturated paste of sample	
pHstr	pH result reported on a straight aliquot of sample	
Q01	Sample precision is not within the control limits.	
Q02	Matrix spike precision is not within the control limits.	
Q03	Matrix spike recovery is not within the control limits.	
Q04	The batch size for the QC set exceeds the control limit.	
Q05	The matrix of the sample does not match that of the spike samples.	

FLAGS	COMMENTS	isRetain
Q06	The dilutions of the quality control set are not consistent.	
R01	The sample result is between the MDL and the PQL.	
R11	Per client request the reported PQL is less than the laboratory PQL but above the laboratory MDL.	
S01	Sample result is not within the quantitation range of the method.	
S02	The relative percent difference between duplicate instrument readings exceeds the control limit.	
S03	A negative reading whose absolute value is greater than the PQL was obtained for the sample..	
S04	The instrument reading for the sample was not a numeric value.	
S05	The sample holding time was exceeded.	
S06	There was an excessive amount of time between the prior sample and this sample in the analytical run.	
S07	This sample result may contain carry over from the prior analytical sample.	
S08	The internal standard on the sample was not within the control limits.	
S09	The surrogate recovery on the sample for this compound was not within the control limits.	
S10	The analyte in the Method Blank is greater than the laboratory PQL and the sample result is less than 10 times the Method Blank.	
S11	The analyte in the Method Blank is greater than the laboratory PQL but the sample result is greater than 10 times the Method Blank.	
S12	The Method Blank bias is greater than the PQL.	
V01	The Initial Calibration Verification (ICV) recovery is not within established control limits.	
V02	Not all of the calibration standards were analyzed prior to the Initial Calibration Verification (ICV).	
V03	The internal standard on the Initial Calibration Verification (ICV) was not within the control limits.	
V11	The Continuing Calibration Verification (CCV) recovery is not within established control limits.	
V12	More than the acceptable number of samples were analyzed between Continuing Calibration Verification (CCV) standards.	
V13	The time interval between Continuing Calibration Verification standards exceeds the control limit.	
V14	The continuing Calibration Verification (CCV) Standard was reanalyzed more than the acceptable number of times.	
V15	There was no Continuing Calibration Verification (CCV) at the end of the analytical sequence.	
V16	The internal standard on the Continuing Calibration Verification (CCV) was not within the control limits.	
V17	The percent deviation between the Continuing Calibration Verification (CCV) and the original calibration exceeds the control limit.	
V18	The instrument response for a System Performance Check Compound (SPCC) on the Continuing Calibration Verification (CCV) is below the control limit.	
V19	The relative standard deviation of the calibration curve response factors for a Calibration Check Compound (CCC) in the Continuing Calibration Verification (CCV) exceeds the control limit.	
z1	[Custom Value] fuel	
Z2	[Custom Value]	X

FORM 14.20

10L172

ASB001

Approved by: _____
Rev. Date: 06/23/2010
Page 1-200

ANALYTICAL STANDARD RECORD

METHOD

8082 - PCB

BC LABORATORIES, INC.

LOG # 1

FROM: 06/02/10 ***TO:*** _____

C:\MY DOCS\WORDPERFECT\LAB_DOCS\LOGBOOKS\ANALSTDRECCV_8082PCB

FORM 14.20

Analytical Standard Record

BC Laboratories

1B23005

Description:	8082 PCB 1016/1260 IC-1	Expires:	09/14/11
Standard Type:	Calibration Stan	Prepared:	02/23/11
Solvent:	Hexane	Prepared By:	Viola Hart
Final Volume (mls):	10	Department:	Semi-Volatiles
Vials:	1	Last Edit:	02/23/11 14:44 by VH1

Analyte	CAS Number	Concentration	Units
PCB-1260 [2C]	11096-82-5	0.02	ug/mL
PCB-1260	11096-82-5	0.02	ug/mL
PCB-1016 [2C]	12674-11-2	0.02	ug/mL
PCB-1016	12674-11-2	0.02	ug/mL
Decachlorobiphenyl (Surrogate) [2C]	2051-24-3	0.002	ug/mL
Decachlorobiphenyl (Surrogate)	2051-24-3	0.002	ug/mL

Parent Standards used in this standard:

Standard	Description	Prepared	Prepared By	Expires	Last Edit	(mls)
0I14008	8082 PCB DCB Surrogate Interme	09/14/10	Viola Hart	09/14/11	09/14/10 15:47 by VH1	0.01
0I14011	8082 PCB Low Intermediate 1016	09/14/10	Viola Hart	09/14/11	02/08/11 11:18 by VH1	0.1

BC LABORATORIES, INC.

Method
8082 PCB
Page 164 of 200

Reviewed By Date

Page 1 of 1

Form 14.21

10L156

EGC015

Approved by: _____
Rev. Date: 06/16/2010
Pages 1-200

EPA 8082-PCB
INSTRUMENT: GC-6
RUN LOG SCHEDULE

BC LABORATORIES, INC.

LOG # 15

FROM: 06/08/10 TO: _____

C:\My DOCS\WordPerfect\LAB_DOCS\LOGBOOKS\8080CV

FORM 14.21

Injection Log

Directory: d:\data\gc6\jan2011\jan24a

Line	Vial	FileName	Multiplier	SampleName	Misc Info	Injected
1	1	24jan01.d	1.	IB		24 Jan 111 12::5
2	2	24jan02.d	1.	CCV		24 Jan 111 13::0
3	3	24jan03.d	1.	CCB		24 Jan 111 13::2
4	4	24jan04.d	1.	IC-6		24 Jan 111 13::5
5	5	24jan05.d	1.	IC-5		24 Jan 111 13::0
6	6	24jan06.d	1.	IC-4		24 Jan 111 13::2
7	7	24jan07.d	1.	IC-3		24 Jan 111 13::3
8	8	24jan08.d	1.	IC-2		24 Jan 111 13::5
9	9	24jan09.d	1.	IC-1		24 Jan 111 12::1
10	10	24jan10.d	1.	ICV1		24 Jan 111 12::2
11	11	24jan11.d	1.	ICB1		24 Jan 111 12::4
12	12	24jan12.d	1.	BUA1377-BLK1		24 Jan 111 12::0
13	13	24jan13.d	1.	BUA1377-BS1		24 Jan 111 12::1
14	14	24jan14.d	1.	BUA1377-MS1		24 Jan 111 12::3
15	15	24jan15.d	1.	BUA1377-MSD1		24 Jan 111 12::5
16	16	24jan16.d	1.	1101244-01		24 Jan 111 12::0
17	17	24jan17.d	1.	1101244-02		24 Jan 111 12::2
18	18	24jan18.d	1.	1101244-03		24 Jan 111 12::4
19	19	24jan19.d	1.	1101005-01		24 Jan 111 12::5
20	20	24jan20.d	1.	1101005-02		24 Jan 111 12::1
21	21	24jan21.d	1.	CCV1		24 Jan 111 12::3
22	22	24jan22.d	1.	CCB1		24 Jan 111 12::4
23	23	24jan23.d	1.	B1-BLK1		24 Jan 111 12::0
24	24	24jan24.d	1.	B1-BS1		24 Jan 111 12::2
25	25	24jan25.d	1.	B1-MS1		24 Jan 111 12::3
26	26	24jan26.d	1.	B1-MSD1		24 Jan 111 12::5
27	27	24jan27.d	1.	CCV2		24 Jan 111 12::1
28	28	24jan28.d	1.	CCB2		24 Jan 111 12::2
29	29	24jan29.d	1.	TEST		25 Jan 111 13::4
30	30	24jan30.d	1.	TEST 2		25 Jan 111 12::0
31	31	24jan31.d	1.	IB		25 Jan 111 12::2
32	32	24jan32.d	1.	1242		25 Jan 111 12::4
33	33	24jan33.d	1.	IB		25 Jan 111 12::5
34	34	24jan34.d	1.	1101297-01		25 Jan 111 12::1
35	35	24jan35.d	1.	1101297-01	2	25 Jan 111 12::3
36	36	24jan36.d	1.	IB	2	25 Jan 111 12::4
37	37	24jan37.d	1.	CCV3	2	25 Jan 111 12::0
38	38	24jan38.d	1.	CCB3	2	25 Jan 111 12::2
39	39	24jan39.d	1.	B2-BLK1	2	25 Jan 111 12::1
40	40	24jan40.d	1.	B2-BS1	2	25 Jan 111 12::2
41	41	24jan41.d	1.	B2-MS1	2	25 Jan 111 12::4
42	42	24jan42.d	1.	B2-MSD1	2	25 Jan 111 13::0
43	43	24jan43.d	1.	1101310-01	2	25 Jan 111 13::1
44	44	24jan44.d	1.	CCV4	2	25 Jan 111 13::3
45	45	24jan45.d	1.	CCB4	2	25 Jan 111 13::5

BC LABORATORIES, INC.
GC Instrument
GC-6
Page 132 of 200

25 Jan 11 11:30

FORM **14.22**
EXT369

QC Approval:_____
Rev. Date:___04/01/2011
Page: 100

EXTRACTION

LOGBOOK

BC LABORATORIES, INC.

LOG # EL__369

From:_____ To:_____

s\WPDOCS\WordPerfect\LAB_DOCS\Logbooks\ELOGCVR

BC LABORATORIES, INC. EXTRACTION LOGBOOK

Analysis_____ S W O Extraction Solvent Used: $MeCl_2$/Acetone EE Hexane $MeCl_2$ ACN R-_____

Ext. Method: 504 / 552 / 556 / 3510 / 3520 / 3550 / 3580 / 8330 / 548 / 549

Ext. Date/Time: _____

Extracted By: _____

Concentrated By: _____

Date Concentrated: _____

Concentration Technique: T-VAP / KD / Dilution / 504 / 552 / 556 / 3520 / 548 / 549

Received by: _____

Date/Time: _____

Reagent #1: R-

Reagent #2: R-

Reagent #3: R-

Reagent #4: R-

Reagent #5: R-

Solvent Exch. Reag. #: R-

Spike Witness: _____

Spike ID: EX-

LAB ID #	SAMPLE WT/ VOL. g / ml	BOTTLE ID	Surr	Spike	SURR. USED	FINAL VOLUME ml	Initial pH	Base mls pH > 10	Acid mls pH < 2	COMMENTS
_____MB					EX-					
_____MS										
_____MSD										
_____LCS										

S - Soil
W - Water
O - Oil
D - Dilution

EE - Ethyl Ether
$MeCl_2$ - Dichloromethane
ACN - Acetonitrile

Heating Block Temp:_____
T-Vap - Turbo Vap Temp:_____
KD - Kuderna Danish Temp _____
N - Evap Temp _____
Coliform Incubator Water Bath Temp_____

ELEMENT BATCH ID:_____

TRACKING ID: 462-_____

1

S:\WPDocs\WordPerfect\LAB_DOCS\LOGBOOKS\ELOGBOOK

UnControlled Copy:
Issued To:
Approved By: Inorganic Supervisor
Approval Date: 2/18/2015
Effective Date: 04/10/2017
Printed Date:
Location:
Printed By:

UNCONTROLLED COPY

1.0 SCOPE AND APPLICATION

1.1 Inductively coupled plasma-optical emission spectroscopy (ICP-OES) determines metals and trace elements in solution. The method is applicable to aqueous matrices which include drinking water, groundwater, and wastewater, as well as solid matrices such as soil.

1.2 Analyte Types:

1.2.1 Dissolved analytes may be determined in aqueous samples which have been appropriately filtered and preserved.

1.2.2 For the "direct analysis" of drinking water for total recoverable analytes, the sample must be preserved with nitric acid and have turbidity less than 1 NTU. For total recoverable analysis of an aqueous sample or drinking water with turbidity >1 NTU, samples are digested by gentle refluxing with nitric and hydrochloric acid.

1.2.3 For analysis of total analytes in non-drinking water samples with high levels of organic matter or suspended solids where the total recoverable digestion is not sufficient to fully solubilize organometallic compounds, a hard acid digestion is recommended. Consult 40 CFR Part 136.3, note 4 and EPA Method 3010 for further clarification.

1.2.4 For analysis of soil and sludge analytes (hazardous waste) a reflux acid digestion is necessary.

1.3 For applicable analytes of this method along with wavelengths used and Practical Quantitation Limits (PQL's) refer to DOE Attachment K< Metals Test Groups SW-846 6010/6010B.

1.4 Use of this method is limited to spectroscopists who are knowledgeable in the correction of spectral, chemical and physical interferences.

2.0 SUMMARY OF METHOD

2.1 This method describes the simultaneous multi-elemental determination of elements by ICP-OES. The method measures element-emitted light by optical spectrometry. Samples are nebulized and the resulting aerosol is transported through the spray chamber to the plasma

torch. Element-specific atomic-line emission spectra are produced by a radio-frequency inductively coupled-plasma. The spectra are dispersed by a grating spectrophotometer.

2.2 Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interferences and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Table 3 should also be recognized and appropriate correction made.

3.0 INTERFERENCES AND CORRECTIVE ACTION

3.1 Spectral interferences are caused by: (1) overlap of a spectral line from another element; (2) unresolved overlap of molecular band spectra, (3) background contribution from continuous or recombination phenomena; and (4) stray light from the line emission of high concentration elements. Unresolved overlap requires selection of an alternate wavelength or the use of interelement correction factors. Background contribution and stray light can be compensated by background correction adjacent to the analyte line. Users of simultaneous multi element instruments must verify the absence of spectral interference from an element in a sample for which there is no instrument detection channel.

3.1.1 Spectral overlaps can be compensated for by equations that correct for interelement contributions. This involves measuring the interfering elements and utilizing interelement correction factors. Some documented interferences for Optima 4300 DV are in Table 3. These interferences are based on the scans of high concentration single element standards. The need for their correction should be confirmed by analyzing single element standards as samples after removing all factors. Adding other elements to this list should only be done after careful study of spectral scans to verify that the interference really exists and is not simply a contamination problem.

3.2 Physical interferences are effects associated with the sample nebulization and sample transportation. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample, by using a peristaltic pump or by using an internal standard method available on the Optima 4300 DV using Scandium as an internal standard. Another problem that can occur with high dissolved solids is salt build-up at the tip of the nebulizer, which affects aerosol flow rate and causes instrumental drift. This problem can be controlled by a high solids nebulizer and/or diluting sample. Additionally, physical interferences that affect sample results may be corrected by the use of internal standardization. The two types of physical interferences internal standardization can correct for are sample viscosity, and sample surface tension variations. Internal standardization uses an Scandium standard present at the same, known concentration in all samples. The reference signal that is generated by the internal standard can be used as a measure of the sample being delivered to the plasma. Consult The WinLab 32 Instrument

UNCONTROLLED COPY

Control Software guide, Chapter 3 pp 122 for further clarification.

3.3 Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique. If observed, they can be minimized by careful selection of operating conditions (RF power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. Chemical interferences are highly dependent on matrix type and the specific analyte element.

3.4 Memory interferences result when analytes in a previous sample contribute to the signals measured in the current sample. This is typically due to sample deposition on the sample introduction system (sample probe, transport and pump tubing, nebulizer and spray chamber) or the torch itself. The normal rinse time between samples within the method is typically 60 seconds (in addition to the next sample flush time) and is usually sufficient to remove these deposits. However, the analyst should be aware of this interference and if it is suspected, the sample must be re-analyzed after a long rinse period.

4.0 APPARATUS AND MATERIALS:

4.1 Computer controlled Optical Emission Spectrometer with background correction

4.2 Variable speed peristaltic pump

4.3 Autosampler

4.4 Appropriate Gases:

4.4.1 Argon gas supply: Welding grade or better
4.4.2 Nitrogen air supply
4.4.3 Compressed air supply

4.5 Appropriate glassware:

4.5.1 Volumetric Flasks, Class A
4.5.2 Volumetric Pipettes, Class A
4.5.3 Graduated cylinders

4.6 Eppendorf pipets, 200µL, 1000µL, 5ml, and appropriate disposable tips

4.7 Pump tubing for peristaltic pump:

4.7.1 Black/Black tubing (0.76 mm ID)
4.7.2 Red/Red tubing (1.14 mm ID)
4.7.3 Yellow/Orange (0.51 mm ID)

4.8 Capillary teflon tubing

4.9 13 x 100 mm polystyrene test tubes

UNCONTROLLED COPY

5.0 REAGENTS AND STANDARD SOLUTIONS

5.1 Reagents

5.1.1 Reagent water, ASTM Type II Deionized Water

5.1.2 2% HNO_3 - add 40 mls concentrated HNO_3 (Nitric Acid) to 1960 mls reagent water to make 2000 mls - Mix.

5.1.3 1:1 HNO_3 – add equal amounts of concentrated HNO3 to ASTM Type II reagent water - Mix.

5.1.4 1% HNO_3:5% HCl - add 10 mls HCl, and 50 mls HNO_3 to 940 mls reagent water to make 1000 mls – Mix.

5.2 Standards - Calibrations Standards

Note: Mixed standards should be prepared as needed or based on the earliest expiration date of the stock solution.

5.2.1 Standard Stock Solutions - Stock Standards are purchased from reputable manufacturers and are prepared using ultra-high purity grade chemicals (99.99% or higher purity).

5.2.2 Calibration standards are prepared from custom mixes which are purchased from reputable manufacturers and are prepared using ultra-high purity grade chemicals (99.99% or higher purity). The conc. of calibration stock solution (stock for Cal Std 1 and Cal Std 2) is listed in table 4.1.

5.2.2.1 Cal Std 3 is prepared by pipetting 100 ml of calibration stock standard into a 1000 ml volumetric flask containing 200 – 500 ml reagent water, 10 ml HNO_3, and 50 ml HCL. This is brought to final volume with reagent water. Concentration of PE ICP STD 3 Cal Std (table 4.2).

5.2.2.2 Cal Std 2 is prepared by pipetting 50 ml of calibration stock standard into a 1000 ml volumetric flask containing 200-500 ml of reagent water, 10 ml of HNO_3 and 50 ml of HCL. This is brought to final volume with reagent water. Concentration of cal std 2 is shown in table 4.3.

5.2.2.3 Cal Std 1A is prepared by pipetting 25 ml of calibration stock standard into a 1000 ml volumetric flask containing 200-500 ml of reagent water, 10 ml of HNO_3 and 50 ml of HCL. This is brought to final volume with reagent water. Concentration of cal std 1A is shown in table 4.6.

UNCONTROLLED COPY

5.2.2.4 Cal Std 1 is prepared by pipetting 1.0 ml of calibration stock standard for standard 1 (PQL Standard as listed in table 4.4) into a 1000 ml volumetric flask containing 200-500 ml of reagent water, 10 ml of HNO_3 and 50 ml of HCL. This is brought to final volume with reagent water. Concentration of cal std 1 is shown in table 4.5.

5.2.3 The accuracy of prepared standards must be verified prior to the standard being placed in service. The standard must be analyzed along with an old previously verified standard or other reference standard. To be verified the standards must agree within 5% of each other (RPD) and the analyzed value must be within 10% of the stated concentration. Upon placement in service the standards must have effective date opened on bottle. This is useful in tracking purposes or cross-referencing spikes.

5.2.4 Each standard is to be logged in its appropriate standards logbook.

5.2.5 Blanks - There are three types of blanks required for analysis.

5.2.5.1 Calibration blank (blank) – Is the same acid matrix as the calibration and QC standards. (1% HNO_3: 5% HCl).

5.2.5.2 Laboratory reagent blank (LRB or Prep Blank, PB1) - Contains all the same reagents in the same volume as processed samples. LRB is prepared exactly the same as samples including sample digestion when applicable.

5.2.5.3 Rinse blank –2% HNO_3 used to flush the instrument uptake system and nebulizer between standards, checks and samples to reduce memory interferences.

5.3 Instrument Performance Check Standards - Initial and continuing calibration verification (ICV/CCV) standards are used to verify instrument performance during analysis. The ICV is prepared from a source independent of that used in the calibration standards. The CCV's are prepared from the same source as the calibration standards. All analytes must be verified in the same way as the mixed calibration standard solutions.

5.3.1 ICV1 is prepared by pipetting 50 ml of PE ICP ICV1 into a 1000 ml volumetric flask containing 200 – 500 ml of reagent water, 10 ml HNO_3, and 50 ml if HCL. This is brought to volume with reagent water, mixed well and transferred to a polyethylene bottle. Concentration of PE ICP STD 1 (table 4.1); ICV1 (table 5.2)

5.3.2 CCV is prepared by pipetting 50 ml of calibration stock standard into a 1000 ml volumetric flask containing 200 – 500 ml of reagent water, 10 ml HNO_3, and 50 ml HCL. This is brought to volume with reagent water, mixed well and transferred to a polyethylene bottle. Concentration of PE ICP STD 1 (table 4.1); CCV (table 5.3)

5.4 Spiking Solutions

5.4.1 Spiking solutions are purchased as custom mix spike standards.

UNCONTROLLED COPY

5.5 Align View Mn Solutions

5.5.1 1 mg/L Mn: 1 ml of 1000 mg/L Mn Stock added to 200 mls reagent water in 1000 ml volumetric flask. Add 10 mls HNO_3 and 50 mls HCL to flask. Dilute to the 1000 ml mark with reagent water.

5.5.2 10 mg/L Mn: 10 mls of 1000 mg/L Mn Stock added to 200 mls reagent water in 1000 ml volumetric flask. Add 10 mls HNO_3 and 50 mls HCL to flask. Dilute to the 1000 ml mark with reagent water.

5.6 Spectral Interference Check Solutions

5.6.1 Interference check solutions (IF A and IF B) are prepared similar to calibration standards and spiking solutions based on Table 7. For the use of the interference check solutions A and A+B, see section 9.1.6.

5.6.2 Additional single element standards should be made from stock solutions in 1% HNO_3 and 5% HCl at 100 mg/L to determine what interelement correction factors are needed in the method or to verify values already in the method. This verification should be performed on an annual basis.

5.6.3 IF A and IF B preparation: See Table 7.

5.7 Internal Standard Solution

5.7.1 1 mL of 1,000 ppm Scandium stock standard, added to reagent water in 1000 ml volumetric flask. Add 10 mls HNO_3 and 50 mls HCL to flask. Dilute to the 1000 ml mark with reagent water.

5.8 Verification standards are prepared by combining appropriate volumes of the stock solutions in volumetric flasks. Transfer the prepared solution to new, acid cleaned FEP or polyethylene bottles. See Table 8 for preparation of the standards.

5.9 A standard will be analyzed that is higher than any sample that exceeds the upper calibration level.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Before collecting aqueous samples, a decision must be made as to the type of data required, (i.e. dissolved or total recoverable). The pH of all samples has to be tested before aliquoting for digestion or direct analyses to ensure proper preservation. If properly preserved with acid the holding time for samples is 6 months.

6.2 Determination of Dissolved Elements: The sample must be filtered through a 0.45 µm membrane filter at the collection site or as soon as practically possible. Glass filtering apparatus is used in the lab to avoid contamination from metals. The filter flask is rinsed

UNCONTROLLED COPY

with a small amount of filtered sample which is then discarded. The required/necessary volume is then filtered and preserved. The filtrate is acidified with 1+1 HNO_3 to a pH of <2.

6.3 Determination of Total and Total Recoverable Elements: Samples are not filtered, but acidified with 3ml of 1+1 HNO_3 per liter of sample to a pH of <2. This can be done at the collection site; however it is recommended that samples be acidified by the laboratory. This avoids contamination, transport restrictions, and hazards of strong acids. Preservation by the laboratory should take place within 2 weeks of sample collection. Following acidification, the sample should be mixed and held for 16 hours (unless preserved in the field) prior to removing a portion for digestion or direct analysis.

6.4 A filter blank should be prepared for samples filtered in the lab.

7.0 PROCEDURE - CALIBRATION AND STANDARDIZATION

7.1 Preliminary treatment of most samples is necessary because of the complexity and variability of sample matrices. Water samples which have been pre-filtered and acidified do not need digestion as long as the matrix of the sample and standards match. Digestion procedures are presented in Sample Preparation Methods.

7.2 Pre Start-Up:

7.2.1 Check gas supply to ensure enough for warm-up and analysis run. Pressure gauge should be adjusted to 80 psi for argon, 40 psi for nitrogen, and 80 psi for compressed air.

7.2.2 Check sample drain tube that feeds into large 10-20 liter plastic bottle.

7.2.3 Check drain tube for dips or loops; waste may collect in them blocking drainage from the nebulizer.

7.2.4 Check container of clean 2% HNO_3 rinse solution close to auto sampler and peristaltic pump. Check sample capillary tube in rinse solution for adequate flow.

7.2.5 Attach pump tube lines of rinse station peristaltic pump, and sample peristaltic pump. Check to see if autosampler capillary tubes are connected.

7.2.6 Check to ensure exhaust ventilation fan is on.

7.2.7 Check to see if RF coil is clean and dry in plasma compartment.

7.2.8 Close the plasma compartment door, and ensure that it is properly sealed.

7.2.9 Check the torch coupler knob. It should be set to –2.5 mm.

7.3 Start-Up

UNCONTROLLED COPY

7.3.1 Open the ESI icon on the computer screen.

7.3.2 Click on "Initialize Autosampler" button.

7.3.3 Open the Win Lab 32 icon on the computer screen.

7.3.4 Click on the "workspace" icon on the taskbar. Proceed to open the workspace entitled "working".

7.3.5 Below the taskbar where the workspace, method, sample info etc. icons are located should be the spectrometer status. Here you will know if the instrument is already initialized and ready to operate. Assuming that it is not, open the diagnostics control window in the tools menu. At the bottom of the window is the spectrometer control button. Open the window, then proceed to click the "initialize" button. The program will then tell you how long the instrument will take to initialize. All stations will be locked at this point until instrument initialization is complete.

7.3.6 After the spectrometer is initialized, click on the plasma button in the same window. Scroll down to check and see if the Water flow is in the "on" status. The lettering should appear green.

7.3.7 Click the switch on the autosampler table to the "on" position. Do the same to the rinse station peristaltic pump.

7.3.8 Close the diagnostics window.

7.3.9 On the plasma control window press the on/off button to the "ON" position.

7.3.10 Gas purge will occur automatically; purge settings will be described in table section.

7.3.11 The plasma will be ignited, and the plasma parameters should stabilize. These parameters will also be described in Table13.

7.3.12 Allow the plasma to stabilize for at least half an hour before performing any analyses.

7.4 Align View

7.4.1 Three alignment procedures are given below. The Hg realignment, axial align view, and radial align view must be performed daily to insure proper alignment for analysis. The mercury realignment procedure is performed when the instrument is initially set up and is then simply run daily to check peak offset and drift. The instrument is aligned in axial and radial viewing modes by aspirating two different concentrations of manganese. All data is entered into the logbook entitled Optima 4300 DV ICP-OES instrument alignment logbook.

7.4.2 Hg Align Procedure:
7.4.2.1 Open the spectrometer control in the "tools" menu.

UNCONTROLLED COPY

7.4.2.2 Click on the Hg realign button. Note: the plasma does not need to be on for this procedure. Allow the instrument to align. Enter all data acquired into the required logbook.

7.4.3 Axial View Align Procedure

7.4.3.1 To the right of the window click on the "axial" button. Aspirate a 1 ppm solution of manganese. Click on the align view button. Allow the instrument to align, and enter all required data into the required logbook.

7.4.4 Radial Align View Procedure

7.4.4.1 To the right of the window click on the "radial" button. Aspirate a 10 ppm solution of manganese. Click on the align view button. Allow the instrument to align, and enter all required data into the required logbook.

7.5 Adjustment of Interelement Correction Factors (IEC's)

7.5.1 Instrument operating conditions can change on a daily basis. If the nature of the samples analyzed (e.g. finished drinking H_20, groundwater, etc.) are such that they do not have concentrations >10 mg/L of the interfering elements, daily IEC or MSF adjustment is not needed.

7.5.2 When the analysis of the Spectral Interference Check Solutions (IFA and IFB) as outlined in Table 7 fail the acceptance criteria and samples will be analyzed which may have concentrations of interfering elements > 10 mg/L, the IEC or MSF adjustments must be made.

7.5.3 All interelement correction factors must be verified annually and updated if necessary.

7.5.4 Procedure:

7.5.4.1 Open the sample information window.

7.5.4.2 Type the sample ID of the IEC samples to be analyzed.

7.5.4.3 Open the manual analysis window.

7.5.4.4 Calibrate the instrument, to do this first analyze the Calibration Blank and all Calibration Standards. When finished, begin analyzing each solution of individual analyte at or near the LDR.

7.5.4.5 Run a series of rinses between each solution or increase rinse time to verify that all analytes are fully rinsed out of the system. Continue to analyze every solution necessary to calculate the IEC's in this manner.

UNCONTROLLED COPY

7.5.4.6 To calculate changes to IEC's, open the "tools" window, and select the interelement correction builder. This program will allow required corrections to be made manually for each element when interferences are observed. When finished, save the results by clicking on the "update method" button in the summarize factors window. Refer to the Optima 4300 DV Software guide for further instructions to the interelement correction builder feature.

7.5.4.7 Alternately use the MSF model builder to mask areas of the base line to compensate for multiple interferences. Refer to the Optima 4300 DV Software guide for further instructions to the using the MSF model.

7.5.4.8 Do not add additional elements where no interfering element is listed. The interference, if not in the table of interfering elements in section 3 of this method, is probably just contamination of the interfering element solution or a result of calibration errors.

7.5.4.9 After making changes to any IEC's, the analyst should reanalyze the SIC solutions to verify that the interference has been corrected and that the readings are now within the range specified in 9.1.6.

8.0 QUALITY CONTROL

Note: For DOD work, DOD QSM requirement version 5.0 must be followed. DOD compliance has been documented in BCL SOP BCDOD001 in section 3.0 thru section 8.0 to be followed. A copy of BCL SOP BCDOD001 is available for reference with Department Supervisors.

8.1 Summary: Each laboratory is required to operate a formal quality control (QC) program. The requirements consist of an initial demonstration of laboratory capability, periodic analysis of laboratory reagent blanks, fortified blanks and other laboratory solutions as a continuing check on performance. Performance records must be maintained to define the quality of the data generated.

8.2 Initial Demonstration of Performance (IDP) - This mandatory procedure is used to characterize instrument performance (linear range and analysis of quality control samples) and laboratory performance (determination of method detection limits) prior to analyses conducted by this method.

8.2.1 Linear dynamic range (LDR): The upper limit of the linear calibration range should be established for each analyte using normal operating conditions. The LDR is determined by analyzing a minimum of three standards of succeedingly higher concentrations of the analyte until the observed concentration is no longer ±10% of its true concentration. The highest concentration which is still within ±10 is the determined LDR. The LDR must be documented and kept on file. Determined sample analyte concentrations that are greater than 90% of the LDR must be diluted

UNCONTROLLED COPY

and reanalyzed. The LDR should be verified every 6 months or more often if the analyst has noted a change in analytical performance.

8.2.2 Quality Control Sample - In order to verify the accuracy of the calibration standards, a standard from a separate source must be analyzed. This requirement is met by analyzing the initial calibration verification (ICV) standard (section 5.3). To verify the calibration the ICV must be within ±5% of the stated value for EPA 200.7 and ± 10% for 6010B. If the calibration cannot be verified then the source of the problem must be identified and corrected before proceeding to method detection limits or on-going analysis.

8.2.3 Method Detection Limit (MDL) - MDLs must be established for all wavelengths using fortified reagent water approximately 3 to 5 times the instrument detection limit. For determination of the MDL, process seven replicate aliquots of the fortified reagent water through the analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. The MDL is calculated as follows:

$$MDL = (t) \times (s)$$

t = Student's t value for 99% confidence level and a standard deviation estimate with n-1 degrees of freedom (t = 3.14 for 7 replicates) s= standard deviation of the replicate analyses.

If additional confirmation is needed reanalyze the seven replicate aliquots on two or more nonconsecutive days and again calculate the MDL values each day. An average of the three MDL values for each analyte may provide a more appropriate MDL estimate. MDL's must be sufficient to detect analytes at the required levels according to compliance monitoring regulation. MDL's should be determined annually, or more often when the analyst decides there is a significant change in analytical performance due to operating conditions or instrument hardware changes. Refer to DOE Attachment K: Metals Test Groups SW-846 6010/6010B for MDL minimum values and requirements.

8.2.3.1 LOQ and LOD will be determined immediately following MDL study and then quarterly. See BCDOD001-DoD compliance SOP for Instructions.

8.2.4 Instrument Detection Limit (IDL): The IDL is equal to three times the standard deviation of a series of ten replicate measurements of the reagent blank. The IDL values for all analytes should be determined every 3 months. Acceptance criteria – Instrument Detection limits shall be ≤ MDL.

8.3 Calibration Acceptance Criteria – Calibration curve includes a blank and three standards. The calibration should have a correlation coefficient (R) of ≥ 0.995.

UNCONTROLLED COPY

9.0 LABORATORY ASSESSMENT OF PERFORMANCE

9.1 The following established steps are mandatory for assessing the performance of the laboratory. Data from these specific steps will assess contamination from the environment, accuracy and precision and interelement interference.

9.1.1 Method Blank (MB) - A method blank must be analyzed with each batch of 10 or fewer samples of the same matrix for 200.7 or 20 or fewer samples for 6010. This data is used to assess contamination from the environment. Refer to the Quality Assurance Program Plan Appendix D for assessment of method blanks. Method blanks should be < ½ PQL.

9.1.1.1 For samples that are analyzed as dissolved, high purity deionized water is used for the method blank. No preparation is necessary.

For samples that are digested and analyzed as total, high purity deionized water is used for the method blank and is taken through the digestion along with the designated samples.

9.1.2 Laboratory fortified blank/Blank spike solution - An LFB must be analyzed with each batch of 10 or fewer samples for EPA 200.7. A blank spike must be analyzed with each batch of 20 or fewer for EPA 6010B. Accuracy is calculated as percent recovery using the following equation:

$$\% R = \frac{\text{LFB/Blank Spike}}{S} \times 100$$

Where: % R = % recovery
LFB = laboratory fortified blank
LRB = laboratory reagent blank
S = concentration equivalent of analyte added to fortify the LFB/Blank Spike solution.

* Refer to the Quality Assurance Program Plan Appendix D for assessment of the LFB or Blank Spike.

9.1.3 LFB/LCSW analyses data must be used to assess performance against the required control limits of 85-115% for water samples and 75-125% for soils. Optional control limits which are equal to or better than the required limits may be developed when sufficient internal performance data become available (20 to 30 analyses). Optional control limits are determined from the mean percent recovery (x) and the standard deviation (s) of the mean. The equation following can be used to establish the upper and lower control limits:

upper control limit = x + 3s
lower control limit = x - 3s

UNCONTROLLED COPY

After each 30 new recovery measurements, new control limits can be calculated using only the most recent 30 data points.

Note: The control limits for CLP work are 80-120% for the LFB/LCSW.

9.1.4 Prepare the LFB by adding 0.2 ml of spike solution to 9.8 ml of reagent water. The LCSW is prepared during the digestion procedure for total and total recoverable analysis by adding 1 ml of spike solution to 50 ml of reagent water and digesting along with the samples and brought to a final volume of 50 ml see Table 6 for spike.

9.1.5 Instrument Performance Check Solutions/Initial and Continuing Calibration Verification and Blanks (ICV/ICB + CCV/CCB).

9.1.5.1 Open the spectrometer control in the "tools" menu. The ICV/ICB solutions must be analyzed following the daily calibration. Analysis of the ICV (a separate source standard) must verify that the instrument is within ± 5% of the stated value for EPA 200.7 and ±10% for EPA 6010B. The ICV/ICB solutions must be analyzed following the daily calibration. Analysis of the ICV (a standard from a vendor/source other than that used for the calibration) must verify that the instrument is within ± 5% of the stated value with a relative standard deviation (RSD) of less than 3% with 4 replicates for EPA 200.7 and within ± 10% of the stated value with an RSD less than 5% with a minimum 2 replicates for EPA 6010.

9.1.5.2 The CCV/CCB must be analyzed after every tenth sample and at the end of the run. Analysis of the CCV (same source as calibration standard) must be within ± 10% of the stated value for EPA 200.7 and ± 10% for EPA 6010B.

9.1.5.3 Refer to the Quality Assurance Program Plan Appendix D "Continuing Calibration Logic for ICP Methods" for assessment of the ICV/CCV. In general the analysis of the calibration blank (ICB or CCB) must be < the PQL, which is 3 to 5 times the MDL, or the blank should be within 3 times the IDL. If the results are not within specified limits, reanalysis of the CCV solution and the CCB is allowed. If on second analysis the results are still outside limits, analysis must be discontinued, the source of problems determined and corrected and/or instrument recalibrated. Samples following the last acceptable CCV/CCB must be reanalyzed. The data from the CCV and CCB solutions must be kept on file with sample analyses data.

9.1.5.4 The source for all ICB's and CCB's is reagent water ASTM Type II.

9.1.6 Spectral Interference Check (SIC/IF) Solution - The laboratory must periodically verify the interelement spectral interference correction routine by analyzing SIC

UNCONTROLLED COPY

solutions. These solutions have concentrations of the interfering elements at levels that will provide an adequate test of the correction factors. Please see Interference Check Solution Table 7 for the concentrations of elements in Solution IFA and IFB.

9.1.6.1 These two solutions are run daily: (for 6010) at the beginning; (for 200.7) at the beginning and end of the analytical sequence to monitor corrections and/or changes that may occur spectrally in the instruments. Solution IFB has a ± 20% acceptance range for the analytes in the mixture and the absolute value of the reading should be less than the PQL for analytes not in solution A. If this control limit is not met then interelement correction factors should be checked and adjusted. For Navy work, the absolute value of the reading should be less than 2 x MDL.

9.1.6.2 Interelement Correction Factors (IEC's) for other analytes should be checked on an annual basis. Analyze either single element solutions in the same acid matrix as the calibration standards at a level of 100 mg/l or at the upper end of the LDR for that analyte.

9.1.6.3 Determined analyte concentrations should fall within a specific concentration range where the absolute value is less than the PQL for that analyte. It is not necessary to spike analytes at a specific concentration and determine recoveries since the instrument will report negative values indicating the need for a negative IEC.

9.1.6.4 Follow the procedure outlined in section 7.5 for any required adjustments to IEC factors.

9.1.7 The IDC is used to indicate that the analyst is capable of producing results that are defensible and meet the quality requirements of the method. Under the supervision of an experienced analyst each new analyst must meet these requirements prior to taking responsibility for analytical results generated by this method.

9.1.7.1 Standards and Reagent Preparation:

9.1.7.1.1 Prepare one of the intermediate standard solutions 5.6 or 5.7

9.1.7.1.2 Prepare all of the working standards (calibrators and controls) 5.8 to 5.11.

9.1.7.1.3 Prepare all of the reagents.

9.1.7.2 Analyze a quality control sample (8.1.2) four times within the criteria in the method.

9.1.7.3 Successfully complete all other applicable requirements listed on the IDC form and have them signed by the appropriate personnel.

9.1.8 All analysts will be responsible for performing an IDC annually.

UNCONTROLLED COPY

9.2 Assessment of Analyte Recovery and Data Quality

9.2.1 Sample composition and the chemical nature of the sample matrix can affect analyte recovery and the quality of the data. Analyzing separate aliquots from the sample for duplicate and spike analyses can assess the effects. The laboratory fortified matrix (LFM/Matrix spike) procedure (Sect. 9.2.5) is required to assess if matrix effects are operative. The analyte addition test (Post Spiking procedure) is also used when a new or unusual sample matrix is encountered.

9.2.2 A minimum of 10% of the routine samples must be analyzed in duplicate and spiked/fortified with a known amount of each analyte. A duplicate sample is a separate aliquot of the sample brought through the entire sample preparation and analysis as the original. Water samples must be fortified the same as the laboratory fortified blank except as noted below.

NOTE: Allowances should be made for the concentration of Ca, Mg, Na, Sr, Fe and Al in environmental waters since their concentrations can vary greatly and are not predictable. Spiking these elements at the same concentration of the LFB can be of little use. It is recommended that these elements be spiked at higher concentrations and diluted if necessary.

9.2.2.1 Total and Total Recoverable digests are spiked during the sample preparation were 1 ml of the spike solution is added to 50 ml of reagent water and digested along with the samples and brought to a final volume of 50 ml.

9.2.2.2 Direct analysis for total metals or Dissolved analysis requires that the analyst add 0.2 ml of spike solution to 9.8 ml of sample aliquot for the spike and spike duplicate.

9.2.3 Calculate the relative percent difference (RPD) between the duplicate determinations and compare them with the control limit of 20%. RPD values are calculated as follows:

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2) / 2} \times 100$$

9.2.4 If the RPD is greater than the designated control limit, the reason for the out-of-control situation must be determined and corrected if necessary before results for that batch are reported. In many cases, sample homogeneity will be the problem and sample results should be flagged accordingly. The analysis of duplicate LCSW samples can be helpful in assessing the source of the RPD problems.

9.2.5 Calculate the percent recovery for each analyte, corrected for background concentrations measured in the unfortified sample, and compare the values to the LFM recovery range of 85-115%. The same criterion applies to solid waste samples. Percent recoveries may be calculated in units appropriate to the matrix using the following equations:

UNCONTROLLED COPY

Digested Samples:

$$\% R = \frac{C_s - C}{S} \times 100$$

Dissolved Samples:

$$\% R = \frac{C_s - C\,(0.98)}{S} \times 100$$

Where:
- %R = Percent recovery
- C_s = Spiked sample concentration
- C = Sample background concentration
- S = Concentration equivalent of analyte added to fortify the sample.

9.2.6 If the recovery falls outside the designated LFM recovery range and the laboratory performance for the analyte is shown to be in control as evidenced by the CCV, CCB, LFB/Blank Spike all being within limits, sample specific matrix interference should be suspect. The results for that sample should be flagged to indicate the presence of matrix interference. In addition, the use of dilutions, the method of standard additions or an internal standard should be considered for more accurate data.

9.3 For each batch of digested samples, the possibility of matrix interferences will be assessed as follows:

9.3.1 For routine work, in addition to a duplicate and matrix spikes on the QC sample, the analyst also sets up a x 5 dilution (SRD) and post spikes the QC sample by adding 0.2 ml. of spiking solution to 9.8 ml. of sample.

9.3.1.1 If the post digestion spike fails, (outside 85 – 115% limits for 200.7 and 75-125% for 6010B) the analyst looks at the SRD and compares to the original analyte result. If the SRD is within ± 10% the original result is accepted. This may occur more frequently with post spikes that are a high mean (analyte concentration > 4 x spike level). The analyte concentration should be at least 10 x above the MDL.

9.3.1.2 Normally when analyte results are low (< 10 x MDL) the post digestion spike is acceptable. If the PDS fails the analyst should assess the need for using method of standard addition.

9.3.2 The dilution test is performed initially followed by the post digestion spike addition and possibly the method of standard additions.

9.3.2.1 If an analyte is present at > 50 x MDL the analyst can run a x 5 dilution on the selected sample, which is usually the designated QC sample. If the dilution (SRD) is within ± 10% of original result, the analyst can accept the original result and no further action is necessary.

UNCONTROLLED COPY

9.3.2.2 If the dilution test falls outside the acceptable limits or analytes are < 50 x MDL a post digestion spike addition is performed. The post spike must be within 85% - 115% recovery for 200.7 and 75-125% for 6010B. If the post spike fails the analyst can either set up the method of standard additions or flag the results as estimated.

9.3.2.2.1 For MSA single additions calculation

$$\text{Final result} = \frac{B \times S \times C}{(A - B) \times V}$$

Where: A = result of sample + standard spike solution
B = result of sample + H_2O blank spike
C = concentration of standard spike solution. (µg/L)
S = volume of standard spike solution or H_2O blank spike. (ml)
V = volume of sample used. (ml)

9.3.3 Calculate the percent recovery for each analyte, corrected for background concentrations measured in the unfortified sample, and compare the values to the LFM recovery range of 85-115% for waters and 75-125% for soils. Percent recoveries may be calculated in units appropriate to the matrix using the following equations:

$$\%R = \frac{C_s - C\,(0.98)}{S} \times 100$$

Where: %R = Percent recovery
C_s = Spiked sample concentration
C = Sample background concentration
S = Concentration equivalent of analyte added to fortify the sample.

9.4 TCLP Analysis: TCLP extracts require special handling to comply with the TCLP method. When matrix spike recoveries are low (<50%) and analytes are within 20%of a regulatory limit, samples may be considered non-hazardous when they really do exceed the limit. In order to avoid this, all TCLP extracts should be post spiked (post digestion spiked) with recoveries within the normal 85% to 115% for 200.7 or 75 to 125%, for 6010B. Extracts not meeting the recovery criteria shall be diluted and re-spiked until the criteria is met. Analysis results will only be accepted from dilutions meeting the post spike criteria.

9.5 Acceptance limits for internal standards are ± 30%.

10.0 SAMPLE PROCEDURE

10.1 Aqueous Sample Preparation

UNCONTROLLED COPY

10.1.1 Dissolved Analytes: For the determination of dissolved analytes in ground waters and surface waters, the sample which has been filtered and acidified according to section 6.2 is ready for analysis. Any dilutions made to deal with high levels of dissolved solids or interferences should be incorporated into the results at the calculation phase of the analysis.

NOTE - If precipitate forms during storage or transport the sample must be treated using the Total Recoverable procedure even though reported as the dissolved analyte.

10.1.2 Total and Total Recoverable Analytes: with the exception of silver, Direct analysis can be used in the total analysis procedure when drinking water samples contain turbidity $\leq$1 NTU. Analyze an unfiltered acid preserved sample while making allowance again for dilutions in the data calculation.

10.1.3 Determination of total and total recoverable analytes in ground waters, surface waters, waste waters or drinking waters with turbidity $\geq$1 NTU are described thoroughly in BC Laboratory prep methods based on EPA methods 200.2, 3005A and 3010A.

11.0 SAMPLE ANALYSIS

11.1 The sample introduction system, including the nebulizer, torch, injector tube and uptake tubing must be checked for salt deposits, dirt and debris that would restrict solution flow and affect instrument performance. At this point the daily calibration of the instrument may be done.

11.2 Calibration/standardization procedures are according to manufacturer's recommendation. This is discussed fully in Section 7.0.

11.3 When completion of the initial requirements have been made (section 8.2), samples are then routinely analyzed as follows:

11.3.1 Calibration/standardization → ICV/ICB → analysis of SIC solutions IFA and IFB → analysis of samples.

11.3.1.1 Compliance with Quality Control (Section 8) and Laboratory Assessment of Performance (Section 9) must be met which includes analysis of LFB/LCSW samples, Duplicates, Spikes, Spike Duplicates, Post Spikes, Prep Blanks and CCV/CCB solutions.

11.3.1.2 Sample analyte concentrations that are more than 90% of the analyte LDR must be reanalyzed after dilution with reagent water that has been acidified in the same manner as the calibration blank. MDL and PQL values for diluted samples must be raised to reflect the dilution factor used to bring the sample analyte within the LDR.

11.3.1.3 IEC's must remain valid during sample analysis therefore the interfering

UNCONTROLLED COPY

element must not exceed its LDR. If the LDR is exceeded for an interfering element then the sample must be diluted. If the MSF model is used for correction the interfering Analyte may exceed the LDR, however the analyst should be aware of transport and nebulizer problems when analyzing samples which exceed the LDR.

11.4 Auto Analysis Table

11.4.1 Open the sample information icon: Here you will enter the data of the samples that will need to be analyzed. The program will automatically place the required QC samples at every interval of ten as required by methods 200.7 and 6010B.

11.4.2 TABLE 1: Autosampler Sequence and Location Table.

Sequence	AS Location	Sample ID
1	9	Blank
2	10	Std 1 Std 1A
3	9	Std 2
4	10	Std 3
5	11	ICV
6	12	ICB
7	13	IFA *
8	14	IFB*
9	15	Sample 3
10	16	Sample 4
11	17	Sample 5
12	18	Sample 6
13	19	Sample 7
14	20	Sample 8
15	21	Sample 9
16	22	Sample 10
17	1	CCV
18	2	CCB
19	0	Rinse
20	17	IFA**
21	18	IFB**

* Counted as Sample
** Not Required for 6010B

11.4.3 The above is an <u>example</u> <u>only</u>. The first six sequences are run in the beginning of every run, this is the initial demonstration used daily to determine the quality of performance for the instrument. These criteria are met daily: ICV for 200.7 is ± 5%. ICV for 6010B is 10%. LFB ± 15% for waters and ± 25% for soils, IFB ± 20%.

UNCONTROLLED COPY

CCV's are ± 10% and all ICB's and CCB's are below PQL's (absolute value). End of the run checks are CCV-1and CCB respectively. CCV's (CCV-1and CCB) are run after every ten "samples". A "sample" is considered any solution aspirated into the instrument to retrieve data other than CCV/CCB solutions.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Sample data is in units of µg/L or mg/L for aqueous samples and mg/kg for solid samples.

12.2 Dissolved aqueous analytes data is reported directly from instrument reading with allowance for sample dilution. Analyte concentrations below the PQL are not reported without appropriate flags indicating estimated value or trace.

12.3 Total recoverable aqueous analytes are reported directly from instrument readings. A 50 ml aqueous aliquot is digested and brought to a final volume of 50 ml. If a different aliquot volume is used in sample preparation the dilution factor must be accounted for in the final calculation. Also, account for any additional dilution of prepared samples needed to keep analyte determinations from exceeding the LDR's.

12.4 For reporting purposes, analytes are rounded according to the Rounding Rules for Reporting Metals analysis - See Appendix.

12.5 The preferred method for determining hardness is to compute it from the results of separate determinations of calcium and magnesium. Calculation of Hardness, mg equivalent $CaCO_3$/L = 2.497 (Ca, mg/L) + 4.118 (Mg, mg/L)

13.0 GENERAL MAINTENANCE AND TROUBLESHOOTING

13.1 The ICP torch is cleaned every other day, or when necessary with 1:1 HNO_3 The torch is dipped in the HNO_3 solution for 10-15 minutes, then flushed thoroughly with reagent water. Excess water is removed with Kimwipes to complete the process.

13.2 The spray chamber is soaked in 1:1 HNO_3 solution and sonicated weekly or when necessary for 10-15 minutes, then thoroughly rinsed with reagent water. Excess water is removed with Kimwipes.

13.3 The nebulizer is soaked in 1:1 HNO_3 solution for 15 minutes, and then flushed with reagent water.

13.4 Internal standard and sample uptake pump tubing is changed daily. Red-red sample waste tubing is changed weekly or as needed. Complete the maintenance form with any changes made to the instrument.

13.5 Spare parts are kept on hand in case of breakage or equipment failure.

13.6 Further instructions for general maintenance are outlined in the maintenance log and should

UNCONTROLLED COPY

be carried out as needed. Specific instructions for all maintenance procedures required can be found in the Perkin Elmer WinLab 32 Instrument Control Software Guide.

13.7 TROUBLESHOOTING PE OPTIMA 4300 DV

Symptom	Cause (s)	Corrective Action (s)
You are not getting the desired results	Pump Tubing: Is the tubing overstretched or does it have flat spots, leaks, or discoloration. Capillary Tubing: Are the nebulizer and sample capillary tubing properly connected? Is the tubing discolored or clogged? Is tubing crimped or pinched? Nebulizer and Spray Chamber: Is there leakage around the end cap? Is there leakage from the spray chamber drain? Is fluid accumulating in the torch? Check the nebulizer spray pattern: Run deionized water for several minutes, and then remove the end nebulizer cap. Is the nebulizer spray sputtering or uneven? Are there deposits inside the end cap or spray chamber? Torch Assembly: Is the quartz torch cloudy or dirty? Is the injector dirty? Purge Window: Is the purge window cloudy or diry?	Install new tubing, stretching it gently beforehand. If the capillary tubing is not in condition, replace it. Make sure the end cap is on securely. If you cannot get a secure fit, the end cap O-ring may need to be replaced. Check the drain fitting and tubing to be sure the spray chamber is being properly drained. Check that the waste is being pumped in the proper direction. If the spray pattern is uneven, the nebulizer tips may be clogged or worn. Disassemble the nebulizer and clean or replace the Gem Tips. Clean out deposits. Check for deposits and clean torch. The injector may be clogged and require cleaning. Rinse with deionized water and Dry with a soft cloth. Or, replace if necessary.
Results erroneously high	Corrections may not have been made for the reagent blank: Standard solutions may have been deteriorated or improperly made:	Aspirate a blank and rerun the standards and samples Restandardize with a proven standard.

UNCONTROLLED COPY

Symptom	Cause (s)	Corrective Action (s)
Results erroneously low	Standard solutions may have been improperly made: Blank solution may be contaminated:	Rerun proven standards. Remake the blank solution.
RSD (Relative Standard Deviation Greater than 1%)	Does the sample have a high viscosity or high percentage of dissolved solids? Look for carryover: RF power and/or nebulizer argon flow may require adjustment:	Try increasing the integration time. Increase the rinse time to flush the sample introduction system completely. Adjust as necessary.
Plasma will not light	Check ignitor: Exhaust vent: Torch Connections: RF Coil: Torch Glassware: Drain: Argon: Injector:	Check that the ignitor contact finger is making contact with the tape on the bottom of the torch glassware. Be certain that your exhaust vent is operating properly and is not blocked. Verify that all gas fittings to the torch are finger-tight. The torch should be cleaned and in good condition. Check the RF coil for condensation. Dry the coil with a soft cloth if necessary. Check the condition of the torch glassware. If it is cloudy or dirty, clean it in a 5-20% nitric acid solution. Check the drain tubing for flat spots and replace the tubing if necessary. Check that the drain fitting on the spray chamber is secure. Be sure that the pump is properly draining the spray chamber and that the drain is not backing up in the torch. Check that the argon supply is on. Check that the pressure at the cylinder regulator is at 80-120 psig. Check that the injector is not clogged.

UNCONTROLLED COPY

Symptom	Cause (s)	Corrective Action (s)
	Nebulizer End Cap and Fittings: Sample Capillary:	Check that it is tightle secured to the spray chamber. Check that it is attached to the nebulizer.
Autosampler does not respond:	There may be a GPIB communication problem. One of the cables may have been disconnected or the autosampler may have been turned off.	Use the Instrument Diagnostics window to reset the autosampler. Check the power cable and the cable connecting the autosampler to the computer. Make sure the power is on.
Detector Cooling Time Exceeded (fatal):	The Cooling system for the Spectrometer was not able to contain or maintain the detector temperature. The system shuts down to prevent damage to the detectors:	Check the external cooling water supply and water filter. Make sure that the chiller is on and sufficiently filled. Make sure that the laboratory temperature is between 10C˚ to 35C˚. Make sure that there are no heat emitting devices near the spectrometer. After checking the above click on the Initialize button on the spectrometer page of the Diagnostics window to begin the warm-up. The warm up will require 15 to 75 minutes depending on the length of time the spectrometer was disabled. Before calling service, turn off the power to the spectrometer and wait a few minutes. Turn the spectrometer back on and restart the software. If the problem goes away, monitor the system and if the problem reappears contact Perking Elmer Service.
Nitrogen Flow Error	Spectrometer nitrogen purge gas flow was interrupted:	Check the nitrogen supply and make sure that the connection between the supply and the spectrometer is correct and that the nitrogen supply is set between 30 to 80 psig.

UNCONTROLLED COPY

13.8 When documenting maintenance log for non-routine instrument problems, certain information is necessary:

1. List the symptoms.
2. Document what you think is wrong.
3. Document what you did to correct the problem.
4. Document if the corrective action worked.
5. Document when instrument was returned to control, initial and date.
6. Ask supervisor to check maintenance log for correct information, initial and date.

14.0 FORMS

14.1 ICP-OP2 Runlog

14.2 ICP-OES Interelement Corrections Logbook

14.3 ICP-OES Instrument Alignment Logbook

14.4 Maintenance Logbook

14.5 DOD/DOE QSM Forms

15.0 SAFETY

15.1 Warning is given to people with pacemakers that prolong presence near instrument could adversely affect the function of pacemakers. All contact with high voltages sections, i.e., RF generator is limited solely to trained manufacturer representatives.

15.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals should be reduced to the lowest possible level. Gloves should be worn at all times during sample and standard preparation, and caution should be taken when odors are present. Hoods are available at various locations in the laboratory and should be used. All preparation of standards and spike solutions should be performed under a hood if solvent exposure is expected to be excessive.

15.3 BC Laboratories has a safety program established to deal with any questions an analyst has regarding his/her safety. This program is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in the method. A reference file for MSDS sheets is also available to all personnel involved in chemical

UNCONTROLLED COPY

analyses.

15.4 Safety meetings are conducted to educate employees, solicit input from the employee on job hazards, and provide a forum for discussion regarding the Health and Safety Program. For further information consult the Employee Safety Handbook.

15.5 All radioactive material must be handled in accordance with Radiation Safety Standard Operating Procedures. Consult the Radiation Safety Officer with any questions.

15.6 Eye protection should be worn at all times while in the Lab.

16.0 WASTE MANAGEMENT

16.1 All laboratory waste management practices are conducted in accordance with all applicable Environmental Protection Agency rules and regulations. All waste solutions that contain any acid will be put into the acid waste stream for proper disposal.

16.2 Refer to the SOP for RAD waste disposal and the SOP for storage and inspection of hazardous waste containers.

17.0 REFERENCES

17.1 Method 200.7, EPA "Determination of Metals and Trace Elements in Water and Wastes by Inductively Couples Plasma-Atomic Spectroscopy", Revision 4.4 EMMC Version. May 1994.

17.2 Perkin Elmer "WinLab 32 Instrument Control Software Guide", Perkin Elmer Inc., 2000.

17.3 Method 6010A, "Inductively Coupled Plasma - Atomic Emission Spectroscopy", Revision 1, July 1992.

17.4 Method (SW846), EPA "Methods for evaluation of Solid Waste Physical/Chemical", third edition, September 1986.

17.5 Method 6010B, "Inductively Coupled Plasma-Atomic Emission Spectrometry', Revision2, December, 1996.

17.6 SM 2340B. - "Standard Methods for the Examination of Water and Wastewater" – 22nd Edition, 2012

UNCONTROLLED COPY

APPENDIX

UNCONTROLLED COPY

ROUNDING RULES FOR REPORTING DATA

For proper rounding of analytical results, the number of significant figures available must be determined. All digits in a reported result should be known with confidence except for the last digit, which may be in doubt. If additional digits which are doubtful are reported they are considered to be not significant.

The number of significant digits available at the time of rounding is based on the instrument reading and any handling of the sample which took place prior to the analysis (weighing, graduated cylinder measurement, dilution, etc.). The analysis of various concentrations of standards over a number of days can provide insight into how many digits are reliable at any given concentration based on the relative standard deviation (RSD). Once this is determined, a chart of concentration verses significant figures can be constructed and values calculated as follows:

1. Compare the raw instrument reading with the chart of significant figures at various levels of concentration to determine how many significant figures can be reported.
2. Use all the available digits to calculate the result prior to rounding.
3. Round the result to the number of significant figures found in step 1.
4. Report the value.

One of the repercussions of this calculation is that when samples have been diluted so that the instrument reading is just above the PQL, most tests have a limited number of significant figures that can be reported.

Take for example the following table for the cyanide test by AAII. Below 0.05 mg/L on the instrument, only 2 significant figures can be reported. Therefore if a sample is diluted by X50 and the instrument reading is 0.01234 one would first see how many significant figures can be reported from that instrument reading of 0.01234 on the table. Finding the correct number to be 2, the value of 0.01234 X 50 is calculated as 0.617 mg/L. However, since this value can only be reported with 2 significant figures, the reported value will be 0.62 mg/L. If this same sample had an instrument reading of 0.1234 at a X 5 dilution then the reported value would be 0.617 since this instrument reading (0.1234) is within the range where 3 significant figures can be reported.

Table 2: Significant Figures

Conc. mg/L	%RSD	Sig. Figures
0		
0.005	6.999984	2
0.02	3.603742	2
0.05	0.316422	3
0.1	0.498379	3
0.2	0.101059	3

Rounding off numbers is the process of dropping digits that are not significant. In order to round off a number to a particular place holder (for example, to the nearest 10) one looks at the next smallest place holder (the 1's place). If the next smallest place holder is a 6,7,8 or 9, then increase the preceding digit by one and drop the digits to the right (if to the right of the decimal) or replace them with zeros (if to the left of the decimal). If the next smallest place holder is a 1, 2, 3 or 4, then do not change the preceding digit and drop the digits to the right or replace with zeros. If the next smallest place holder is a 5 and any number to the right of the 5 is not zero, then treat it as 6,7,8 or 9 as above. If the next smallest place holder is a 5 and all

UNCONTROLLED COPY

digits to the right of this digit are zero, then round the preceding digit to the nearest even number (0,2,4,6,8) and drop the digits to the right or replace with zeros. Thus, 2.250001 becomes 2.3 and 2.250000 becomes 2.2, and 6.750 becomes 6.8. Do not round off previously rounded values. In other words, do not round off during a preliminary calculation. Carry as many digits as possible until the final value has been calculated and then round off as needed based on the significant digits available.

UNCONTROLLED COPY

Table 3: Interference Correction Table

Element	Wavelength (nm)	Interferants
Ag 328.068	328.068	Fe, Mn, V
Al 308.215 ®	308.213	Co, Mo, V
As 188.979	188.982	Ca, Cr, Fe, Mo
B 249.677	249.674	Co, Cr, Fe, Mo
Ba 233.527 ®	233.526	Fe, V
Be 313.107	313.105	Cr
Ca 315.887®	315.889	Co, Cr, Mo
Cd 214.440 ®	214.436	--
Co 228.616	228.617	Ba, Cr, Mo, Ni, Ti
Cr 267.716	267.707	Al, Mg, Mn, V
Cu 324.752	324.755	Fe, Mo
Fe 238.204®	238.205	Co
K 766.490	766.496	--
K 766.490®	766.496	--
Li 670.784®	670.799	--
Mg 279.077®	279.077	--
Mn 257.610®	257.610	Fe
Mo 202.031	202.032	--
Na 589.592	589.600	--
Na 589.592®	589.600	--
Ni 231.604	231.605	Fe, Sb, Tl
Pb 220.353	220.354	Al, Ca, Fe, Mo, Ni
Sb 206.836	206.834	Cr, Mo, Sn, Ti, V
Se 196.026	196.026	Ca, Co, Fe, Mg
Si 251.611	251.611	Fe, Mg, Mn, Mo, Sn
Sn 189.927	189.928	Ti
Sr 421.552 ®	460.744	Al, Ca, Fe, Mg
Ti ® 334.940	334.946	Ca, Cr
Tl 190.801	190.795	Ca, Co, Mg, Mn, Mo, Ti, V
V 290.880	290.883	Cr, Fe, Mg, Mo, Tl
Zn 206.200	206.199	Cr, Fe

UNCONTROLLED COPY

	Table 4.1 Calibration Stock Standard for Std 1A, Std 2 and Std 3			
PE ICP STD 1	1 % HNO_3 + 10% HCL			
	Concentrations in mg/L 0.5%			
	AL	1000		
	Sb	10		
	As	10		
	Ba	50		
	Be	10		
	B	50		
	Cd	50		
	Ca	1000		
	Cr	10		
	Co	10		
	Cu	10		
	Fe	1000		
	Pb	10		
	Li	50		
	Mg	1000		
	Mn	50		
	Mo	50		
	Ni	10		
	K	1000		
	Se	10		
	Si	50		
	Ag	5		
	Na	1000		
	Sr	50		
	Tl	10		
	Sn	10		
	Ti	50		
	V	10		
	Zn	50		

	Table 4.2 Calibration Standard Std 3						
Standard	Element	Conc. (mg/L) unless noted			Reagent Name		Amount
Cal Std 1		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	100					
	Sb	1					
	As	1					
	Ba	5					
	Be	1					
	B	5					

UNCONTROLLED COPY

	Cd	5					
	Ca	100					
	Cr	1					
	Co	1					
	Cu	1					
	Fe	100					
	Pb	1					
	Li	5					
	Mg	100					
	Mn	5					
	Mo	5					
	Ni	1					
	K	100					
	Se	1					
	Si	5					
	Ag	0.5					
	Na	100					
	Sr	5					
	Tl	1					
	Sn	1					
	Ti	5					
	V	1					
	Zn	5					
					Amount of Stock =		100
					Reagent Water		840
					Total =		1000

	Table 4.3 Calibration Standard Std 2						
Standard	Element	Conc. (mg/L) unless noted			Reagent Name		Amount
Cal Std 1		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	50					
	Sb	.5					
	As	.5					
	Ba	2.5					
	Be	.5					
	B	2.5					
	Cd	2.5					
	Ca	50					
	Cr	.5					
	Co	.5					
	Cu	.5					
	Fe	50					
	Pb	.5					
	Li	2.5					

UNCONTROLLED COPY

	Mg	50					
	Mn	2.5					
	Mo	2.5					
	Ni	.5					
	K	50					
	Se	.5					
	Si	2.5					
	Ag	0.25					
	Na	50					
	Sr	2.5					
	Tl	.5					
	Sn	.5					
	Ti	2.5					
	V	.5					
	Zn	2.5					
					Stock Standard =		50 ml
					Reagent Water		890
					Total =		1000

	Table 4.4 Calibration Stock For Standard 1 (PQL Std.)			
PE ICP STD 1	1 % HNO_3 + 10% HCL			
	Concentrations in mg/L			
	AL	50		
	Sb	20		
	As	10		
	Ba	3		
	Be	1		
	B	100		
	Cd	3		
	Ca	100		
	Cr	10		
	Co	2		
	Cu	10		
	Fe	50		
	Pb	5		
	Li	20		
	Mg	50		
	Mn	10		
	Mo	10		
	Ni	8		
	K	1000		
	Se	20		
	Si	100		
	Ag	10		

UNCONTROLLED COPY

	Na	500		
	Sr	10		
	Tl	100		
	Sn	50		
	Ti	10		
	V	2		
	Zn	10		

	Table 4.5 Calibration Standard Std 1						
Standard	Element	Conc. (µg/L) unless noted			Reagent Name		Amount
Cal Std 1		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	50					
	Sb	20					
	As	10					
	Ba	3					
	Be	1					
	B	100					
	Cd	3					
	Ca	100					
	Cr	10					
	Co	2					
	Cu	10					
	Fe	50					
	Pb	5					
	Li	20					
	Mg	50					
	Mn	10					
	Mo	10					
	Ni	8					
	K	1000					
	Se	20					
	Si	100					
	Ag	10					
	Na	500					
	Sr	10					
	Tl	100					
	Sn	50					
	Ti	10					
	V	2					
	Zn	10					
					Stock Standard =		1 ml
					Reagent Water		939
					Total =		1000

UNCONTROLLED COPY

	Table 4.6 Calibration Standard Std 1A						
Standard	Element	Conc. (mg/l) unless noted			Reagent Name		Amount
Cal Std 1A		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	25					
	Sb	0.25					
	As	0.25					
	Ba	1.25					
	Be	0.25					
	B	1.25					
	Cd	1.25					
	Ca	25					
	Cr	0.25					
	Co	0.25					
	Cu	0.25					
	Fe	25					
	Pb	0.25					
	Li	1.25					
	Mg	25					
	Mn	1.25					
	Mo	1.25					
	Ni	0.25					
	K	25					
	Se	0.25					
	Si	1.25					
	Ag	0.125					
	Na	25					
	Sr	1.25					
	Tl	0.25					
	Sn	0.25					
	Ti	1.25					
	V	0.25					
	Zn	1.25					
					Stock Standard =		1 ml
					Reagent Water		939
					Total =		1000

UNCONTROLLED COPY

	Table 5.1 ICV Stock Standard			
	1% HNO_3 + 10% HCL			
	Concentrations in mg/L 0.5%			
	Al	1000		
	Sb	10		
	As	10		
	Ba	50		
	Be	10		
	B	50		
	Cd	50		
	Ca	1000		
	Cr	10		
	Co	10		
	Cu	10		
	Fe	1000		
	Pb	10		
	Li	50		
	Mg	1000		
	Mn	50		
	Mo	50		
	Ni	10		
	K	1000		
	Se	10		
	Si	50		
	Ag	5		
	Na	1000		
	Sr	50		
	Tl	10		
	Sn	10		
	Ti	50		
	V	10		
	Zn	50		

	Table 5.2 ICV1						
Standard	Element	Conc. (mg/L) unless noted			Reagent Name		Amount
ICV1		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	100					
	Sb	1					
	As	1					
	Ba	5					
	Be	1					
	B	5					
	Cd	5					

UNCONTROLLED COPY

	Ca	100					
	Cr	1					
	Co	1					
	Cu	1					
	Fe	100					
	Pb	1					
	Li	5					
	Mg	100					
	Mn	5					
	Mo	5					
	Ni	1					
	K	100					
	Se	1					
	Si	5					
	Ag	0.5					
	Na	100					
	Sr	5					
	Tl	1					
	Sn	1					
	Ti	5					
	V	1					
	Zn	2.5					
					Stock Standard		50
					Reagent Water		890
					Total =		1000

	Table 5.3 CCV						
Standard	Element	Conc. (mg/L) unless noted			Reagent Name		Amount
CCV		1%			Concentrated HNO_3		10
		5%			Concentrated HCL		50
	Al	100					
	Sb	1					
	As	1					
	Ba	5					
	Be	1					
	B	5					
	Cd	5					
	Ca	100					
	Cr	1					
	Co	1					
	Cu	1					
	Fe	100					
	Pb	1					
	Li	5					
	Mg	100					

UNCONTROLLED COPY

	Mn	5					
	Mo	5					
	Ni	1					
	K	100					
	Se	1					
	Si	5					
	Ag	0.5					
	Na	100					
	Sr	5					
	Tl	1					
	Sn	1					
	Ti	5					
	V	1					
	Zn	2.5					
					Stock Standard		50
					Reagent Water		890
					Total =		1000

	Table 6.1 Water Spike Stock Standard			
PE ICP WATER SPIKE	1% HNO_3 + 10% HCL			
	Concentrations in mg/L 0.5%			
	Al	50		
	Sb	20		
	As	10		
	Ba	20		
	Be	10		
	B	50		
	Cd	10		
	Ca	500		
	Cr	10		
	Co	10		
	Cu	20		
	Fe	50		
	Pb	20		
	Li	10		
	Mg	500		
	Mn	25		
	Mo	10		
	Ni	20		
	K	500		
	Se	10		
	Si	500		
	Ag	5		
	Na	500		

UNCONTROLLED COPY

	Sr	25		
	Te	20		
	Sn	10		
	Ti	50		
	V	10		
	Tl	20		
	Zn	25		

	Table 6.2 Soil Spike Stock Solution			
PE ICP SOIL SPIKE	1% HNO_3 + 10% HCL			
	Concentrations in mg/L 0.5%			
	Al	500		
	Sb	100		
	As	10		
	Ba	100		
	Be	10		
	B	100		
	Cd	10		
	Ca	500		
	Cr	100		
	Co	100		
	Cu	100		
	Fe	500		
	Pb	100		
	Li	50		
	Mg	500		
	Mn	200		
	Mo	100		
	Ni	100		
	K	500		
	Se	10		
	Si	50		
	Ag	10		
	Na	100		
	Sr	10		
	Tl	100		
	Sn	10		
	Ti	10		
	V	100		
	Zn	100		
	Li	10		

UNCONTROLLED COPY

Table 7 Interference Check Standard Table				
Std. Name	**Element**	**Conc.(mg/L) unless noted**	**Reagent Name**	**Amount (mls)**
IFA	-	1%	Concentrated HNO_3	10
	-	5%	Concentrated HCl	50
	Al	1000		
	Ca	1000		
	Fe	400		
	Mg	1000		
	-	-	IF A Stock Standard	100
			Reagent water	840
			Total =	1000
IFB		1%	Concentrated HNO_3	10
		5%	Concentrated HCl	50
	Ag	2.0		
	Ba	1.0		
	Be	1.0		
	Cd	2.0		
	Co	1.0		
	Cr	1.0		
	Cu	1.0		
	Mn	1.0		
	Ni	2.0		
	Pb	2.0		
	V	1.0		
	Zn	2.0		
			IF A Stock Standard	100
			IF B Stock Standard	10
			Reagent Water	830
			Total =	1000

UNCONTROLLED COPY

Table 13	
ICP Instrument Operating Conditions	
RF power	1500 watts
Viewing height above work coil	15 mm
Nebulizer Flow	.65 L/min
Auxillary Flow	0.2 L/min
Plasma Flow	16 L/min
Coolant flow rate	15 L/min.
Sample uptake rate controlled to	.75 ml./min.
Spray Chamber Heater	30 F

UNCONTROLLED COPY

Form 14.1

BC LABORATORIES, INC. PE-OP2 LOGBOOK OPTIMA 4300 DV

AUTO SAMPLER TABLE

DATE:_____ ANALYST:_____

Digestion Method_____ Analysis Method_____ Sample Matrix_____

1	23	45
2	24	46
3	25	47
4	26	48
5	27	49
6	28	50
7	29	51
8	30	52
9	31	53
10	32	54
11	33	55
12	34	56
13	35	57
14	36	58
15	37	59
16	38	60
17	39	61
18	40	62
19	41	63
20	42	64
21	43	65
22	44	66
SEQUENCE # _____	_____	_____

Blank:	_____	ICV:	_____
STD-1:	_____	CCV:	_____
IFA:	_____	ICB/CCB:	_____
IFB:	_____	SPIKE: (MS/MSD)	_____
Post Spike:	_____	PIPETTE CALIBRATION 0.2 ml =_____g @ _____°C	

79 [S:\WPDOCS\WordPerfect\LAB_DOCS\LOOGBOOKS\ICP4300LG

Form 14.2

BC LABORATORIES, INC. INTERELEMENT CORRECTION FACTORS OPTIMA 4300 DV

Matrix : Water Method: 200.7/6010B

Analyst Initial	Date	Affecting Element * I.D. Conc. mg/L	Affected Element	Affecting Element (A) Instrument Reading mg/L	Affected Element (B) Instrument Reading mg/L	Calculated (C) IEC Factor B÷A	Existing (D) IEC Factor	New Factor D+C

*All Standards traceable To New Standards Logbook

Raw Data Attachment ❑

[H:\DOCS\WP80\LAB_DOCS\LOGBOOKS\IT4300LG]

FORM 14.3

BC LABORATORIES, INC. ICP-OES INSTRUMENT ALIGNMENT LOGBOOK MONTH _____ YEAR 201_____

Init.	DATE	TIME	Path Offset(nm)	Drift(nm)	Slit Adjustment	TIME	X-viewing(mm)	X-Peak Intensity	TIME	X-viewing(mm)	Y-viewing(mm)	Y-Peak Intensity	Y-Peak Intensity
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												
	26												
	27												
	28												
	29												
	30												
	31												

17

S\WPDOCS\WordPerfect\LAB_DOCS\LOGBOOKS\DOE4300LG

FORM 14.4

BC LABORATORIES, INC. **ICP-OES MAINTENANCE LOGBOOK**

MONTH _____ YEAR 201__

	DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	INITIALS																															
Daily Start up	Secure nebulizer cap																															
	Check or change capillary tubing																															
	Check to see if RF coil is clean and dry																															
	Check pump & drain functions																															
	Check hood & recirculator																															
Daily Shut Down	Flush system for 5 min. after running sample																															
	Release tubing when finished																															
Weekly	Sonicate spray chamber																															
	Clean nebulizer w/nitric acid solution																															
	Check database for information to archive or delete																															
Monthly	Clean filters																															
If Needed	Replace Nebulizer																															
	Replace Torch																															
	Replace Probe																															

COMMENTS:

22

C:\MyDOCS\WordPerfect\LAB_DOCS\LOGBOOKS\DOEMNTLG2

FORM 10.5

Table – 8. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Linear Dynamic Range (LDR) or high-level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range.	Within ± 10% of true value.	Dilute samples within the calibration range, or re-establish/ verify the LDR.	Flagging is not appropriate.	Data cannot be reported above the high calibration range without an established/passing high-level check standard.
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, $r^2 \geq 0.99$.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.

Table – 8. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Continuing Calibration Verification (CCV)	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level Calibration Check Standard (Low-level ICV)	Daily.	All reported analytes within ± 20% of true value.	Correct problem and repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard (LLICV). Low-level calibration check standard should be less than or equal to the LOQ.
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

Table – 8. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Interference Check Solutions (ICS) (also called Spectral Interference Checks)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the failed ICS.	All analytes must be within the LDR. ICS-AB is not needed if instrument can read negative responses.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Must contain all reported analytes. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to the source(s) of difference, i.e., matrix effect or analytical error.

Table – 8. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes ≤ 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.
Dilution Test	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 x LOQ (prior to dilution). Use along with MS/MSD and PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition (ICP only)	Perform if MS/MSD fails. One per preparatory batch (using the same sample as used for the MS/MSD if possible).	Recovery within 80-120%.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria applies for samples with concentrations <50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution test or post digestion spike fails and if required by project.	NA.	NA.	NA.	Document use of MSA in the case narrative.

UnControlled Copy:
Issued To:
Approved By: Inorganic Supervisor
Approval Date: 05/19/2015
Effective Date: 10/17/2016
Printed Date:
Location:
Printed By:

Note: ISM procedures are presented in Section 4.10.8.1 through 4.11. The subsampling procedure in Section 4.10.8.3 is the Japanese slabcake procedure.

1.0 SCOPE AND APPLICATION

1.1 This procedure is applied to all samples except water samples. The purpose is to homogenize samples prior to analytical work and split into appropriate containers for preparation, analyzing or subcontracting.

2.0 SUMMARY OF METHOD

2.1 The sample is divided into multiple aliquots. One aliquot is left undisturbed for organic testing. Another sample aliquot is subjected to various particle size methods to homogenize the sample; this sample aliquot is used for inorganic testing and for subcontracting. All sample aliquots are placed into refrigerators.

3.0 APPARATUS AND MATERIALS

3.1 EQUIPMENT

3.1.1 Butcher Paper, Paper Bags, Tarp

3.1.2 Sample Containers: 8 oz. glass jars with labels and lids, VOA vials, 2 oz. cups, 5 x 6 plastic bag, 6 x 9 plastic bag

3.1.3 Protective Equipment: Gloves, Eye Protection, Tyvek Suit, Hearing Protection, Face Shield, Respirator, Particle Masks.

3.1.4 Tools: Spatula, Scissors, Tin snips, Trowels, Hammer, Hack saw, Butcher knife, Machette, Magnet, Screwdrivers (flat blade & philips), Vise, Box Cutter, Mortar & pestle, Chisel, Sieves, Wiley Mill grinder, Rock crusher, Pulverizer

3.1.5 Sieve: #10 (2 mm) stainless steel, plastic or Teflon.

3.1.6 Logbook and Date Stamper

4.0 PROCEDURE

4.1 The prep person receives a copy of all chain of custodies for samples that require splitting. Determine if the sample needs to be split for subcontract tests by comparing the tests requested with the list of subcontracted tests as found in the appendix of this method.

4.2 The prep person logs the samples to be split out of the walk-in refrigerator. "Logging out" is defined as documenting the work order and lab number, prep person's initials, date and time of sample removal. The same information is documented in the logbook at the time the sample is returned to the refrigerator.

4.3 Avoid keeping samples out of the refrigerator for long periods of time to reduce exposure to the warmer room temperatures.

4.4 From this point the procedure may be different and the sample handled differently depending on the type of sample, the type and the number of containers.

4.5 Normally, split samples are placed in 8 oz. clear glass jars for storage in the split sample refrigerators or in the subcontract refrigerator in the sample receiving area for shipping to a subcontract laboratory. These jars are labeled with the same sample number and container ID as the sample from which they are split.

4.6 Clean butcher paper is spread out on the counter where the sample is to be split to avoid cross contamination between samples. Other tools used for crushing or grinding solid samples or stirring of liquid samples should also be cleaned between samples.

4.7 Composite samples from multiple containers are prepared by taking equal amounts of well mixed sample (either by weight or by volume) from each container and mixing them together. Use the first bottle designator (A, B, C, etc.) as the designator for the composite and add the word "Composite" to the label. Leave a portion of the original discreet sample in the original container for possible future testing of the discreet samples that make up the composite.

4.8 Record all split samples into the Sample Split/Preparation Log. Information recorded should be the Laboratory number, date, a physical description of the sample (light colored soil, oily water, clear yellow liquid, etc.), the Title 22 sample type (Type i, ii, iii or Liquid with <0.5% solids), a short description of the preparation required (mix only, crush and mix, crush and composite, etc.), the department that will receive the split, the subcontracted test if any and the technicians initials.

4.9 Have the splitting procedure reviewed by a peer or supervisor to document that the samples were split and labeled correctly. This review is recorded in the log with the reviewer's initials.

4.10 Sample types and their processing

4.10.1 Wipe samples: Do not split wipe samples. Whatever material is on the wipe is not evenly distributed and cannot be homogenized. The entire wipe and solids or liquids in the sample jar are required to be tested for each prep/analysis requested.

4.10.2 Type i: Millable solid with no free liquid.

4.10.2.1 The portion of the sample to be split (if not the entire sample) should be placed on the covered counter. The sample should be passed or ground to pass through a No. 10 (two millimeter) sieve. If the sample contains non-friable solid particles which do not pass through the sieve and which are extraneous and irrelevant as hazardous constituents to the sample, they may be removed to the extent feasible by mechanical means and discarded.

4.10.2.2 The portion of the sample which passed directly through the sieve and that which was ground to pass through the sieve are then mixed thoroughly to make the sample homogenous before the split portion is transferred to the split jar or jars.

4.10.3 Type ii: Filterable liquids with 0.5% or more solids.

4.10.3.1 If the sample can be homogenized by thorough mixing and/or shaking and a representative portion transferred to a split sample jar then the split portion should be taken in this way.

4.10.3.2 If the solids drop to the bottom of the container or float to the top when mixing is stopped and a representative portion cannot be transferred to a split sample jar then the solids and liquids should be separated so they can be split separately.

4.10.3.2.1 Allow the solids to settle or separate from the liquid portion of the sample and then separate the two phases by physical means. This may involve decanting the liquid, skimming the solids off the top or other physical means to separate the phases. The two phases do not need to be completely separated for this step (i.e. some liquid may remain in the solids and some solids may remain in the liquids). The two phases need only be separated to the point that they can be mixed or shaken and a representative portion removed for analysis. The solids should be crushed or ground as needed to make representative sub-sampling possible.

4.10.3.2.2 Weigh the two phases and calculate the percent of each phase in the original sample.

4.10.3.2.3 Split a portion of each phase into separate split jars and tape the two split jars together. Indicate on each jar that the split represents only one phase of the sample and what percentage of the sample it represents so the analyst or prep person can reconstitute the original mixture of the two phases at the time they weigh out the sub-sample for analysis.

4.10.4 Type iii: Nonfilterable, nonmillable sludge, slurry or oily tarry or resinous material

4.10.4.1 The sample should be mixed as best as is possible depending upon its nature and any extraneous material which is non-friable and larger than will pass through a No. 10 (two millimeter) sieve and which is irrelevant as hazardous constituents to the sample shall be removed by physical means.

4.10.4.2 A portion of the mixed sample is transferred to a split jar and labeled.

4.10.5 Liquid samples with < 0.5% solids

4.10.5.1 Mix the sample by shaking or stirring so that the solids are uniformly dispersed in the liquid and quickly pour out a representative portion into a split sample jar.

4.10.6 Liquid samples with multiple phases (typically oil and water)

4.10.6.1 If the sample can be homogenized by thorough mixing and/or shaking and a representative portion transferred to a split sample jar then the split portion should be taken in this way.

4.10.6.2 If the two phases separate too quickly when mixing is stopped and a representative portion cannot be transferred to a split sample jar then the two phases should be separated so they can be split separately in the same way as the Type ii samples above which separate too quickly.

4.10.6.3 Split the two phases separately and tape the split jars together and label them in the same fashion as the Type ii samples above.

4.10.7 Wood chips and solid fuels

4.10.7.1 Wood chip samples require special handling to make the sub-samples representative because the contaminants (metals, dirt, etc.) are often

concentrated in the fine particles which settle to the bottom and are difficult to include.

4.10.7.2 Empty the sample container onto the clean bench top or other clean surface.

4.10.7.3 Manually separate the fines (< ½" pieces) from the larger chips. This may require lifting and shaking the larger chips and moving them to another pile or picking out the larger pieces from the pile of fines.

4.10.7.4 Mix each pile separately using either the rolling pile technique or the coned pile technique as outlined below to create a homogeneous mixture.

4.10.7.5 Divide each pile into 4 equal size sections using a large spatula or other tool and take two sections which are on opposite sides of the pile to represent half of each pile.

4.10.7.6 Repeat this halving procedure until ½ the piles represent the size of sub-sample required for subcontracting and in house testing. Each pile (the fines and the larger pieces) must be halved the same number of times.

4.10.7.7 Combine the final ½ pile of the fines with the ½ pile of the larger chips and mix thoroughly. Transfer the mixture to a jar or plastic bag and label with the laboratory and container number of the original container.

4.10.8 Multi-Increment Samples (MIS): Samples collected using multi-increment sampling techniques based on the approaches developed by Pierre Gy (USEPA, 1999c; Pitard, 1993).

4.10.8.1 Soil drying: Dry the entire soil sample only if necessary to allow for sieving. This may not be appropriate for volatile organics and possibly some semi-volatiles in which case another splitting technique should be employed. Dry at room temperature in a paper bag, turning and mixing the soil occasionally to facilitate the drying process.

4.10.8.2 Sieving: Sieve the entire sample through a #10 (2 mm) sieve without crushing or grinding particles which do not pass the sieve. Dirt clods may require crushing to pass but do not crush rocks, sticks or other large particles. Sieving only a portion of the sample invalidates the MIS technique. Save the portion which does not pass the sieve for future reference in a jar stored with the original sample containers with an appropriate label to indicate this portion was not included in the testing.

4.10.8.3 Sub-sampling: Arrange the sieved sample on a piece of butcher paper on the table in a long pile using a plastic or wooden spatula. The pile should

be only about ½ in. in depth and only about 2 in. wide. Using a piece of card stock paper or file folder material form a square cornered trough or "U" shaped scoop to take cross sections of the pile. Each cross sectional scoop should be approximately 1 g (about ½ teaspoon) of soil and should include all particles within the cross section. Collect 30 to 50 scoops from equally spaced sections of the pile and transfer them to a pre-weighed 8 oz. glass jar. Weigh and record the weight of the sample on the jar so organics can perform their extraction in the jar and use the weight in their prep log. The normal extraction for semi-volatile organics uses 30 g.

4.10.8.4 Sub-sample additional jars as needed using a minimum of 30 scoops in each jar to provide for each extraction, any subcontracted portions, a jar for metals (if needed) and one extra subsample used for moisture analysis and as a backup to the other analyses.

4.10.8.5 Return the left over portion to the original sample container for storage and label each sub-sample jar with a unique letter for entry into the LIMS and tracking purposes.

4.11 Sample Splitting Techniques:

4.11.1 Rolling pile technique

4.11.1.1 The sample to be split is placed on a sheet of butcher paper or other suitable clean cloth, paper or plastic depending on it's size and weight.

4.11.1.2 The corner of the sheet is lifted and pulled at a low angle across the surface of the sample on a diagonal line to cause the sample to roll over itself.

4.11.1.3 Repeat this rolling technique on the diagonal lines with the other corners of the sheet for 50 to 100 times to mix the sample thoroughly.

4.11.1.4 At this point the pile is spread out and divided into quarters using a large spatula or other tool.

4.11.1.5 Opposing quarters are rejected from the sample leaving ½ the original pile.

4.11.1.6 This process is repeated until the sample size is reduced to the appropriate amount.

4.11.2 Coning technique

4.11.2.1 The sample is mixed by shoveling or pilling the sample into the shape of a

cone.

4.11.2.2 Scoops or from all sides of the pile are placed on the apex of the cone and allowed to run down the sides. The scoops should be taken from all around the pile and the cone should not move from its original position.

4.11.2.3 The pile can be flattened from time to time to make scoops easier to pick up.

4.11.2.4 Once the pile is thoroughly mixed it can be flattened and quartered to reduce its size by ½ as in the rolling pile technique.

4.11.2.5 Coning and quartering should be repeated until the sample size is reduced to the appropriate amount.

4.12 Protocol for samples requiring volatile organics testing (8260, TPH Gas):

4.12.1 Soil Sleeves: Take the split sample from one end of the sleeve leaving the other end intact and undisturbed.

4.12.2 Single opening containers: Upon opening the container, fill a VOA vial with sample. Seal, label and deliver the sample to the appropriate analyst or the volatiles department supervisor.

4.12.3 Multiple containers requiring composite: Prepare the composite as quickly as possible and then fill, seal, label and deliver the VOA vial.

4.13 Vapor Pressure Analysis:

4.13.1 Vapor pressure on petroleum or petroleum products (gasoline, diesel, etc.) is performed on containers which have not been opened. The client must submit a separate container for the vapor pressure analysis if there are multiple tests to be performed.

4.13.2 Samples cannot be split or composites prepared for vapor pressure analysis.

5.0 FORMS

5.1 Table 1: Subcontract tests and required volumes

5.2 Sample Split/Preparation Log

5.3 Walk-in Refrigerator Sample/Tracking Logbook

6.0 SAFETY

6.1 Respiratory Protection

6.1.1 As a minimum, wear a particle mask.

6.1.2 Respirators

6.1.2.1 Use a respirator when a sample is known to contain hazardous constituents.

6.1.2.2 Usage of respirators is limited to personnel who have been trained, fitted, and certified for respiratory usage. If you do not meet these requirements, then do not split the sample; consult your supervisor.

6.2 Skin Protection

6.2.1 Disposable gloves must be worn at all times when handling, grinding or sieving sample.

6.3 Special precautions

6.3.1 Use Tyvek suit and respirator when splitting samples suspected to contain asbestos.

6.3.2 Use goggles when splitting sulfur cakes or grinding wood or rocks. The dust may irritate eyes if only safety glasses are worn.

APPENDIX

Table 1
Subcontract Work

Analysis	Lab (Subject to change)	Minimum Sample Needed
Fish Toxicity (Aquatic Bioassay, 96 hr LC50)	Aquatic Testing Lab	25 grams
TOC-9060	Advanced Technologies	20 ml
Gypsum	Zalco	50 grams
Organic Pb(Solids)-DOHS/Luft Method	Alpha Analytical	100 grams
Organic Pb(Water)-DOH/Luft Method	Alpha Analytical	500 ml minimum
TOX-9020	Advanced Technologies	5 grams
Total Nitrogen	Desert Analytical	1 gram
Asbestos	EMSL	1/5 of a sandwich bag
Flash Pt./Ignitability	Zalco	½ 8oz. Jar
Total Sulfides-9030	Zalco	3 grams
Salmonella	Biovir	½ 8oz. Jar
Dioxins & Furans-8280-8290	Maxam	½ 8oz. Jar
Total Fluoride	Columbia (Bellack Distillation)	½ 8oz. Jar
Ethylene-Glycol-8015	Zalco	½ 8oz. Jar
Methanol-8015	Cal Science	1 (one) VOA vial
Vapor Pressure (True or Reid)	Zalco	Original un-opened container

BC LABORATORIES, INC.

SAMPLE SPLIT/PREPARATION LOG										REVIEW				
LABORATORY ID	DATE/TIME	PHYSICAL DESCRIPTION OF THE SAMPLE	TITLE 22 SAMPLE TYPE	PREPARATION DONE	SPLIT FOR			SPLIT FOR OUT	TECHNICIAN INITIALS	SPLIT PORTION CONSISTENT WITH ORIGINAL	NUMBERING CORRECT	DATE	REQUIRES RE-SPLIT	REVIEWERS INITIALS
					O	GC	FP							

O - Organics Dept. GC - General Chemistry FP - Flashpoint

C:\...\My Documents\WordPerfect Docs\LAB_DOCS\LOGBOOKS \SSPRP1LG

1

BC LABORATORIES, INC

WALK-IN REFRIGERATOR
SAMPLE/TRACKING LOGBOOK

Sample No.	Date Removed	Time Removed	Initials	Date Returned	Time Returned	Initials

C:\...\My Documents\Word Docs\LABDOCS\LOGBOOKS\WLKINLOG

SGS LABORATORY SOPS

GC 014.14	Analysis of Polychlorinated Biphenyls by Gas Chromatography, Electron Capture Detector
GC 015347	Analysis of Organochlorine Pesticides by Gas Chromatography, Electron Capture Detector
MET 100.15	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry
MET 104.12	Digestion of Soils for ICP Analysis (including Incremental Sampling Methodology Sample Preparation Methods [see Appendix A])

ANALYSIS OF POLYCHLORINATED BIPHENYLS BY GAS CHROMATOGRAPHY, ELECTRON CAPTURE DETECTOR

Prepared by: Norm Farmer Date: 08/19/17

Approved by: Mike Eger Date: 08/21/17

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 08/25/17

Issued to: SVOC Department Date: * 08/25/17

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: ANALYSIS OF POLYCHLORINATED BIPHENYLS BY GAS CHROMATOGRAPHY, ELECTRON CAPTURE DETECTOR

REFERENCES: SW846 8082A

REVISED SECTIONS: 1.1.3-1.1.7, 1.2.3, 4.5, 7.1.3, 7.2, 7.4.1.2, 7.4.3, 9.2.1, 9.3.1, 10.0 and 11.1

1.0 SCOPE AND APPLICATION, SUMMARY

1.1 Scope and Application

1.1.1 This method is used to determine the polychlorinated biphenyl (PCB) concentrations in water, solid, and waste matrices utilizing a gas chromatograph equipped with an electron capture detector.

1.1.2 PCBs for this method are reported as Aroclors. Aroclors are multi-component mixtures consisting of various chlorinated biphenyl congeners. Quantitation is based on individual Aroclor standards. For the purpose of this SOP, the term Aroclor and PCB may be used interchangeably. The following compounds can be reported by this method:

Aroclor 1016	Aroclor 1221	Aroclor 1232
Aroclor 1242	Aroclor 1248	Aroclor 1254
Aroclor 1260	Aroclor 1262	Aroclor 1268

1.1.3 The Lower Limit of Quantitation (LLOQ) or Reporting limits (RL) are based on the extraction procedure and the lowest calibration standard. LLOQs may vary depending on matrix complications and volumes. LLOQs for this method are in the range of 0.5 ug/l for aqueous samples, 33 ug/kg for solid samples, 1ug/wipe for surface wipe samples, and 10 mg/kg for oil samples. Solid matrices are reported on a dry weight basis.

1.1.4 The Method Detection Limit (MDL) for each analyte is evaluated on an annual basis for each matrix and instrument. MDLs are pooled for each matrix, and the final pooled MDLs are verified. The verified MDLs are stored in the LIMS and should be at least 2 to 3 times lower than the LLOQ. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported LLOQ.

1.1.5 The LLOQ for each analyte is evaluated on an annual basis for each matrix and instrument. The LLOQ verifications are prepared by spiking a clean matrix at 0.5 to 2 times the current LLOQ level. This LLOQ verification is carried through the same preparation and analytical procedures as the samples. Recovery of the analytes should be within the established limits. The DOD QSM requirements for

Limit of Detection (LOD) and Limit of Quantitation (LOQ) verifications are different. See SOP QA020 for complete requirements for MDL, LOD, LOQ, and LLOQ.

1.1.6 Compounds detected at concentrations between the LLOQ and MDL are quantitated and qualified as estimated values and reported with either a "J" or "I" qualifier. Some program or project specifications may require that no values below the LLOQ be reported.

1.1.7 For DOD projects refer to QSM 4.2, Table F2; QSM 5.0, Table 1; or QSM 5.1 Table B-1 for additional method requirements and data qualifying guidance.

1.2 Summary

1.2.1 This method is adapted from SW846 method 8082A.

1.2.2 Samples are received, stored and extracted within the appropriate holding times.

1.2.3 Sample preparation is performed in accordance with SGS Accutest - Orlando SOP OP008, OP009, or OP033.

1.2.4 The extracts are analyzed on a gas chromatograph equipped with dual electron capture detectors.

1.2.5 Manual integrations are performed in accordance with SOP QA029.

2.0 PRESERVATION AND HOLDING TIME

2.1 Preservation

2.1.1 Samples shall be collected in amber glass bottles with Teflon lined caps. One-liter or 250ml bottles are used for aqueous samples and 4oz jars are recommended for solid samples.

2.1.2 The samples must be protected from light and refrigerated at ≤ 6°C from the time of collection until extraction. The extracts must be stored at ≤ 6°C until analysis.

2.2 Holding Time

2.2.1 Aqueous samples must be extracted within 7 days of collection.

2.2.2 Solid and waste samples must be extracted within 14 days of collection.

2.2.3 Extracts must be analyzed within 40 days of extraction.

3.0 INTERFERENCES

3.1 Data from all blanks, samples, and spikes must be evaluated for interferences.

3.2 Method interferences may be caused by contaminants in solvents, reagents, or glassware. Interferences from phthalate esters can be eliminated by using plastic-free solvent containers and solvent rinsed glassware.

3.3 Other organic compounds, including chlorinated pesticides, chlorinated hydrocarbons, phenols, and phthalate esters may be co-extracted by this method. Many of these interferences can be removed by sulfuric acid cleanup.

3.4 Interferences from sulfur compounds can be eliminated using either a tetrabutyl ammonium sulfite (TBA) cleanup or an activated copper powder cleanup. Regional samples are generally high in sulfur content; therefore, all sample extracts may be sulfur cleaned prior to analysis.

3.5 The DDT analogs (DDT, DDE, and DDD) are frequently co-extracted with the PCBs. A single point DDT analog standard should be analyzed periodically to show if any PCB peaks are subject to interference.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. For all GC and HPLC methods, a CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

4.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the LLOQ.

4.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.10 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

4.12 Surrogate: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Surrogates are used to measure the extraction efficiency.

5.0 REAGENTS

5.1 Hexane – pesticide grade or equivalent

5.2 PCB Stock standards – Traceable to Certificate of Analysis

5.3 Surrogate standard – TCMX and Decachlorobiphenyl

5.4 DDT analogs standard – Mixture of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD

6.0 APPARATUS

6.1 Gas Chromatograph – Agilent Technologies 6890 or 7890 with 7683 Autosampler

Suitable gas chromatograph equipped with a split-splitless injection port and electron capture detectors.

Autosampler allows for unattended sample and standard injection throughout the analytical run.

6.2 Data System – Agilent Technologies MS Chemstation rev. DA 03.0x or EA 02.0x.

6.2.1 A computer system interfaced to the gas chromatograph that allows for the continuous acquisition and storage of all data obtained throughout the duration of the chromatographic program.

6.2.2 Data is archived to a backup server for long term storage.

6.3 Dual CLP PEST/PEST2 or equivalent: 30m X 0.53mm X 0.50/0.42um
Dual MR1/MR2 or equivalent: 30m X 0.53mm X 0.5um

6.4 Gas-tight syringes and class "A" volumetric glassware for dilutions of standards and extracts.

7.0 PROCEDURE

7.1 Standards Preparation

Standards are prepared from commercially available certified reference standards. All standards must be logged in the Semivolatile Standards Logbook. All standards shall be traceable to their original source. The standards should be stored at ≤ 6°C, or as recommended by the manufacturer. Calibration levels, spike and surrogate concentrations, preparation information, and vendor part numbers can be found in the GC STD Summary in the Active SOP directory.

7.1.1 Stock Standard Solutions

Stock standards are available from several commercial vendors. All vendors must supply a "Certificate of Analysis" with the standard. The certificate will be retained by the lab. Hold time for unopened stock standards is until the vendor's expiration date. Once opened, the hold time is reduced to one year or the vendor's expiration date (whichever is shorter).

7.1.2 Intermediate Standard Solutions

Intermediate standards are prepared by quantitative dilution of the stock standard with hexane. The hold time for intermediate standards is six months or the vendor's expiration date (whichever is shorter). Intermediate standards may need to be remade if comparison to other standards indicates analyte degradation or concentration changes.

7.1.3 Calibration Standards

Calibration standards for PCB 1016 and 1260 are prepared at a minimum of five concentration levels through quantitative dilutions of the intermediate standard. The low standard is at a concentration at or below the LLOQ and the remaining standards define the working range of the detector.

Standards for the remaining PCBs are made at a single level near the low to mid-point of the curve. **NOTE:** Some projects may require that samples with positive detects for any of the remaining PCBs be reanalyzed and quantitated using a 5-point calibration.

Calibration standard concentrations for PCB 1016 and PCB 1260 are verified by the analysis of an initial calibration verification (ICV) standard. Additional ICV standards for the other PCBs may be required.

7.2 Gas Chromatograph Conditions

2-3ul autosampler injection Splitless or 2:1 split injection

Carrier gas – UHP Hydrogen (3.0 ml/min) or (8.0 ml/min)

Detector gas – UHP Nitrogen (45-90 ml/min)

Injection port temperature – 200 °C Detector temperature – 325 °C

Oven program – 125 °C for 0.5 minutes
35 °C/min to 250 °C for 0 minutes
25 °C/min to 310 °C for 4 minutes

GC conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

7.3 Sample Preparation

7.3.1 Water Samples

A 250ml or 1000ml aliquot of sample is extracted with methylene chloride utilizing separatory funnel extraction. The extract is solvent exchanged into hexane, concentrated to 5.0ml, sulfur cleaned, and acid cleaned.

7.3.2 Solid Samples

A 15-gram aliquot of sample is extracted with hexane:acetone utilizing pulse sonication or microwave extraction. The extract is concentrated, adjusted to 5ml with hexane, sulfur cleaned, and acid cleaned.

7.3.3 Surface Wipe Samples

A wipe sample is extracted with hexane utilizing a wrist shaker. The extract may then be sulfur cleaned or acid cleaned.

7.3.4 Oil Samples

A one-gram aliquot of sample is diluted in hexane to 10ml. The extract may then be sulfur cleaned or acid cleaned.

7.4 Gas Chromatographic Analysis

Instrument calibration consists of three major sections:

Initial Calibration Procedures
Daily Calibration Procedures
Continuing Calibration Verification

7.4.1 Initial Calibration Procedures

Before samples can be run, the chromatographic system must be calibrated, retention time windows must be determined, pattern recognition standards must be analyzed and DDT analogs interference check must be analyzed.

7.4.1.1 External Standard Calibration

Prime the GC by injecting a conditioning standard, this is a high level PCB standard. This will aid in deactivating the injection port and column.

Quantitation for this method is based on the response of individual peaks in each individual PCB standard. Three to six major peaks from each Aroclor are used for quantitation purposes. Each individual PCB peak is assigned the concentration of the total PCB standard.

A minimum 5-point calibration curve is created for PCB 1016, PCB 1260, TCMX, and Decachlorobiphenyl. PCB 1016 and 1260 are used to establish linearity for all of the PCBs.

The remaining PCBs are calibrated at a single level in the low to mid-point range of the PCB 1016/1260 curve. The single point standards are also used for pattern recognition.

NOTE: DoD QSM projects require a 5-point calibration for all PCBs.

Historically, many analytical methods have relied on linear models of the calibration relationship, where the instrument response is directly proportional to the amount of a target compound. The linear model has many advantages including simplicity and ease of use. However, given the advent of new detection techniques and because many methods cannot be optimized for all the analytes to which they may be applied, the analyst is increasingly likely to encounter situations where the linear model neither applies nor is appropriate. The option of using non-linear calibration may be necessary to address specific instrumental techniques. However, it is not EPA's intent to allow non-linear calibration to compensate for detector saturation or avoid proper instrument maintenance.

NOTE: Because of this concern, select programs including SC DHEC do not support the use of non-linear regressions.

Calibration factors (CF) for PCBs are determined at each concentration by dividing the total area (or height) of the PCB (3 to 6 major peaks) by the concentration of the standard. Calibration factors for the surrogate are determined at each concentration by dividing the area (or height) of the peak by the concentration of the standard.

The mean CF and standard deviation of the CF are determined for each analyte. The percent relative standard deviation (%RSD) of the calibration factors is calculated for each analyte as follows:

%RSD = (Standard Deviation of CF X 100) / Mean CF

If the %RSD $\leq$ 20%, linearity through the origin can be assumed and the mean CF can be used to quantitate target analytes in the samples. Alternatively a calibration curve of response vs. amount can be plotted. This method allows for the use of average response factors, linear regressions, and non-linear regressions. Linear regressions may be unweighted or weighted as $1/x$ or $1/x^2$. If the correlation coefficient (r) is $\geq$0.995 (r^2 $\geq$0.990) then the curve can be used to quantitate target analytes in the samples.

NOTE: If a non-linear calibration curve (quadratic) is used for PCB 1016 and/or 1260, then the remaining PCBs such as 1221, 1232, 1242, 1248, 1254, 1262, and 1268 must be calibrated using a multipoint technique.

Regardless of which calibration model is chosen, the laboratory should visually inspect the curve plots to see how the individual calibration points compare to the plot.

Alternatively either of the two techniques described below may be used to determine whether the calibration function meets acceptable criteria. These involve refitting the calibration data back to the model. Both % Error and Relative Standard Error (RSE) evaluate the difference between the measured and the true amounts or concentrations used to create the model.

Calculation of the % Error

% ERR = (xi-x'i) / xi * 100

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

Percent error between the calculated and expected amounts of an analyte should be ≤ 30% for all standards. For some data uses, ≤50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n} \left[\frac{x_i' - x_i}{x_i}\right]^2 \Big/ (n-p)}$$

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

p = Number of terms in the fitting equation. (average = 1, linear = 2, quadratic = 3)

n = Number of calibration points.

The %RSE acceptance limit criterion is ≤20%.

7.4.1.2 Initial Calibration Verification (ICV)

The validity of the initial calibration curve must be verified through the analysis of an initial calibration verification (ICV) standard. The ICV should be prepared from a second source at a mid-range concentration.

The %D for all analytes of interest should be ≤ 20%. If the ICV does not meet this criteria, a second standard should be prepared. If the ICV still does not meet criteria, analyze an ICV prepared from a third source. If this ICV meets criteria, proceed with sample analysis.

For any DoD QSM project, if samples must be analyzed with a target analyte having a %D > 20%, then the data must be qualified accordingly.

If the ICV still does not meet criteria, determine which two standards agree. Make fresh calibration standards and an ICV from the two sources that agree. Recalibrate the instrument.

7.4.1.3 Retention Time Windows

Retention time windows must be established whenever a new column is installed in an instrument or whenever a major change has been made to an instrument.

Individual PCB peaks must fall within the appropriate retention time windows; however, Aroclor identification is based primarily on individual peak ratios and pattern recognition.
Retention time windows are crucial to the identification of target compounds. Absolute retention times are used for compound identification in all GC and HPLC methods that do not employ internal standard calibration. Retention time windows are established to compensate for minor shifts in absolute retention times that result from normal chromatographic variability. The width of the retention time window should be carefully established to minimize the occurrence of both false positive and false negative results.

Retention time windows are established by injecting all standard mixes three times over the course of 72 hours. The width of the retention time window for each analyte, surrogate, and major constituent in multi-component analytes is defined as ± 3 times the standard deviation of the mean absolute retention time or 0.03 minutes, whichever is greater.

Establish the center of the retention time window for each analyte and surrogate by using the absolute retention time for each analyte and surrogate from the calibration verification standard at the beginning of the analytical shift. For samples run during the same shift as an initial calibration, use the retention time of the mid-point standard of the initial calibration.

Peak identification is based on the retention time of a peak falling within the retention time window for a given analyte. Time reference peaks (surrogates) are used to correct for run-to-run variations in retention times due to temperature, flow, or injector fluctuations.

The retention time windows should be used as a guide for identifying compounds; however, the experience of the analyst should weigh heavily in the interpretation of the chromatograms. The analyst should monitor the retention times of known peaks (standards and surrogates) throughout an instrument run as an indication of instrument performance.

Because calculated retention time windows are generally very tight (less than ± 0.03 minutes), the retention time windows for the data processing method are generally set wider than the calculated window. This is done to ensure that the software does not miss any potential “hits”. The analyst will then review these “hits” and determine if the

retention times are close enough to the retention time of the target analyte to positively identify the peak or to require confirmation.

7.4.1.4 DDT Analogs Interference Check

Analyze a DDT analogs standard consisting of DDT, DDE, and DDD at a concentration near the midpoint of the PCB calibration curve. Overlay the DDT analogs standard with the mid-level PCB standard (and single point standards) and determine if there are any interferences. Note on the runlog which PCB peaks co-elute with the DDT series. Instrument conditions should be optimized to minimize interferences.

The analyst must be aware of these co-eluting peaks when quantitating samples that may contain DDT series. It may be necessary to omit a co-eluting peak in order to obtain the most accurate value.

7.4.2 Daily Calibration Procedures

Prime the GC by injecting a conditioning standard, this is a high level PCB standard. This will aid in deactivating the injection port and column.

Analyze a continuing calibration verification standard (section 7.4.3) for PCB 1016 and PCB 1260. Then analyze the PCBs that are calibrated at a single concentration level.

The single point standards must be analyzed every 24 hours; they do not have to be analyzed at the same frequency as the CCV standard. For DoD QSM projects the CCVs for the other PCBs should be analyzed at the same frequency as PCB 1016 and PCB 1260.

NOTE: DoD QSM projects require CCVs for each PCB to be analyzed throughout the sequence.

7.4.3 Continuing Calibration Verification (CCV)

Continuing calibration verification standards for PCB 1016 and PCB 1260 are prepared at various concentrations (CCV standards for other PCBs may be required); at least one CCV must be below the mid-point of the calibration curve. A continuing calibration standard must be analyzed at the beginning and end of each run to verify that the initial calibration is still valid. Additionally a CCV must be analyzed after every 10 samples.

The percent difference (%D) for each analyte of interest will be monitored. The |%D| should be $\leq$ 20% for each analyte.

If the first continuing calibration verification does not meet criteria, a second standard may be injected. If the second standard does not meet criteria, the system must be

recalibrated. If the second standard meets criteria then the system is considered in control and results may be reported.

Rationale for second standard such as instrument maintenance, clipped column, remade standard, etc should be documented in the run log or maintenance log. Reanalysis of second standard without valid rationale may require the analysis of a third standard (in which case both the second and third standard would have to pass).

NOTE: For any DoD QSM project, if the second standard meets criteria, then a third standard must be analyzed. If the third standard also meets criteria then the system is considered in control and results may be reported.

If the |%D| is greater than 20%, then documented corrective action is necessary. This may include recalibrating the instrument and reanalyzing the samples, performing instrument maintenance to correct the problem and reanalyzing the samples, or qualifying the data. Under certain circumstances, the data may be reported. i.e. The CCV failed high, the associated QC passed, and the samples were ND.

NOTE: For any DoD QSM project, if samples must be reported with a target analyte having a %D > 20%, then the data must be qualified accordingly, regardless of whether the analyte was detected or not.

NOTE: Samples that are being reported to the State of California require that the |%D| ≤ 15% for each analyte.

NOTE: Any target analytes that are detected in the samples must be bracketed by an acceptable initial calibration curve and acceptable CCV standards; otherwise, the samples must be reanalyzed or the data must be qualified.

7.4.4 Sample Extract Analysis

7.4.4.1 Samples are analyzed in a set referred to as an analysis sequence or batch. A batch consists of the following:

Conditioning Standard
Initial Calibration Standards (or Initial CCV)
Single Point Standards
QC Extracts
Sample Extracts
CCV Standards

7.4.4.2 One or two microliters (same amount as standards) of extract is injected into the GC by the autosampler. A splitless injection technique is used. The data system then records the resultant peak responses and retention times.

7.4.4.3 Tentative identification of an analyte occurs when the peaks from the sample extract fall within the established retention time windows for a calibrated compound on the primary column.

7.4.4.4 If the peaks of interest fall within the retention time windows on the confirmation column, the identification is confirmed. Quantitation of the analyte on the primary and confirmation column should agree within 40%. If the difference is greater than 40% and no obvious reason can be found, the higher result should be reported and flagged as "estimated"; otherwise, the result from the primary column should be reported.

7.4.4.5 Pattern comparisons should also be used to aid in the identification of the multipeak analytes.

7.4.4.6 If the compound identification does not confirm on a dissimilar column, then the result should be reported as ND or "U".

7.4.4.7 If the analyte response exceeds the linear range of the system, the extract must be diluted and reanalyzed. It is recommended that extracts be diluted so that the response falls into the middle of the calibration curve.

7.4.4.8 If peak or pattern identification is prevented by the presence of interferences, further cleanup may be required or the extract must be diluted so that the interference does not mask any analytes.

7.5 Maintenance and Trouble Shooting

7.5.1 Refer to SOP GC001 for routine instrument maintenance and trouble shooting.

7.5.2 All instrument maintenance must be documented in the appropriate "Instrument Repair and Maintenance" log. The log will include such items as problem, action taken, correction verification, date, and analyst.

7.5.3 Repairs performed by outside vendors must also be documented in the log. The analyst or Department Supervisor responsible for the instrument must complete the log if the repair technician does not.

7.5.4 PC and software changes must be documented in the "Instrument Repair and Maintenance" log. Software changes may require additional validation.

8.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method

performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to statistically generated control limits. These control limits are reviewed and updated annually. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

9.0 QUALITY ASSURANCE / QUALITY CONTROL

Accuracy and matrix bias are monitored by the use of surrogates and by the analysis of a QC set that is prepared with each batch (maximum of 20 samples) of samples. The QC set consists of a method blank (MB), blank spike (BS), matrix spike (MS), and matrix spike duplicate (MSD).

9.1 Surrogates

9.1.1 Tetrachloro-m-xylene (TCMX) and Decachlorobiphenyl are used as the surrogate standards to monitor the efficiency of the extraction and clean-up procedures.

A known amount of surrogate standard is added to each sample including the QC set prior to extraction. The percent recovery for each surrogate is calculated as follows:

% Recovery = (Sample Amount / Amount Spiked) X 100

The percent recovery must fall within the established control limits for both surrogates for the results to be acceptable.

9.1.2 If the surrogate recoveries are not within the established control limits, the following are required.

9.1.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, or surrogate solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.1.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.1.2.3 If no problem is found, re-extract and reanalyze the sample. **NOTE:** If the recoveries are high and the sample is non-detect, then re-extraction may not be necessary. For any DoD QSM projects the resulting data must be qualified accordingly. If there is insufficient sample for re-extraction, reanalyze the sample and footnote this on the report.

9.1.2.4 If upon reanalysis, the recovery is still not within control limits, the problem is considered matrix interference. Surrogates from both sets of analysis should be reported on the final report.

9.2 Method Blank

9.2.1 The method blank is either de-ionized water or sodium sulfate (depending upon sample matrix) to which the surrogate standard has been added. The method blank is then extracted and taken through all cleanup procedures along with the other samples to determine any contamination from reagents, glassware, or high level samples. The method blank must be free of any analytes of interest or interferences at ½ the required LLOQ to be acceptable. If the method blank is not acceptable, corrective action must be taken to determine the source of the contamination. Samples associated with a contaminated method blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-extracting and reanalyzing the samples or qualifying the results with a “B” or “V” qualifier.

9.2.2 If the MB is contaminated but the samples are non-detect, then the source of contamination should be investigated and documented. The sample results can be reported without qualification.

9.2.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination should be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. This must be approved by the department supervisor.

9.2.4 If the MB is contaminated but the samples results are < 10 times the contamination level, the source of the contamination should be investigated and documented. The samples should be re-extracted and reanalyzed for confirmation. If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.3 Blank Spike

9.3.1 The blank spike is either de-ionized water or sodium sulfate (depending upon sample matrix) to which the surrogate standard and spike standard have been added. The blank spike is then extracted and taken through all cleanup procedures along with the other samples to monitor the efficiency of the extraction procedure. The percent recovery for each analyte is calculated as follows:

$$\% \text{ Recovery} = (\text{Blank Spike Amount} / \text{Amount Spiked}) \times 100$$

The percent recovery for each analyte of interest should fall within the established control limits for the results to be acceptable.

NOTE: A secondary check against 70-130% limits should be performed for all analytes reported to SC DHEC.

9.3.2 If the blank spike recoveries are not within the established control limits, the following are required.

9.3.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, or spike solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.3.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

9.3.2.3 Check to see if the recoveries that are outside of control limits are analytes of concern. If the analytes are not being reported, additional corrective action is not necessary and the sample results can be reported without qualification.

9.3.2.4 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable. For any DoD QSM projects the resulting data must be qualified accordingly.

9.3.2.5 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples, re-extracting and reanalyzing the samples, or qualifying the results as estimated.

9.3.2.6 If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.4 Matrix Spike and Matrix Spike Duplicate

9.4.1 Matrix spike and spike duplicates are replicate sample aliquots to which the surrogate standard and spike standard have been added. The matrix spike and spike duplicate are then extracted and taken through all cleanup procedures along with the other samples to monitor the precision and accuracy of the extraction procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = [(Spike Amount – Sample Amount) / Amount Spiked] X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable.

9.4.2 If the matrix spike recoveries are not within the established control limits, the following are required.

9.4.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, or spike solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.4.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.4.2.3 If no problem is found, compare the recoveries to those of the blank spike. If the blank spike recoveries indicate that the problem is sample related, document this on the run narrative. Matrix spike recovery failures are not grounds for re-extract but are an indication of the sample matrix effects.

9.4.3 Precision

Matrix spike and spike duplicate recoveries for each analyte are used to calculate the relative percent difference (RPD) for each compound.

RPD = [| MS Result – MSD Result | / Average Result] X 100

The RPD for each analyte should fall within the established control limits. If the RPDs fall outside of the established control limits, the MS and MSD should be reanalyzed to ensure that there was no injection problem. If upon reanalysis the RPDs are still outside of the control limits, the department supervisor shall review the data and determine if any further action is necessary. RPD failures are generally not grounds for re-extraction.

10.0 CALCULATIONS

The amount of the PCB in the samples is determined by averaging the concentration of the major peaks for each individual PCB. The MS Chemstation software will automatically sum and average the peaks used for each individual Aroclor.

The concentration of each individual PCB peak in the original sample is calculated as follows:

PCB Water (ug/l) = $(CONC_{inst})$ X (V_F / V_I) X DF

PCB Soil (ug/kg) = $[(CONC_{inst})$ X (V_F / W_I) X DF] / %solids

$CONC_{inst}$	=	Instrument concentration calculated from the initial calibration using mean CF, curve fit, or single point
DF	=	Dilution Factor
V_F	=	Volume of final extract (ml)
V_I	=	Volume of sample extracted (ml)
W_I	=	Weight of sample extracted (g)
%solids	=	Dry weight determination in decimal form

All soils are reported on a dry weight basis.

11.0 SAFETY AND POLLUTION PREVENTION

11.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS Health and Safety Program, which includes the use of safety glasses, gloves, and lab coats.

The toxicity of each reagent and target analyte has not been precisely defined; however, each reagent and sample should be treated as a potential health hazard. Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) are available for all reagents and many of the target analytes. Exposure must be reduced to the lowest possible level. Personal protective equipment should be used by all analysts.

11.2 Pollution Prevention

Waste solvents from the sample analysis and standards preparation are collected in waste storage bottles and are eventually transferred to the non-chlorinated waste drum.

Sample Extracts are archived and stored for 60 days after analysis. Old extracts and standards are disposed of in the waste vial drum.

12.0 REFERENCES

SW846 Method 8000D Revision 4, July 2014

SW846 Method 8082A Revision 1, February 2007

ANALYSIS OF ORGANOCHLORINE PESTICIDES BY GAS CHROMATOGRAPHY, ELECTRON CAPTURE DETECTOR

Prepared by: Norm Farmer Date: 08/19/17

Approved by: Mike Eger Date: 08/21/17

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 10/23/16

Issued to: SVOC Department Date: * 10/23/16

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: ANALYSIS OF ORGANOCHLORINE PESTICIDES BY GAS CHROMATOGRAPHY, ELECTRON CAPTURE DETECTOR

REFERENCES: SW846 8081B

REVISED SECTIONS: 1.1.2-1.1.7, 1.2.3, 4.5, 7.2, 7.1.3, 7.4.1.2, 7.4.2, 7.4.3, 9.2.1, 9.3.1, 10.0 and 11.1

1.0 SCOPE AND APPLICATION, SUMMARY

1.1 Scope and Application

1.1.1 This method is used to determine the concentrations of specific organochlorine pesticides in water and solid matrices utilizing a gas chromatograph equipped with an electron capture detector.

1.1.2 The following compounds can be reported by this method:

Aldrin	Dieldrin
Alpha-BHC	Endosulfan I
Beta-BHC	Endosulfan II
Delta-BHC	Endosulfan Sulfate
Gamma-BHC (Lindane)	Endrin
Chlordane (Technical)	Endrin Ketone
Alpha-chlordane	Endrin Aldehyde
Gamma-chlordane	Heptachlor
4,4'-DDD	Heptachlor Epoxide
4,4'-DDE	Methoxychlor
4,4'-DDT	Toxaphene

1.1.3 The Lower Limit of Quantitation (LLOQ) or Reporting limits (RL) are based on the extraction procedure and the lowest calibration standard. LLOQs may vary depending on matrix complications and volumes. LLOQs for the single peak pesticides in this method are in the range of 0.05 to 0.10 ug/l for aqueous samples and 1.7 to 3.3 ug/kg for solid samples. Solid matrices are reported on a dry weight basis.

1.1.4 The Method Detection Limit (MDL) for each analyte is evaluated on an annual basis for each matrix and instrument. MDLs are pooled for each matrix, and the final pooled MDLs are verified. The verified MDLs are stored in the LIMS and should be at least 2 to 3 times lower than the LLOQ. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported LLOQ.

1.1.5 The LLOQ for each analyte is evaluated on an annual basis for each matrix and instrument. The LLOQ verifications are prepared by spiking a clean matrix at 0.5 to 2 times the current LLOQ level. This LLOQ verification is carried through the same preparation and analytical procedures as the samples. Recovery of the analytes should be within the established limits. The DOD QSM requirements for Limit of Detection (LOD) and Limit of Quantitation (LOQ) verifications are different. See SOP QA020 for complete requirements for MDL, LOD, LOQ, and LLOQ.

1.1.6 Compounds detected at concentrations between the LLOQ and MDL are quantitated and qualified as estimated values and reported with either a "J" or "I" qualifier. Some program or project specifications may require that no values below the LLOQ be reported.

1.1.7 For DOD projects refer to QSM 4.2, Table F2; QSM 5.0, Table 1; or QSM 5.1 Table B-1 for additional method requirements and data qualifying guidance.

1.2 Summary

1.2.1 This method is adapted from SW846 method 8081B.

1.2.2 Samples are received, stored and extracted within the appropriate holding times.

1.2.3 Sample preparation is performed in accordance with SGS Accutest - Orlando SOP OP008 and OP009.

1.2.4 The extracts are analyzed on a gas chromatograph equipped with dual electron capture detectors.

1.2.5 Manual integrations are performed in accordance with SOP QA029.

2.0 PRESERVATION AND HOLDING TIME

2.1 Preservation

2.1.1 Samples shall be collected in amber glass bottles with Teflon lined caps. One-liter or 250ml bottles are used for aqueous samples and 4oz jars are recommended for solid samples.

2.1.2 The samples must be protected from light and refrigerated at ≤ 6°C from the time of collection until extraction. The extracts must be stored at ≤ 6°C until analysis.

2.2 Holding Time

2.2.1 Aqueous samples must be extracted within 7 days of collection.

2.2.2 Solid and waste samples must be extracted within 14 days of collection.

2.2.3 Extracts must be analyzed within 40 days of extraction.

3.0 INTERFERENCES

3.1 Data from all blanks, samples, and spikes must be evaluated for interferences.

3.2 Method interferences may be caused by contaminants in solvents, reagents, or glassware. Interferences from phthalate esters can be eliminated by using plastic-free solvent containers and solvent rinsed glassware.

3.3 Other organic compounds, including PCBs, chlorinated hydrocarbons, phenols, and phthalate esters may be co-extracted by this method.

3.4 Interferences from sulfur compounds can be eliminated using a tetrabutyl ammonium sulfite (TBA) or activated copper powder cleanup. Regional samples are generally high in sulfur content; therefore, all sample extracts should be sulfur cleaned prior to analysis.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. For all GC and HPLC methods, a CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

4.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the LLOQ.

4.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.10 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

4.12 Surrogate: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Surrogates are used to measure the extraction efficiency.

5.0 REAGENTS

5.1 Hexane – pesticide grade or equivalent

5.2 Pesticide stock standards – Traceable to Certificate of Analysis

5.3 Surrogate standard – TCMX and Decachlorobiphenyl

6.0 APPARATUS

6.1 Gas Chromatograph – Agilent Technologies 6890 or 7890 with 7683 Autosampler

Suitable gas chromatograph equipped with a split-splitless injection port and electron capture detectors.

Autosampler allows for unattended sample and standard injection throughout the analytical run.

6.2 Data System – Agilent Technologies MS Chemstation rev. DA 00.01, DA 03.0x or EA 02.0x.

6.2.1 A computer system interfaced to the gas chromatograph that allows for the continuous acquisition and storage of all data obtained throughout the duration of the chromatographic program.

6.2.2 Data is archived to a backup server for long term storage.

6.3 Dual MR1/MR2 (multiresidue) Column or equivalent: 30m X 0.53mm X 0.50um
Dual CLP/CLP2 Column or equivalent: 30m X 0.50mm X 0.5/0.42um

6.4 Gas-tight syringes and class "A" volumetric glassware for dilutions of standards and extracts.

7.0 PROCEDURE

7.1 Standards Preparation

Standards are prepared from commercially available certified reference standards. All standards must be logged in the Semivolatile Standards Logbook. All standards shall be traceable to their original source. The standards should be stored at ≤ 6°C, or as recommended by the manufacturer. Calibration levels, spike and surrogate concentrations, preparation information, and vendor part numbers can be found in the GC STD Summary in the Active SOP directory

7.1.1 Stock Standard Solutions

Stock standards are available from several commercial vendors. All vendors must supply a "Certificate of Analysis" with the standard. The certificate will be retained by the lab. Hold time for unopened stock standards is until the vendor's expiration date. Once opened, the hold time is reduced to one year or the vendor's expiration date (whichever is shorter)

7.1.2 Intermediate Standard Solutions

Intermediate standards are prepared by quantitative dilution of the stock standard with hexane. The hold time for intermediate standards is six months or the vendor's expiration date (whichever is shorter). Intermediate standards may need to be remade if comparison to other standards indicates analyte degradation or concentration changes.

7.1.3 Calibration Standards

Calibration standards for the single peak pesticides are prepared at a minimum of five concentration levels through quantitative dilutions of the intermediate standard. The low standard is at a concentration at or below the LLOQ and the remaining standards define the working range of the detector.

Standards for the multipeak pesticides (Toxaphene and Technical Chlordane) are made at a single level near the RL. **NOTE:** Some projects may require that samples with positive detects for either toxaphene or technical chlordane be reanalyzed and quantitated using a 5-point calibration.

Calibration standard concentrations for the single peak pesticides are verified by the analysis of an initial calibration verification (ICV) standard.

7.2 Gas Chromatograph Conditions

4ul autosampler injection Splitless or 2:1 split injection

Carrier gas – UHP Hydrogen (5-10 ml/min ramped flow)

Detector gas – UHP Nitrogen (45 - 90 ml/min)

Injection port temperature – 190 -200 °C Detector temperature – 325 - 350 °C

Oven program – 160 °C for 0.5 minutes
25 °C/min to 320 °C for 2.0 minutes
Or
120 °C for 0 minutes
45 °C/min to 200 °C
12.5 °C/min to 230 °C
20 °C/min to 320 °C for 2.0 minutes

Pressure Program – 5.0 ml/min for 1.0 minute
1.0 ml/min to 10.0 ml/min for 0 minutes

GC conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

7.3 Sample Preparation

7.3.1 Water Samples

A 250ml or 1000ml aliquot of sample is extracted with methylene chloride utilizing separatory funnel extraction. The extract is solvent exchanged into hexane, concentrated to 5.0ml, and sulfur cleaned.

7.3.2 Solid Samples

A 15-gram aliquot of sample is extracted with hexane:acetone utilizing pulse sonication or microwave extraction. The extract is concentrated, adjusted to 5.0ml with hexane, and sulfur cleaned.

7.4 Gas Chromatographic Analysis

Instrument calibration consists of three major sections:

Initial Calibration Procedures
Daily Calibration Procedures
Continuing Calibration Verification

7.4.1 Initial Calibration Procedures

Before samples can be run, injection port inertness must be verified, the chromatographic system must be calibrated, and retention time windows must be determined.

7.4.1.1 Breakdown Check

Prime the GC by injecting a conditioning standard; this is a pesticide standard that is approximately 20 times the concentration of the mid-level standard. This will aid in deactivating the injection port and column.

Endrin and DDT breakdown must be verified at the start of each 12-hour shift. Inject a DDT/Endrin standard that is at a concentration near the mid-point of the curve. Calculate the percent breakdown of each analyte as follows (height may be used instead of area):

$$\%DDT_{BREAKDOWN} = \frac{(\text{DDE Area + DDD Area}) \times 100}{(\text{DDE Area + DDD Area + DDT Area})}$$

$$\%Endrin_{BREAKDOWN} = \frac{(\text{Endrin ketone Area + Endrin aldehyde Area}) \times 100}{(\text{Endrin ketone Area + Endrin aldehyde Area + Endrin Area})}$$

The percent breakdown for both DDT and endrin must not exceed 15%. If breakdown exceeds 15%, instrument maintenance must be performed before any samples can be analyzed.

7.4.1.2 External Standard Calibration

A minimum 5-point calibration curve is created for the single peak pesticides, TCMX, and Decachlorobiphenyl. SGS Accutest Orlando routinely performs a 6-point calibration to maximize the calibration range.

The low point may be omitted from the calibration table for any compound with an LLOQ set at the level two standard. Additionally the high point may be omitted for any compound that exhibits poor linearity at the upper end of the calibration range.

An entire level may be omitted provided that a minimum of 5 points remain. There must be technical justification to omit an entire level. This should be documented in the run log.

Toxaphene and chlordane (technical) are calibrated at a single level near the RL. **NOTE:** DoD QSM projects require at 5-point calibration for technical chlordane and toxaphene if they are being reported.

Historically, many analytical methods have relied on linear models of the calibration relationship, where the instrument response is directly proportional to the amount of a target compound. The linear model has many advantages including simplicity and ease of use. However, given the advent of new detection techniques and because many methods cannot be optimized for all the analytes to which they may be applied, the analyst is increasingly likely to encounter situations where the linear model neither applies nor is appropriate. The option of using non-linear calibration may be necessary to address specific instrumental techniques. However, it is not EPA's intent to allow non-linear calibration to compensate for detector saturation or avoid proper instrument maintenance.

NOTE: Because of this concern, select programs including SC DHEC do not support the use of non-linear regressions.

Calibration factors (CF) for the single peak pesticides and surrogates are determined at each concentration by dividing the area (or height) of each compound by the concentration of the standard.

Quantitation for technical chlordane is based on the individual peaks in the chlordane standard. Three to six major peaks are used for quantitation purposes. Each individual chlordane peak is assigned the concentration of the total chlordane standard. Toxaphene may be quantitated by individual peaks (4 to 6 major peaks) or by total area. For the individual peak approach, each individual toxaphene peak is assigned the concentration of the total toxaphene standard. See method 8081B for additional information.

Calibration factor (CF) for chlordane is determined by dividing the total area (or height) of chlordane (3 to 6 major peaks) by the concentration of the standard. The calibration factor for the toxaphene is determined by dividing the total area (height cannot be used) of Toxaphene (4 to 6 major peaks) by the concentration of the standard.

The mean CF and standard deviation of the CF are determined for each analyte. The percent relative standard deviation (%RSD) of the calibration factors is calculated for each analyte as follows:

%RSD = (Standard Deviation of CF X 100) / Mean CF

If the %RSD $\leq$ 20%, linearity through the origin can be assumed and the mean CF can be used to quantitate target analytes in the samples. Alternatively a calibration curve of response vs. amount can be plotted. This method allows for the use of average response factors, linear regressions, and non-linear regressions. Linear regressions may be unweighted or weighted as $1/x$ or $1/x^2$. If the correlation coefficient (r) is $\geq$0.995 (r^2 $\geq$0.990) then the curve can be used to quantitate target analytes in the samples. Regardless of which calibration model is

chosen, the laboratory should visually inspect the curve plots to see how the individual calibration points compare to the plot.

Alternatively either of the two techniques described below may be used to determine whether the calibration function meets acceptable criteria. These involve refitting the calibration data back to the model. Both % Error and Relative Standard Error (RSE) evaluate the difference between the measured and the true amounts or concentrations used to create the model.

Calculation of the % Error

% ERR = (xi-x'i) / xi * 100

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

Percent error between the calculated and expected amounts of an analyte should be ≤ 30% for all standards. For some data uses, ≤50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n} \left[\frac{x_i' - x_i}{x_i}\right]^2 \Big/ (n-p)}$$

x'i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

p = Number of terms in the fitting equation.
(average = 1, linear = 2, quadratic = 3)

n = Number of calibration points.

The %RSE acceptance limit criterion is ≤20%.

7.4.1.3 Initial Calibration Verification (ICV)

The validity of the initial calibration curve must be verified through the analysis of an initial calibration verification (ICV) standard. The ICV should be prepared from a second source at a mid-range concentration.

The %D for all analytes of interest should be ≤ 20%. If the ICV does not meet this criteria, a second standard should be prepared. If the ICV still does not meet criteria, analyze an ICV prepared from a third source. If this ICV meets criteria, proceed with sample analysis.

For any DoD QSM project, if samples must be analyzed with a target analyte having a %D > 20%, then the data must be qualified accordingly.

If the ICV still does not meet criteria, determine which two standards agree. Make fresh calibration standards and an ICV from the two sources that agree. Recalibrate the instrument.

7.4.1.4 Retention Time Windows

Retention time windows must be established whenever a new column is installed in an instrument or whenever a major change has been made to an instrument.

Retention time windows are crucial to the identification of target compounds. Absolute retention times are used for compound identification in all GC and HPLC methods that do not employ internal standard calibration. Retention time windows are established to compensate for minor shifts in absolute retention times that result from normal chromatographic variability. The width of the retention time window should be carefully established to minimize the occurrence of both false positive and false negative results.

Retention time windows are established by injecting all standard mixes three times over the course of 72 hours. The width of the retention time window for each analyte, surrogate, and major constituent in multi-component analytes is defined as ± 3 times the standard deviation of the mean absolute retention time or 0.03 minutes, whichever is greater.

Establish the center of the retention time window for each analyte and surrogate by using the absolute retention time for each analyte and surrogate from the calibration verification standard at the beginning of the analytical shift. For samples run during the same shift as an initial calibration, use the retention time of the mid-point standard of the initial calibration.

Peak identification is based on the retention time of a peak falling within the retention time window for a given analyte. Time reference peaks

(surrogates) are used to correct for run-to-run variations in retention times due to temperature, flow, or injector fluctuations.

The retention time windows should be used as a guide for identifying compounds; however, the experience of the analyst should weigh heavily in the interpretation of the chromatograms. The analyst should monitor the retention times of known peaks (standards and surrogates) throughout an instrument run as an indication of instrument performance.

Because calculated retention time windows are generally very tight (less than ± 0.03 minutes), the retention time windows for the data processing method are generally set wider than the calculated window. This is done to ensure that the software does not miss any potential "hits". The analyst will then review these "hits" and determine if the retention times are close enough to the retention time of the target analyte to positively identify the peak or to require confirmation.

7.4.2 Daily Calibration Procedures

Prime the GC by injecting a conditioning standard; this is a pesticide standard that is approximately 20 times the concentration of the mid-level standard. This will aid in deactivating the injection port and column.

Analyze a DDT/Endrin breakdown standard as described in section 7.4.1.1. This standard must be analyzed at the start of each 12-hour shift.

Analyze a continuing calibration verification standard (section 7.4.3) for the single peak pesticides. Then analyze the Technical Chlordane and Toxaphene standards that are calibrated at a single concentration level. The single point standards must be analyzed every 12 hours; they do not have to be analyzed at the same frequency as the CCV standard.

For DoD QSM projects the Technical Chlordane and Toxaphene standards must be analyzed at the beginning of the 12-hour window. Additional standards may be analyzed through the run.

7.4.3 Continuing Calibration Verification (CCV)

Continuing calibration verification standards for the single peak pesticides are prepared at various concentrations; at least one CCV must be below the mid-point of the calibration curve. A continuing calibration standard must be analyzed at the beginning and end of each run to verify that the initial calibration is still valid. Additionally a CCV must be analyzed after every 10 samples. If toxaphene or technical chlordane is known to be present at the site or if it a DoD QSM project, the analyst should analyze additional CCVs for these analytes.

The percent difference (%D) for each analyte of interest will be monitored. The |%D| should be ≤ 20% for each analyte.

If the first continuing calibration verification does not meet criteria, a second standard may be injected. If the second standard does not meet criteria, the system must be recalibrated. If the second standard meets criteria then the system is considered in control and results may be reported.

Rationale for second standard such as instrument maintenance, clipped column, remade standard, etc should be documented in the run log or maintenance log. Reanalysis of second standard without valid rationale may require the analysis of a third standard (in which case both the second and third standard would have to pass).

NOTE: For any DoD QSM project, if the second standard meets criteria, then a third standard must be analyzed. If the third standard also meets criteria then the system is considered in control and results may be reported.

If the |%D| is greater than 20%, then documented corrective action is necessary. This may include recalibrating the instrument and reanalyzing the samples, performing instrument maintenance to correct the problem and reanalyzing the samples, or qualifying the data. Under certain circumstances, the data may be reported. i.e. The CCV failed high, the associated QC passed, and the samples were ND.

NOTE: For any DoD QSM project, if samples must be reported with a target analyte having a %D > 20%, then the data must be qualified accordingly, regardless of whether the analyte was detected or not.

NOTE: Samples that are being reported to the State of California require that the |%D| ≤ 15% for each analyte.

NOTE: Any target analytes that are detected in the samples must be bracketed by an acceptable initial calibration curve and acceptable CCV standards; otherwise, the samples must be reanalyzed or the data must be qualified.

7.4.4 Sample Extract Analysis

7.4.4.1 Samples are analyzed in a set referred to as an analysis sequence or batch. A batch consists of the following:

Conditioning Standard
DDT/Endrin Breakdown Standard
Initial Calibration Standards (or Initial CCV)
Single Point Standards
QC Extracts
Sample Extracts
CCV Standards

7.4.4.2 Four microliters (same amount as standards) of extract is injected into the GC by the autosampler. A split or splitless injection technique is used. The data system then records the resultant peak responses and retention times.

7.4.4.3 Tentative identification of an analyte occurs when the peaks from the sample extract fall within the established retention time windows for a calibrated compound on the primary column.

7.4.4.4 If the peaks of interest fall within the retention time windows on the confirmation column, the identification is confirmed. Quantitation of the analyte on the primary and confirmation column should agree within 40%. If the difference is greater than 40% and no obvious reason can be found, the higher result should be reported and flagged as "estimated"; otherwise, the result from the primary column should be reported.

7.4.4.5 Pattern comparisons should also be used to aid in the identification of the multipeak analytes.

7.4.4.6 If the compound identification does not confirm on a dissimilar column, then the result should be reported as ND or "U".

7.4.4.7 The TBA-sulfite sulfur cleaning procedure used for this method will lower the Endrin Aldehyde recoveries to 10-20%. If Endrin, Endrin Ketone or Endrin Aldehyde is detected in the samples, the analyst should analyze a "non-sulfur cleaned" aliquot or a copper cleaned aliquot (and associated QC samples). If possible, Endrin Aldehyde should be reported from this analysis.

7.4.4.8 If the analyte response exceeds the linear range of the system, the extract must be diluted and reanalyzed. It is recommended that extracts be diluted so that the response falls into the middle of the calibration curve.

7.4.4.9 If peak identification is prevented by the presence of interferences, further cleanup may be required or the extract must be diluted so that the interference does not mask any analytes.

7.5 Maintenance and Trouble Shooting

7.5.1 Refer to SOP GC001 for routine instrument maintenance and trouble shooting.

7.5.2 All instrument maintenance must be documented in the appropriate "Instrument Repair and Maintenance" log. The log will include such items as problem, action taken, correction verification, date, and analyst.

7.5.3 Repairs performed by outside vendors must also be documented in the log. The analyst or Department Supervisor responsible for the instrument must complete the log if the repair technician does not.

7.5.4 PC and software changes must be documented in the "Instrument Repair and Maintenance" log. Software changes may require additional validation.

8.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to statistically generated control limits. These control limits are reviewed and updated annually. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

9.0 QUALITY ASSURANCE / QUALITY CONTROL

Accuracy and matrix bias are monitored by the use of surrogates and by the analysis of a QC set that is prepared with each batch (maximum of 20 samples) of samples. The QC set consists of a method blank (MB), blank spike (BS), matrix spike (MS), and matrix spike duplicate (MSD).

9.1 Surrogates

9.1.1 Tetrachloro-m-xylene (TCMX) and Decachlorobiphenyl are used as the surrogate standards to monitor the efficiency of the extraction and clean-up procedures.

A known amount of surrogate standard is added to each sample including the QC set prior to extraction. The percent recovery for each surrogate is calculated as follows:

% Recovery = (Sample Amount / Amount Spiked) X 100

The percent recovery must fall within the established control limits for both surrogates for the results to be acceptable.

9.1.2 If the surrogate recoveries are not within the established control limits, the following are required.

9.1.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, surrogate solutions or internal standards. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.1.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.1.2.3 If no problem is found, re-extract and reanalyze the sample. **NOTE:** If the recoveries are high and the sample is non-detect, then re-extraction may not be necessary. For any DoD QSM projects the resulting data must be qualified accordingly. If there is insufficient sample for re-extraction, reanalyze the sample and footnote this on the report.

9.1.2.4 If upon reanalysis, the recovery is still not within control limits, the problem is considered matrix interference. Surrogates from both sets of analysis should be reported on the final report.

9.2 Method Blank

9.2.1 The method blank is either de-ionized water or sodium sulfate (depending upon sample matrix) to which the surrogate standard has been added. The method blank is then extracted and taken through all cleanup procedures along with the other samples to determine any contamination from reagents, glassware, or high level samples. The method blank must be free of any analytes of interest or interferences at ½ the required LLOQ to be acceptable. If the method blank is not acceptable, corrective action must be taken to determine the source of the contamination. Samples associated with a contaminated method blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-extracting and reanalyzing the samples or qualifying the results with a “B” or “V” qualifier.

9.2.2 If the MB is contaminated but the samples are non-detect, then the source of contamination should be investigated and documented. The sample results can be reported without qualification.

9.2.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination should be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. This must be approved by the department supervisor.

9.2.4 If the MB is contaminated but the samples results are < 10 times the contamination level, the source of the contamination should be investigated and documented. The samples should be re-extracted and reanalyzed for confirmation. If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.3 Blank Spike

9.3.1 The blank spike is either de-ionized water or sodium sulfate (depending upon sample matrix) to which the surrogate standard and spike standard have been added. The blank spike is then extracted and taken through all cleanup procedures along with the other samples to monitor the efficiency of the extraction procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = (Blank Spike Amount / Amount Spiked) X 100

The percent recovery for each analyte of interest should fall within the established control limits for the results to be acceptable. The large number of analytes in this method presents a substantial probability that a few of the analytes will fall outside of the established control limits. This may not indicate that the system is out of control; therefore, corrective action may not be necessary.

Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary. A marginal exceedance in the Blank Spike is defined as a recovery being outside of 3 standard deviations but within 4 standard deviations of the mean.

The number of allowable marginal exceedances is based on the number of analytes in the Blank Spike. Marginal Exceedances must be random. If the same analyte exceeds the BS control limits repeatedly, it is an indication of a systematic problem and corrective action must be taken.

Marginal exceedances are not permitted for analytes that are deemed to be “Compounds of Concern” for a specific project. “Compounds of Concern” are different from “Target Compounds”. “Target Compounds” are all analytes that are being reported for a site where “Compounds of Concern” are those analytes expected to be present at the site.

The number of allowable marginal exceedances is as follows:

1) 11-30 analytes in BS, 1 analyte allowed in ME range;

2) < 11 analytes in BS, no analytes allowed in ME range

NOTE: SC DHEC does not recognize the concept of Marginal Exceedances. Additionally a secondary check against 70-130% limits should be performed for all analytes reported to SC DHEC.

9.3.2 If the blank spike recoveries are not within the established control limits, the following are required.

9.3.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions or internal standards. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.3.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

9.3.2.3 Check to see if the recoveries that are outside of control limits are analytes of concern. If the analytes are not being reported, additional corrective action is not necessary and the sample results can be reported without qualification.

9.3.2.4 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable. For any DoD QSM projects the resulting data must be qualified accordingly.

9.3.2.5 Excessive exposure to the sulfur cleaning reagents may adversely impact the recoveries of Delta BHC, Endrin Aldehyde, and Endosulfan Sulfate. Therefore, a non-sulfur cleaned fraction is always retained. If recoveries for these analytes are low in the sulfur cleaned blank spike, analyze the non-sulfur cleaned aliquot.

If the recoveries are within control limits then the entire "non-sulfur cleaned" batch should be analyzed and results reported from that analysis. Under NO circumstances can just the blank spike be reanalyzed and reported.

9.3.2.6 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples, re-extracting and reanalyzing the samples, or qualifying the results as estimated.

9.3.2.7 If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.4 Matrix Spike and Matrix Spike Duplicate

9.4.1 Matrix spike and spike duplicates are replicate sample aliquots to which the surrogate standard and spike standard have been added. The matrix spike and spike duplicate are then extracted and taken through all cleanup procedures along with the other samples to monitor the precision and accuracy of the extraction procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = [(Spike Amount – Sample Amount) / Amount Spiked] X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable.

9.4.2 If the matrix spike recoveries are not within the established control limits, the following are required.

9.4.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions or internal standards. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

9.4.2.2 Check instrument performance. It may be necessary to re-vial and re-inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.4.2.3 If no problem is found, compare the recoveries to those of the blank spike. If the blank spike recoveries indicate that the problem is sample related, document this on the run narrative. Matrix spike recovery failures are not grounds for re-extract but are an indication of the sample matrix effects.

9.4.3 Precision

Matrix spike and spike duplicate recoveries for each analyte are used to calculate the relative percent difference (RPD) for each compound.

RPD = [| MS Result – MSD Result | / Average Result] X 100

The RPD for each analyte should fall within the established control limits. If more than 33% of the RPDs fall outside of the established control limits, the MS and MSD should be reanalyzed to ensure that there was no injection problem. If upon reanalysis the RPDs are still outside of the control limits, the department supervisor shall review the data and determine if any further action is necessary. RPD failures are generally not grounds for re-extraction.

10.0 CALCULATIONS

The concentration of each single peak pesticide or toxaphene (if using the total area technique) in the original sample is calculated as follows:

Water (ug/l) = $(CONC_{inst})$ X (V_F / V_I) X DF

Soil (ug/kg) = $[(CONC_{inst})$ X (V_F / W_I) X DF] / %solids

$CONC_{inst}$	=	Instrument concentration calculated from the initial calibration using mean CF or curve fit.
DF	=	Dilution Factor
V_F	=	Volume of final extract (ml)

V_l	=	Volume of sample extracted (ml)
W_l	=	Weight of sample extracted (g)
%solids	=	Dry weight determination in decimal form

All soils are reported on a dry weight basis.

The amount of chlordane or toxaphene (if using the multipeak technique) in the samples is determined by averaging the concentration of the major peaks for each multipeak pesticide. The MS Chemstation software will automatically sum and average the peaks used for each multipeak pesticide.

11.0 SAFETY AND POLLUTION PREVENTION

11.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS Health and Safety Program, which includes the use of safety glasses, gloves, and lab coats.

The toxicity of each reagent and target analyte has not been precisely defined; however, each reagent and sample should be treated as a potential health hazard. Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) are available for all reagents and many of the target analytes. Exposure must be reduced to the lowest possible level. Personal protective equipment should be used by all analysts.

11.2 Pollution Prevention

Waste solvents from the sample analysis and standards preparation are collected in waste storage bottles and are eventually transferred to the non-chlorinated waste drum.

Sample Extracts are archived and stored for 60 days after analysis. Old extracts and standards are disposed of in the waste vial drum.

12.0 REFERENCES

SW846 Method 8000D Revision 4, July 2014

SW846 Method 8081B Revision 2, February 2007

METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY

Prepared by:	David Metzgar III	Date:	06/21/2016
Approved by:	Svetlana Izosimova	Date:	06/21/2016

Annual Review

Reviewed by:	Date:
Reviewed by:	Date:
Reviewed by:	Date:

Document Control

Issued to:	QA Department	Date:	06/23/2016
Issued to:	Metals	Date: *	06/23/2016
Issued to:		Date:	
Issued to:		Date:	
Issued to:		Date:	
Issued to:		Date:	

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY

REFERENCES: SW846 6010C, EPA 200.7 Rev 4.4 1994

REVISED SECTIONS: Section 2.0: "preserved within 24hrs" changed to "as soon as possible"
Section 1.10: added IDL detail (performed quarterly)

INSTRUMENT: THERMO 6500, SERIAL # 20100903 SSTRACE 1
INSTRUMENT: THERMO 6500, SERIAL # 20103825 SSTRACE 2
AUTOSAMPLER: CETAC 240 POSITION, SERIAL # 031038A520 SSTRACE 1
AUTOSAMPLER: CETAC 240 POSITION, SERIAL # 041048A520 SSTRACE 2

SUGGESTED WAVELENGTH (S): TABLE 2

1.0 SCOPE AND APPLICATION

SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

Method EPA 200.7 has been modified within the flexibility allowed in 40CFR136.6.

1.1 This method is applicable for the determination of metals in water, sludges, sediments, and soils. Elements that can be reported by this method include: Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Strontium, Titanium, Thallium, Tin, Vanadium, and Zinc.

1.2 Sample matrices are pretreated following SW846 and EPA methods for digestion of soil, sediment, sludge or water samples. Refer to specific metals department digestion SOP's for more information on digestion techniques.

1.3 This inductively coupled argon plasma optical emission spectrometer (s) (ICP-OES) uses an Echelle optical design and a Charge Injection Device (CID) solid-state detector to provide elemental analysis. Control of the spectrometer is provided by PC based iTEVA software. In the instrument, digested samples are introduced into the Thermo 6500 ICP, passed through a nebulizer and transported to a plasma torch. The element-specific emission spectra are produced by a radio frequency inductively coupled plasma. The spectra are dispersed by a spectrometer, and the intensities of the emission lines are monitored with the solid state detector.

1.4 Reporting limits (RL) are based on the extraction procedure. Reporting limits may vary depending on matrix complications, volumes and by client needs, but the reporting limits must always be verified with a low check which meets the criteria outlined in this SOP. Solid matrices are reported on a dry weight basis. Refer to table 1 of this SOP for SGS Accutest - Orlando typical reporting limits. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits.

1.5 MDLs must be established for all analytes, using a solution spiked at approximately 3 times the estimated detection limit. To determine the MDL values, take seven replicate aliquots of the spiked sample and process through the entire analytical method. The MDL is calculated by multiplying the standard deviation of the replicate analyses by 3.14, which is the student's t value for a 99% confidence level. MDLs must be determined approximately once per year for each matrix and instrument. Please refer to SGS Accutest - Orlando QA SOP QA020, current version for further information regarding method performance criteria and experimental method detection limits.

1.6 An MDL check standard will be analyzed at the time of the annual MDL study and on a quarterly basis for verification. The concentration of the MDL check standard must be 1x-4x the statistical MDL. The MDL Check Standard is carried through the entire preparation and analytical procedure. This is a qualitative check; therefore, the analyte needs to be detected only. If the analyte is not detected, the concentration of the MDL check standard must be increased to a level where the analyte is detected. This then becomes the current MDL.

1.7 Lower limit of quantitation check sample. The lower limit of quantitation check (LLQC) sample should be analyzed after establishing the lower laboratory reporting limits and on a quarterly basis to demonstrate the desired detection capability. The LLQC sample is carried through the entire preparation and analytical procedure. Lower limits of quantitation are verified when all analytes in the LLQC sample are detected within 20 percent of their true value.

1.8 MDLs are generated for each matrix on both ICP instruments. The higher of the two statistically calculated MDL's is entered into LIMS as the MDL. The verified MDLs are stored in the LIMS and must be at least 2 to 3 times lower than the RL. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported RL.

1.9 Compounds detected at concentrations between the RL and MDL are quantitated and qualified as estimated values and reported with either a "J" or "I" qualifier. Some program or project specifications may require that no values below the RL be reported.

1.10 Instrument Detection Limits (IDL). IDL's should be completed upon initial instrument installation and on a quarterly basis. The Instrument Detection Limits (in ug/L) are determined by analyzing 7 replicates of a reagent blank solution on 3 non consecutive days. The IDL is defined as 3 times the average of the standard deviation of the 3 days. Each IDL measurement shall be performed as though it were a separate analytical sample. IDLs shall be determined and reported for each wavelength used in the analysis of the samples.

2.0 PRESERVATION AND BOTTLEWARE

All samples should be preserved with nitric acid to a pH of <2 at the time of collection. All sample pH are checked in sample receiving and within the metals department. Samples that are received with a pH >2 must be preserved to pH <2 and held for 24 hours prior to metals digestion to dissolve any metals that absorb to the container walls. Refer to SOP SAM101, current revision for further instruction. Final pH of TCLP extracts are checked and recorded in SGS Accutest - Orlando Extractions Department. Please refer to TCLP (1311) fluid determination logbook and SPLP (1312) fluid determination logbook for further information. TCLP extracts received from SGS Accutest - Orlando Extractions Department are prepared as soon as possible, no longer than 24 hours from time of receipt. If precipitation is observed during the sample preparation process the sample(s) are immediately re-prepped on dilution until no precipitation is observed. Samples received for dissolved metals analysis should be filtered and preserved to pH<2 as soon as possible and held for 24 hours prior to digestion. Refer to SGS Accutest - Orlando Sample Filtration Logbook for further information.

All soil samples must be stored in a refrigerator at $\leq 6^{o}C$ upon receipt. Refer to SOP SAM101, current revision for further instruction.

All bottleware used by SGS Accutest - Orlando is tested for cleanliness prior to shipping to clients. Analysis results must be less than one half the reporting limit to be acceptable. Refer to SOP SAM104, current revision for further instruction.

3.0 HOLDING TIME AND BATCH SIZE

All samples must be prepared and analyzed within 6 months of the date of collection. Refer to appropriate SGS Accutest - Orlando digestion SOP, current revision for batch size criteria.

4.0 INTERFERENCES

Several types of interferences can cause inaccuracies in trace metals determinations by ICP. These interferences are discussed below.

4.1 Spectral interferences are caused by overlap of a spectral line from another element, unresolved overlap of molecular band spectra, background contribution from continuous or recombination phenomena, and background contribution from stray light from the line emission of high concentration elements. Corrections for these interferences can be made by using interfering element corrections, by choosing an alternate analytical line, and/or by applying background correction points. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak.

Note: Refer to section 17.0 of this SOP for further instruction regarding interfering element correction factor generation.

4.2 Physical interferences can be caused by changes in sample viscosity or surface tension, by high acid content in a sample, or by high dissolved solids in a sample. These interferences can be reduced by making sample dilutions.

4.3 Matrix interferences in high solid samples can be overcome by using an internal standard. Yttrium/Indium mix is used for the Thermo 6500 ICP. The concentration must be sufficient for optimum precision but not so high as to alter the salt concentration of the matrix. The element intensity is used by the instrument as an internal standard to ratio the analyte intensity signals for both calibration and quantitation.

4.4 Chemical interferences are not pronounced with ICP due to the high temperature of the plasma, however if they are present, they can be reduced by optimizing the analytical conditions (i.e. power level, torch height, etc.).

5.0 APPARATUS

5.1 Currently there are two solid state ICPs available for use in the lab. Both are Thermo 6500 ICP units. These units have been optimized to obtain lower detection limits for a wide range of elements. Since they are solid state systems, different lines may be included for elements to obtain the best analytical results. However, the lines which are normally included in the normal analysis program are shown in Table 2.

5.2 Instrument auto samplers. For random access during sample analysis.

5.3 Class A volumetric glassware and pipettes.

5.4 Polypropylene auto sampler tubes.

5.5 Eppendorf Pipette (s) - Pipette (s) are checked daily for accuracy and to ensure they are in good working condition prior to use. Volumes are checked at 100% of maximum volume (nominal volume). Pipettes are checked within the metals department and results are stored electronically in the “Pipette Calibration Log”. Refer to SOP QA006, current revision for further information regarding pipette calibration. BIAS: mean must be within 2% of nominal volume. Precision: RSD must be $\leq$ 1% of nominal volume based on three replicates.

5.6 Fisher Brand 0.45 micron (um) filter or equivalent. Filter lots are checked for cleanliness through the Method Blank process. All Method Blank analytical results must be less than one half the reporting limit to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated filters must be re-filtered through acceptable filters.

5.7 Fisher Brand disposable 10 ml syringes or equivalent. Syringe lots are checked for cleanliness through the Method Blank process. All Method Blank results must be less than one half the reporting limit to be acceptable, if not , the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated syringes must be re-filtered through acceptable syringes.

5.8 Data System

Microsoft Windows XP Professional Version 2002
Instrument software SST1 – Thermo iTEVA version 2.8.0.89
Instrument software SST2 – Thermo iTEVA version 2.7.0.87

5.8.1 A computer system interfaced to the Thermo 6500 ICP that allows for the continuous acquisition and storage of all data obtained throughout the duration of the analytical run sequence.

5.8.2 Data is archived to a backup server for long term storage.

6.0 REAGENTS

All chemicals listed below are trace metal grade unless otherwise specified. Refer to Acid Certificate of Analysis logbook for Certificates of Analysis and compliance with the specifications of the grade listed. SGS Accutest - Orlando produces DI water to the specifications for the ASTM Type II standard designation based on the system manufacturer's performance specifications. The DI water is used exclusively for laboratory purposes. De-ionized (DI) water should be used whenever water is required. Refer to SOP QA037, current revision for more information regarding testing and monitoring. Refer to the Metals Department Standard Prep Logbook for the make-up and concentrations of standards and stock solutions being used within this SOP. Some of the information included in the logbook is as follows: standard name, elements in mix, manufacturer, lot number, parent expiration date, acid matrix, stock concentration, volume of standard added, total volume, final prepared concentration, prep date, initials, MET number, and prepared standard expiration date. Standards and prepared reagents must be prepared every 6 months or before stock standard expiration date, whichever comes first**.** Refer to tables 3 through 7 of this SOP for concentration levels of standards used. Unless otherwise approved, the calibration curve must contain 3 points determined by a blank and a series of standards representing the elements of interest.

6.1 2.5 ppm Yttrium and 10 ppm Indium internal standard, made from ICP quality standard.

6.2 Hydrochloric acid, trace metals grade.

6.3 Nitric Acid, trace metals grade.

6.4 ICP quality standard stock solutions are available from Inorganic Ventures, Spex, Plasma Pure, Ultra, Environmental Express, or equivalent.

6.5 Calibration Standards. These can be made up by diluting the stock solutions to the appropriate concentrations. The calibration standards should be prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation.

6.5.1 For calibration and quantitation an internal standard (Yttrium/Indium) is used to limit nebulization problems. If it is known that the samples contain a significantly different

acid matrix, the samples must be diluted so that they are in a similar matrix to the curve. All sample results are referenced to the initial calibration blank (ICB) Internal Standard counts. The criteria is 60-125 percent of the initial calibration blank (ICB) counts. If the internal standard counts fall outside these criteria matrix effects must be suspected and the sample diluted until it meets the criteria or footnoted in LIMS as suspected matrix interference.

6.5.2 Standards must be prepared so that there is minimal spectral interference between analytes.

Note: All Ag stock and intermediate solutions must be stored away from direct sunlight.

6.6 Analytical Quality Control Solutions.

All of the solutions below are prepared by adding either mixed or single element metals solutions to a solution prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation.

6.6.1 Blank (Calibration, ICB, CCB)

This reagent blank contains Nitric Acid at 3 percent and Hydrochloric Acid at 5 percent.

6.6.2 Initial Calibration Verification solution.

This standard solution must be made from a different source than the calibration curve. The concentrations for each element must be within the range of the calibration curve and should be approximately at the midpoint of the curve. This solution is used to verify the accuracy of the initial calibration. Levels for the ICV standard are shown in Table 4.

6.6.3 Continuing Calibration Verification solution.

The metals concentrations for this standard should be at approximately the mid point of the calibration curve for each element. This standard should be prepared from the same source that is used for the calibration curve. Levels for the CCV standard are shown in Table 5.

6.6.4 Interference Element Check Solutions.

These solutions must be analyzed to check the interfering element correction factors (IEC's) on the ICP instruments. Refer to section 17.0 of this SOP for further information regarding generation of IEC's.

6.6.4.1 ICSA Solution.

The ICSA solution contains only the interfering elements. Levels for the ICSA are shown in Table 9.

6.6.4.2 ICSAB Solution.

The ICSAB solution contains both the interferents and the analytes of interest. Levels for the ICSAB are shown in Table 10.

6.6.4.3 Single element interference check solutions

Prepared as single solutions. Levels for the single element interference solutions are shown in Table 11.

6.7 CRIA Standard Solution (Also referred to as LLCCV)

The CRIA standard contains the elements of interest at levels equal to SGS Accutest - Orlando quantitation limits (RL). Please refer to Table 6 for list of elements of interest and concentration levels for the CRIA. If special client reporting limits are requested, then low checks corresponding to those reporting limits must also be analyzed.

6.8 Matrix Spike, Matrix Spike duplicate, and Spike Blank Solution.

This solution is prepared by adding either mixed or single element metals solutions to a solution containing 3 percent nitric acid and 5 percent hydrochloric acid and diluting to a fixed final volume with this acid mixture. Spiking solution (s) must be added to the spike blank, matrix spike, and the matrix spike duplicate prior to digestion. Levels for the MS and MSD and Spike Blank standard are shown in Table 7.

6.9 Liquid Argon or Argon Gas. (99.999% purity)

7.0 ANALYTICAL PROCEDURE

Note: Please refer to section 8 of this SOP for further detail on quality control standards. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements.

7.1 General procedure on how to operate the Thermo 6500 is described below. Refer to the Thermo 6500 operation manual for further details.

7.2 Before starting up the instrument, make sure that the pump tubing is in good condition, the torch assembly, the nebulizer, and the spray chamber are clean, the dehumidifier (if used) is filled with DI water up to the level between Minimum and Maximum, and that there are no leaks in the torch area.

7.3 Turn on the recirculating cooler. Verify that the argon is turned on and there is enough for the entire days analytical run.

7.4 Tighten the pump platens and engage the peristaltic pump. Make sure sample and internal standard solutions are flowing smoothly.

7.5 Put a new solution of acid rinse into the rinse reservoir. The composition of the rinse solution may be periodically changed to minimize sample introduction problems and sample carryover. If internal standard is being used, make sure that sufficient amount of internal standard is prepared for the entire analytical run.

7.6 Start up the instrument following the sequence show below.

7.6.1 Double click the **iTEVA Control Center** Icon on the desktop. Type ***admin*** in User Name field, and then click **OK**.

7.6.2 Once the iTEVA Control Center window is opened, click on **Plasma** Icon at status bar area. Then click on **Instrument Status** to check the interlock indicators (torch compartment, purge gas supply, plasma gas supply, water flow and exhaust should be in green; drain flow and busy should be in gray) and the Optics Temperature. (It should be around 38°C.) Click on the Close box.

7.6.3 Click **Plasma On**. When the plasma is on, click close. Let the instrument warm up for 15 to 20 minutes before starting the analysis. New tubing may take an hour to stabilize.

7.7 Torch Alignment and Auto Peak

7.7.1 If the torch has been cleaned, then the torch alignment procedure must be performed.

7.7.2 Open the method and then click on **Sequence** tab, then click on **List View** Icon until you reach rack display.

7.7.3 Go to S-6 position (you can assign any position in the rack for torch alignment), then right click to select **Go** to empty sample S:6. (Now, the auto sampler tip moves from Rinse to this position).

7.7.4 Click on **Analysis** tab, then select **Torch Alignment** from Instrument drop down menu. There will be a pop up dialog box present. Click **Run**. Then there will be another dialog pop up box (This is a reminder for Torch Alignment Solution (2 ppm Zn)), click **Ok**. Now, the instrument is initializing an automated torch alignment. It takes about 7 minutes to complete this step. Progress is indicated in the progress bar.

7.7.5 After torch alignment is complete, click **Close**. Click on **Sequence** tab, then followed by **List View** Icon.

7.7.6 Go to Rinse position at rack display, right click to select Go to rinse and let it rinse for approximately 5 minutes.

7.7.7 Perform Auto Peak

7.7.8 It is recommended that the Auto Peak Adjust procedure be performed daily prior to calibration. A standard that contains all of the lines of interest is used and the system automatically makes the appropriate fine adjustments. (High standard solution should be used for this process.)

7.7.9 Click **Sequence** tab, then click on **List View** Icon until the rack is displayed.

7.7.10 Go to S-5 position (you can assign any position in the rack for auto peak adjust), then right click to select **Go** to empty sample S:5. (Now, the auto sampler tip moves from the Rinse position to this position). Click on **Analysis** tab. All elements result is shown in the display area. From Instrument drop down menu, select **Perform Auto Peak**. There will be a pop up dialog box present. Highlight "All Elements", and then click **Run**. Then there will another pop up dialog box (This is a reminder for Auto Peak Solution), click **Ok**. Now, the instrument is performing auto peak adjust. It takes about 5 minutes to complete this process. The Auto Peak dialog box will show a green check mark in front of "All Elements", which indicates Auto Peak is complete.

7.8 Open the method and start up the run.

7.8.1 Click on **Analyst** Icon at the workspace. Go to the method and choose Open from the drop down menu. Select the method with the latest revision number.

7.8.2 Go to **Method** tab at the bottom of left hand corner to click on **Automated Output** at the workspace area. Type a filename in Filename field in the data display area (i.e. : SA101010M1, starts with SA, then followed by MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs.) Click on **Apply To All Sample Types**.

7.8.3 Click on **Sequence** tab at the bottom of left hand corner. From Auto Session drop down menu bar, click on **New Auto sampler** to create a sequence. This will pop up a dialog box, then click on **New** and fill in number of samples (i.e.: 100) in the Number of Samples field and the sample I.D. (leave this field empty) in Sample Name field. Type a sequence name (i.e. : SEQ101010M1, starts with SEQ, then MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs) in the Sequence Name field. Click Ok, then put in "0" as settle time between between sequences, and click **Ok**.

7.8.4 Right click on **Untitled** (Cetac ASX-520 Enviro 5 Named Rack is the rack that is currently used) at the workspace area, click on **Auto-Locate All** to locate all sample positions.

7.8.5 Double click on **Untitled** again, then click on the sequence name (i.e. : SEQ101010M1), on the data display area, type the sequence in Samplename column, dilution factor (if needed) in CorrFact column, check the box in front of Check column, and select an appropriate check table.

7.8.6 Once done with creating sequence, go to **Method** drop down menu and save all changes as **Save As**. There will be a Save a Method dialog box present, go to the

save option to check on "Overwrite Method and bump revision number" box, and then click **Ok**.

7.8.7 Go to Sequence tab, click on List View Icon from tool bar, then click on Connect Autosampler to PC and Initialize Icon.

7.8.8 See table 8 for a typical run sequence.

7.9 Calibrate the instrument as outlined below. See table 3 for calibration standards concentrations. This calibration procedure is done a minimum of once every 24 hours. The calibration standards may be included in the auto sampler program or they may be run manually from the **Calibrate Instrument (graduated cylinder)** icon located on the Analyst tab. All curves must be determined from a linear calibration prepared in the normal manner using the established analytical procedure for the instrument. Refer to instrument manual for further detail. Unless otherwise approved, the calibration curve must be determined by a blank and a series of three standards representing the elements of interest. Three exposures will be used with a percent relative standard deviation of less than 5 percent. The resulting correlation coefficient must be $\geq$0.998. If the calibration curves do not meet these criteria, analysis must be terminated, the problem corrected, and instrument re-calibrated. Correlation coefficients, slopes, and y-intercepts for each wavelength are printed and included in each analytical data package.

7.10 After the instrument is properly calibrated, begin by reanalyzing the high standard(s) for each element. The standards can be combined into one solution for this analysis. The analyzed value must be within 5 percent of the true value or that element must be re-calibrated. The High Standard Check shall be used for 200.7 only. After the high standards are analyzed, the ICV check standard shall be run. For the ICV, all elements to be reported must be within 5 percent of the true value for 200.7 and 10 percent of the true value for 6010C. If the ICV fails, analysis shall be terminated, problem corrected, and the instrument re-calibrated.

7.11 After analyzing the ICV, the ICB must be analyzed. The results of the ICB must be less than one half the reporting limit. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a "B" or "V" qualifier, or raising the reporting limit for all samples to greater than two times the background concentration.

7.12 Before analyzing any real samples the CRIA (also referred to as LLCCV) must be analyzed. The CRIA contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning and end of each analytical run. For all elements the results must be within 20 percent of the true value for client specific reporting limits (CRIA Requirement). For all others a 30 percent criterion will be applied. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits (CRIA Requirement). If the initial CRIA fails no samples associated with the failing CRIA can be reported, and the CRIA should be reanalyzed for the failing elements. If the closing CRIA fails the criteria, the samples associated with the CRIA shall be evaluated as to the best corrective action for

each particular sample. This may include reanalyzing the samples associated with the CRIA, or qualifying the results in LIMS.

7.13 Before analyzing any real samples, the interference check standards (ICSA, ICSAB) must be analyzed. For all spiked elements, the analyzed results must be within 20 percent of the true value. For non-spiked elements, the interfering element solutions must be ± the absolute value of the reporting limit for each element. Also, on an as needed basis (i.e.: instrument repair), analyze the single element interference check solutions (SIC). The same criteria as outlined above apply. If the ICSA and/or the ICSAB fall outside this criterion the problem must be corrected and the instrument re-calibrated or data footnoted in LIMS system. If the closing ICSA/ICSAB fails the criteria, the samples associated with the ICSA/ICSAB shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples associated with the ICSA/ICSAB, or qualifying the results in LIMS. Refer to section 17.0 of this SOP for Interfering Element Correction (IEC) procedure.

7.14 After the initial analytical quality control has been analyzed, the samples and the preparation batch matrix quality control shall be analyzed. Each sample analysis must be a minimum of 3 readings using at least a 5 second integration time. Between each sample, flush the nebulizer and the solution uptake system with a blank rinse solution for at least 60 seconds or for the required period of time to ensure that analyte memory effects are not occurring.

7.15 Analyze the continuing calibration verification solution and the continuing calibration blank after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value for method 6010C and 5 percent for method 200.7 (for the initial CCV (ICCV)), the CCV shall be reanalyzed to confirm the initial value. If the CCV is not within criteria after the reanalysis, no samples can be reported in the area bracketed by the failing CCV. Immediately following the analysis of the CCV the CCB shall be analyzed. The results of the CCB must be less than one half the reporting limit for all elements. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit for all samples to greater than two times the background concentration.

7.16 One sample per preparation batch, or whenever matrix interferences are suspected for a batch of samples, a serial dilution (SDL) must be prepared. For the serial dilution, a 1:5 dilution must be made on the sample. The results of the 1:5 dilution shall agree within 10 percent of the true value as long as the sample and the dilution result are greater than 10 times the method detection limit or greater than 50 times the IDL. If the results are outside these criteria then matrix interference should be suspected and the proper footnote entered into LIMS. A post digestion spike (PDS) must be performed if the SDL fails. The PDS must recover within ± 20 percent for method SW846-6010C and ± 15 percent for method EPA 200.7. If the PDS is outside these limits then matrix interference must be suspected and the proper footnote entered into LIMS.

7.17 The upper limit of quantitation may exceed the highest concentration calibration point and can be defined as the “linear dynamic” range. Sample results above the linear dynamic range shall be diluted under the linear dynamic range and reanalyzed. Samples following a sample with high concentrations of analyte (s) must be examined for possible carryover.

Verification may be done by rinsing the lines with an acid solution and then reanalyzing the sample. A limit check table is built into the autosampler file so that samples exceeding the standardization range are flagged on the raw data.

7.18 After the instrument is optimized and all initial QC has been run, click on **Run Auto-Session** Icon to start the analytical run sequence.

7.18.1 If you need to add or delete samples once the run is started, follow the steps shown below.

7.18.2 Click on **Sequence** tab, then click on **List View** Icon at the tool bar. There is the sequence table shown on the display area.

7.18.3 Click on **Add Samples** Icon. This will pop up a dialog box, and then fill in number of samples that need to be added. Click **Ok**. By doing this, samples will be added to the end of the current sequence without a rack location.

7.18.4 On the Samplename column type in the sample I.D., correction factors, and check tables. **Click on Auto Locate All.**

7.18.5 The added samples will be analyzed at the end of the original sequence run order unless they are assigned a different run order.

7.18.6 Deleting Samples

7.18.7 Click on **Sequence** tab, and then click on **List View** Icon under the sequence display area.

7.18.8 Highlight all samples that need to be deleted and then click on the **Delete Samples** icon.

7.19 When the analysis is completed export the data to LIMS following the procedure outlined below.

7.19.1 Double click on **ePrint** Icon on desktop. There will be a **LEADTOOLS ePRINT** pop up box, click on **Finish Jobs** and **OK** boxes.

7.19.2 Double click the **PDF** Icon on the desktop; the PDF file will be present as Document_#. Right click on that file, select **rename** to change the filename to an assigned analytical run I.D. (i.e.: MA9000). This is the raw data file for MA9000.

7.19.3 Drop the raw data to the **LIMS Data Drop** icon located on the desktop.

7.19.4 By completing the above steps, the raw data (i.e.: MA9000) can be viewed and/or printed from the Raw Data Search function.

7.19.5 Go to **Analysis** tab, right click on sample header, and select export all samples. A pop up dialog box will come up, type in the analytical run I.D. (i.e.: SA101010M1) and click **Ok**. Go to **LIMS Export** folder located on the desktop, right click on analytical

run and change extension from .TXT to .ICP. Open the analytical file and make any necessary changes, such as deleting any samples that need to be re-run on dilution. **Save** the file. Drop the data file to the **LIMS Data Drop** icon located on the desktop. This will then send the export file to LIMS for review.

7.20 The data can be evaluated by running an automated data evaluation program, which will help to generate quality control summary pages. Each run must be evaluated as quickly as possible to make sure that all required quality control has been analyzed. With each data package include: cover sheet, copies of all prep sheets, autosampler run sequence, dilution sheets, and raw data. Label each folder with MA#, instrument run I.D., instrument used, and date.

7.21 At the end of the analysis day the ICP must be shutdown using the following sequence.

7.21.1 Place the auto sampler tip in the rinse cup and rinse in a mixed solution of approximately 5 percent nitric acid and 5 percent hydrochloric acid for 10 minutes and then in DI water for 20 minutes.

7.21.2 Turn off the plasma by clicking on the **Plasma** Icon and then by clicking **Plasma Off.**

7.21.3 Close all iTeva programs/windows.

7.21.4 Release the tension on the sample pump platens.

7.21.5 Turn off recirculating chiller.

8.0 QUALITY CONTROL

This section outlines the QA/QC operations necessary to satisfy the analytical requirements for method SW846 6010C. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements. Check with the area supervisor or lab manager for any non compliant quality control for further information.

8.1 High Standard Check.

After the instrument is properly calibrated, the high standard(s) shall be reanalyzed for each element. The analyzed value must be within 5 percent of the true value. If the High Standard falls outside this criteria analysis shall be terminated, problem corrected, and the instrument re-calibrated.

Note: High Standard Check is for method 200.7 only. The standards can be combined into one solution for this analysis.

8.2 Initial Calibration Verification Standard (ICV).

After each calibration, a standard from a different source than the calibration standard shall be analyzed. For the ICV, all elements to be reported must be within 10 percent of the true value for 6010C and within 5 percent for 200.7. If the ICV is outside these criteria then the analysis must be terminated, problem corrected, and the instrument re-calibrated.

8.3 Continuing Calibration Blank/Initial Calibration Blank.

Analyze the Initial calibration blank solution at the beginning of each run and the continuing calibration blank after every tenth sample and at the end of the sample run. The ICB/CCB must be less than one half the reporting limit for each element. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit for all samples to greater than two times the background concentration.

8.4 Low Standard Check (CRIA).

The CRIA (also referred to as LLCCV) contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning and end of each analytical run. For all elements the results must be within 20 percent of the true value for client specific reporting limits (CRIA Requirement). For all others a 30 percent criterion will be applied. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits (CRIA Requirement). If the initial CRIA fails no samples associated with the failing CRIA can be reported, and the CRIA should be reanalyzed for the failing elements. If the closing CRIA fails the criteria, the samples associated with the CRIA shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples associated with the CRIA, or qualifying the results in LIMS.

8.5 ICSA and ICSAB and Single Element Interference Solutions

Analyze the ICSA and ICSAB at the beginning and end of each run following the analysis of the CRIA. Also, on an as needed basis (i.e.: instrument repair), analyze the single element interference check solutions (SIC). For all spiked elements, the analyzed results must be within 20 percent of the true value. For non-spiked elements, the interfering element solutions must be $\pm$ the absolute value of the reporting limit for each element. If the ICSA and/or the ICSAB fall outside this criterion the problem must be corrected and the instrument re-calibrated or data footnoted in LIMS system. If the closing ICSA/ICSAB fails the criteria, the samples associated with the ICSA/ICSAB shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples associated with the ICSA/ICSAB, or qualifying the results in LIMS. Refer to section 17.0 of this SOP for Interfering Element Correction (IEC) procedure.

8.6 Continuing Calibration Verification.

Analyze the continuing calibration verification solution and the continuing calibration blank after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value for method 6010C and 5 percent for method 200.7 (for the initial CCV (ICCV)) the CCV must be reanalyzed to confirm the initial value. If the CCV is not within criteria after reanalysis no samples can be reported in the area bracketed by the failing CCV.

8.7 Method Blank.

The laboratory must digest and analyze a method blank with each batch of samples. The method blank must contain elements at less than one half the reporting limit for each element. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit. Samples associated with the contaminated blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-digesting and reanalyzing the samples, qualifying the results with a "B" or "V" qualifier, or raising the reporting limit to greater than two times the background concentration,

8.8 Blank Spike Sample.

The laboratory must digest and analyze a spike blank sample with each batch of samples. Blank Spikes must be within 20 percent of the true value for method SW846-6010C and within 15 percent for method EPA 200.7. If the lab control is outside of the control limits for a reportable element, all samples must be re-digested and reanalyzed for that element. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit. In that case, the sample results may be reported with no flag. For solid standard reference materials (SRMs) $\pm$ 20 percent accuracy may not be achievable and the manufacturer's established acceptance criterion should be used for all soil SRMs.

8.9 Matrix Spike and Matrix Spike Duplicate Recovery.

The laboratory must digest and analyze a matrix spike and matrix spike duplicate with each batch of samples. The matrix spike recovery is calculated as shown below and must be within 20 percent of the true value for method SW846-6010C and within 30 percent for method EPA 200.7. If a matrix spike is out of control, then the results must be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and must be footnoted to that effect.

Note: Both the matrix spike amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\frac{\text{(Spiked Sample Result - Sample Result)}}{\text{Amount Spiked}} \times 100 = \text{matrix spike recovery}$$

8.10 Matrix Duplicate/Matrix Spike Duplicate Relative Percent Difference.

The laboratory must digest a duplicate with each batch of samples. The relative percent difference (RPD) between the duplicate and the sample must be assessed and must be $\leq$ 20 percent for sample results at or above the reporting limit. If the RPD is outside the 20 percent criteria the results must be qualified in LIMS. RPD's are also calculated in LIMS for sample results below the reporting limit. RPD's outside the 20 percent criteria are not considered failing and LIMS automatically footnotes these as "RPD acceptable due to low duplicate and sample concentrations."

Note: Both the duplicate amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

8.11 Serial Dilution Analysis and Post Digestion Spike.

For one sample per preparation batch, or whenever matrix interferences are suspected for a batch of samples, a serial dilution must be prepared. For the serial dilution, a 1:5 dilution must be made on the sample. The results of the 1:5 dilution must agree within 10 percent of the true value as long as the sample and the dilution result are greater than 10 times the method detection limit and/or greater than 50 times the IDL. If the dilution does not agree, then the sample must be post digestion spiked (PDS) at a level no less than 10 times but no greater than 100 times the MDL concentration. The PDS must recover within ± 20 percent for method SW846-6010C and ± 15 percent for method EPA 200.7. If the PDS is outside these limits then matrix interference must be suspected and the proper footnote entered into LIMS.

$$\frac{(\text{Sample Result} - \text{Serial Dil. Result})}{\text{Sample Result}} \times 100 = \text{Serial Dilution RPD}$$

8.12 Linear Calibration ranges.

The upper limit of the linear calibration ranges must be established for all elements by determining the signal responses from a minimum of three concentration standards, one of which is close to the upper limit of the linear range. The linear calibration range, which may be used for the analysis of samples must be judged by the analyst from the resulting data. The upper range limit should be an observed signal no more than 10% below the level extrapolated from lower standards. Linear calibration ranges must be determined whenever there is a significant change in instrument response or at a minimum, every 6 months.

8.13 Sample RSD

For samples containing levels of elements greater than five times the reporting limits, the relative standard deviation for the replicates should be less than 5%. If not, reanalyze the sample. If upon reanalysis, the RSD's are acceptable then report the data from the reanalysis. If RSD's are not acceptable upon reanalysis, then the results for that element should be footnoted that there are possible analytical problems and/or matrix interference indicated by a high RSD between replicates.

8.14 Interelement Spectral Interference Correction Validity

For the interelement spectral interference corrections to remain valid during sample analysis, the interferent concentration must not exceed its linear range. If the interferent concentration exceeds its linear range or its correction factor is big enough to affect the element of interest even at lower concentrations, sample dilution with reagent blank and

reanalysis is required. In these circumstances, analyte dilution limits are raised by an amount equivalent to the dilution factor.

8.15 Internal Standard (Yttrium/Indium)

For any readings where the internal standard is outside of the range 60-125 percent of the internal standard level in the reference standard (Initial Calibration Blank), then the sample must be diluted until the internal standard is within range and all sample results must be footnoted in LIMS.

8.16 MSA (Method of Standard Additions)

SGS Accutest - Orlando uses the internal standard technique as an alternative to the MSA per SW846-6010C section 4.4.2. However, in certain circumstances MSA may be needed by some project specific requirements. SGS Accutest - Orlando may perform an MSA when sample matrix interference is confirmed through the post digestion spike process or may qualify the results in LIMS. SGS Accutest - Orlando will use a single addition method as described in SW846-7000B.

9.0 GLASSWARE CLEANING

All glassware must be washed with soap and tap water and then rinsed with 5 percent nitric acid. It must then be rinsed at least 3 times with DI water. Refer to SOP GN196, current revision for further information regarding glassware cleaning.

10.0 DOCUMENTATION REQUIREMENTS

Refer to the Laboratory Quality Assurance Manual for documentation requirements. All raw data is printed to .PDF format and archived to a backup server for long term storage.

11.0 SAFETY

The analyst must follow normal safety procedures as outlined in the SGS Accutest - Orlando Laboratory Safety Manual which includes the use of safety glasses and lab coats. In addition, all acids are corrosive and must be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor. Follow proper safety precautions when working with gas cylinders.

12.0 CALCULATIONS

For water samples, the following calculations must be used. Refer to the QC section for the calculations to be used for the QC samples.

Original sample concentration of metal (ug/l) =

$$\frac{\text{(conc. in the digestate (ug/l)) x (final digestate volume (ml))}}{\text{(initial sample volume (ml))}}$$

For soil samples, the following calculations must be used.

Concentration of the metal in the dry sample (mg/kg) =

$$\frac{\text{(conc. in the digestate (mg/l) x final digestate volume(L))}}{\text{(sample wt. (kg)) x (\% solids/100)}}$$

13.0 INSTRUMENT MAINTENANCE

Recommended periodic maintenance includes the items outlined below. All maintenance must be recorded in the instrument maintenance log.

13.1 Change the pump tubing as needed.

13.2 Clean the filter on the recirculating pump approximately once a month and dust off the power supply vents as needed.

13.3 Clean or replace the nebulizer, torch assembly, and injector tube as needed.

13.4 Change the sampler tip as needed.

13.5 Clean the recirculating pump lines and internal sock filter every 3 months or as needed.

13.6 Clean the radial view quartz surface weekly or more often if needed.

14.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

14.1 Pollution Prevention

Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids must be followed. All method users must be familiar with the waste management practices described in Section 14.2.

14.2 Waste Management

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

15.0 GENERIC DEFINITIONS

15.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or 24 hours whichever comes first.

15.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

15.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. A CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

15.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

15.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point must be at a level equal to or below the reporting level.

15.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor must be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

15.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the performance of a method in a given sample matrix.

15.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the precision and performance of a method in a given sample matrix.

15.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

15.10 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

15.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

16.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Statistical control limits are stored in the LIMS for QA purposes only. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

17.0 GENERATION OF INTERFERING ELEMENT CORRECTION FACTORS

17.1 It is recommended that all IEC's be verified and updated approximately every 6 months or whenever instrument conditions change significantly. It is also recommended that elements with frequent high concentrations or with large IEC's should be checked more frequently.

17.2 Calculate the IEC correction factors and enter them into the method (refer to Thermo 6500 instrument manual). Calculate the correction factor using the equation shown below. This correction factor must be added to the correction factor already in place in the method for a given element.

$$\text{IEC} = \frac{\text{Concentration Result of the element with the interference}}{\text{Concentration result of the interfering element}}$$

17.3 Verify the new correction factors by reanalyzing the ICSA/ICSAB solutions and/or the SIC solutions or by reloading and recalculating the previously stored results. If the reanalysis is not within QC limits, make additional changes to the IEC factors and then re-verify both the individual and combined solution values.

17.4 Save and update the method.

17.5 Interfering element correction factors are saved as raw data along with the run printouts on a daily basis so that the IEC's for a given run are traceable.

TABLE 1: REPORTING LIMIT BY ELEMENT

Analyte	Water Reporting Limit (ug/L)	Soil Reporting Limit (mg/kg)	TCLP Reporting Limit (mg/L)/MCL
Tin	50	5	
Aluminum	200	20	
Antimony	5	1	
Arsenic	10	0.5	0.10 / 5.0
Barium	200	20	10 / 100
Beryllium	4	0.5	
Cadmium	5	0.4	0.05 / 1.0
Calcium	1000	500	
Chromium	10	1	0.10 / 5.0
Cobalt	50	5	
Copper	25	2.5	
Iron	300	10	
Lead	5	1	0.5 / 5.0
Magnesium	5000	500	
Manganese	15	1.5	
Nickel	40	4.0	
Potassium	5000	500	
Selenium	10	1	0.5 / 1.0
Silver	10	1	0.10 / 5.0
Sodium	5000	500	
Thallium	10	1	
Vanadium	50	5	
Zinc	20	2	
Molybdenum	50	2.5	
Strontium	10	0.5	
Titanium	10	0.5	

TABLE 2. THERMO 6500 ANALYSIS LINES

Element	Wavelength
Al	396.1
As	189.042
Ca	317.933
Fe	259.9
Mg	279.078
Mn	257.610
Pb	220.353
Se	196.026
Tl	190.864
V	292.402
Ag	328.068
Ba	455.4
Be	313.042
Cd	226.502
Co	228.616
Cr	267.716
Cu	324.753
K	766.491
Na	589.5
Ni	231.604
Sb	206.838
Zn	206.2
Mo	202.030
Sn	189.900
Sr	407.7
Ti	334.9

TABLE 3: LOW, MID AND HIGH STANDARD LEVELS

Element	Low	Mid	High
	ug/l	ug/l	ug/l
Al	10000	40000	80000
As	500	2000	4000
Ca	10000	40000	80000
Fe	10000	40000	80000
Mg	10000	40000	80000
Mn	500	2000	4000
Pb	500	2000	4000
Se	500	2000	4000
Tl	500	2000	4000
V	500	2000	4000
Ag	62.5	250	500
Ba	500	2000	4000
Be	500	2000	4000
Cd	500	2000	4000
Co	500	2000	4000
Cr	500	2000	4000
Cu	500	2000	4000
K	10000	40000	80000
Na	10000	40000	80000
Ni	500	2000	4000
Sb	500	2000	4000
Zn	500	2000	4000
Mo	500	2000	4000
Sn	500	2000	4000
Sr	500	2000	4000
Ti	500	2000	4000

TABLE 4: ICV STANDARD LEVELS

Element	Concentration
	ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Sn	2000
Sr	2000
Ti	2000

TABLE 5: CCV STANDARD LEVELS

Element	Concentration
	ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Sn	2000
Sr	2000
Ti	2000

TABLE 6: CRIA STANDARD LEVELS

Element	CRIA
	ug/l
Al	200
As	10
Ca	1000
Fe	300
Mg	5000
Mn	15
Pb	5
Se	5
Tl	10
V	50
Ag	10
Ba	200
Be	5
Cd	5
Co	50
Cr	10
Cu	25
K	5000
Na	5000
Ni	40
Sb	5
Zn	20
Mo	50
Sn	50
Sr	10
Ti	10

TABLE 7: BLANK SPIKE, MATRIX SPIKE AND MATRIX SPIKE DUPLICATE LEVELS

Element	Concentration
	ug/l
Al	27000
As	2000
Ca	25000
Fe	26000
Mg	25000
Mn	500
Pb	500
Se	2000
Tl	2000
V	500
Ag	50
Ba	2000
Be	50
Cd	50
Co	500
Cr	200
Cu	250
K	25000
Na	25000
Ni	500
Sb	500
Zn	500
Mo	500
Sn	500
Sr	500
Ti	500

TABLE 8: TYPICAL RUN SEQUENCE

BLANK
LOW
MID
HIGH
HIGH STD
ICV
ICB
CRIA
ICSA
ICSAB
CCV
CCB
MB
SB
SAMPLE1
DUPLICATE
SERIAL DILUTION
MATRIX SPIKE
MATRIX SPIKE DUPLICATE
POST DIGESTION SPIKE
SAMPLE2
SAMPLE3
CCV
CCB
SAMPLE4
SAMPLE5
SAMPLE6
SAMPLE7
SAMPLE8
SAMPLE9
SAMPLE10
SAMPLE11
SAMPLE12
SAMPLE13
CRIA CLOSING
ICSA CLOSING
ICSAB CLOSING
CCV
CCB

TABLE 9: ICSA SOLUTION LEVELS

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	200
Mg	500
Mn	0
Pb	0
Se	0
Tl	0
V	0
Ag	0
Ba	0
Be	0
Cd	0
Co	0
Cr	0
Cu	0
K	0
Na	0
Ni	0
Sb	0
Zn	0
Mo	0
Sn	0
Sr	0
Ti	0

TABLE 10: ICSAB SOLUTION LEVELS

Element	Concentration
	mg/l
Al	500
As	1.0
Ca	500
Fe	200
Mg	500
Mn	0.5
Pb	1.0
Se	1.0
Tl	1.0
V	0.5
Ag	1.0
Ba	0.5
Be	0.5
Cd	1.0
Co	0.5
Cr	0.5
Cu	0.5
K	0
Na	0
Ni	1.0
Sb	1.0
Zn	1.0
Mo	1.0
Sn	1.0
Sr	1.0
Ti	1.0

TABLE 11: SINGLE ELEMENT INTERFERENCE CHECK SOLUTION (SIC) LEVELS

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	200
Mg	500
Mn	0
Pb	0
Se	0
Tl	0
V	0
Ag	0
Ba	0
Be	0
Cd	0
Co	0
Cr	0
Cu	0
K	0
Na	0
Ni	0
Sb	0
Zn	0
Mo	0
Sn	0
Si	50
Sr	0
Ti	0

DIGESTION OF SOILS FOR ICP ANALYSIS

Prepared by:	David Metzgar III	Date:	06/21/2016
Approved by:	Svetlana Izosimova	Date:	06/21/2016

Annual Review

Reviewed by:	Date:
Reviewed by:	Date:
Reviewed by:	Date:

Document Control

Issued to:	QA Department	Date:	06/23/2016
Issued to:	Metals	Date: *	06/23/2016
Issued to:		Date:	
Issued to:		Date:	
Issued to:		Date:	
Issued to:		Date:	

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: DIGESTION OF SOILS FOR ICP ANALYSIS

REFERENCES: 3050B

REVISED SECTIONS: SOP rebranded

1.0 SCOPE AND APPLICATION, SUMMARY

1.1 This method is applicable for the digestion of sediments, soils, sludges and solid wastes. After digestion, the samples can be analyzed by ICP. This digestion method is based upon SW846 method 3050B.

1.2 An aliquot of a homogenized soil is digested with repeated additions of nitric acid and hydrogen peroxide. Hydrochloric acid is added and the sample is refluxed for an additional 15 minutes. The sample is cooled to room temperature and diluted to 50 ml. If particulate matter is present, the sample is filtered.

2.0 PRESERVATION

All soils must be refrigerated at $\leq$ 6 ^{o}C. All bottleware used by SGS Accutest - Orlando is tested for cleanliness prior to shipping to clients. Analysis results must be < ½ RL to be acceptable. Please refer to SOP SAM104, current revision for further instruction.

3.0 HOLDING TIME

All samples should be digested and analyzed within 6 months of the time of collection.

4.0 INTEREFRENCES

Sludge and soil samples can contain diverse matrix types, which may contain a variety of interference. Spiked samples can be used to determine if this interference is adequately treated in the digestion process. For discussion of other interference, refer to specific analytical methods.

5.0 APPARATUS

The apparatus needed for this digestion procedure are listed below.

5.1 Automatic repipettor (s)

5.2 Fisher Brand 0.45 micron (um) filter or equivalent. Filter lots are checked for cleanliness through the Method Blank process. All Method Blank analytical results must be < ½ RL to be acceptable, if not, the contaminated lot must be identified and removed from laboratory

use. Samples filtered through the contaminated filters must be re-filtered through acceptable filters.

5.3 Top loader balance- capable of accurately weighing 0.01g. Refer to SOP QA005, current revision for balance calibration information.

5.4 Thermometer- capable of measuring to at least 125^0C and checked against NIST traceable thermometers. Refer to SOP QA002, current revision for further information.

5.5 Environmental Express Hot Block or equivalent capable of maintaining a temperature of 90-95°C.

5.6 Environmental Express digestion vessels or equivalent, 65ml capacity. Each Lot of digestion tubes comes with a Certificate of Analysis which demonstrates cleanliness as well as volume accuracy at the 50ml mark. Please refer to Digestion Tube Certificate Logbook for further information. Tube Lots are also checked through the Method Blank process. All Method Blank analytical results must be < ½ RL to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Re-digestion is required for all samples prepared with the contaminated tube lot.

5.7 Fisher Brand disposable 10 ml syringes or equivalent. Syringe lots are checked for cleanliness through the Method Blank process. All Method Blank results must be < ½ RL to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated syringes must be re-filtered through acceptable syringes.

5.8 Fisher Brand wooden spatulas or equivalent.

5.9 Eppendorf Pipette (s) - Pipette (s) are checked daily for accuracy and to ensure they are in good working condition prior to use. Volumes are checked at 100% of maximum volume (nominal volume). Pipettes are checked within the metals department and results are stored electronically in the “Pipette Calibration Log”. Refer to SOP QA006, current revision for further information regarding pipette calibration. BIAS: mean must be within 2% of nominal volume. Precision: RSD must be $\leq$ 1% of nominal volume based on three replicates.

5.10 Class A volumetric flask (s)

5.11 Class A volumetric pipette (s)

5.13 Teflon Chips

5.14 Solid Standard Reference Material (SRM) as required per project/client specific requirements.

5.15 Environmental Express ribbed watch glasses or equivalent.

6.0 REAGENTS

All chemicals listed below are trace metal grade unless otherwise specified. Refer to Acid Certificate of Analysis logbook for Certificate of Analysis and compliance with specifications of the grade listed. De-ionized (DI) water should be used whenever water is required. SGS Accutest Laboratories produces DI water to the specifications for the ASTM Type II standard designation based on the system manufacturer's performance specifications. The DI water is used exclusively for laboratory purposes. Refer to SOP QA037, current revision for more information regarding testing and monitoring.

6.1 Hydrochloric acid, Fisher Trace metal grade or equivalent

6.2 Nitric acid, Fisher Trace metal grade or equivalent

6.3 Hydrogen peroxide, reagent grade ,30%

6.4 Metals spiking solutions commercially purchased:

Environmental Express Multielement spiking solution or equivalent made with 5% HNO3 and a trace of HF.

Inorganic Ventures 5000 mg/l Mineral solution.

Prepared Metals Standards:

100ppm Molybdenum, 100ppm Tin, 100ppm Strontium, and 100ppm Titanium spiking solution prepared as follows: Using a 10ml class A volumetric pipette, add 10mls of 1000ppm stock Molybdenum, 10mls of 1000ppm stock Tin, 10mls of 1000ppm Strontium, and 10mls of 1000ppm Titanium to a 100ml class A volumetric flask containing approximately 50mls of DI water and 3mls of concentrated Nitric acid and 5mls of concentrated HCL. Dilute to volume with DI water and mix well. This standard must be prepared every 6 months or before stock standard expiration date, whichever comes first. Refer to Metals Standard Prep Logbook for further information. Some of the information included in the logbook is as follows: standard name, elements in mix, manufacturer, lot number, parent expiration date, acid matrix, stock concentration, volume of standard added, total volume, final prepared concentration, prep date, initials, MET number, and prepared standard expiration date.

7.0 PROCEDURE

7.1 Decant any free liquid from the solid sample. Remove any foreign objects such as twigs or rocks. The sample container must have enough room to move the matrix around with the wooden spatula. Mix the sample thoroughly using the wooden spatula. Make certain the entire sample is mixed well. The wooden spatula must reach the bottom of the original container and be able to be moved through the entire sample to ensure proper mixing. If the sample is packed tightly or matrix is dense and cannot be efficiently moved around in the original jar, a secondary container such as a porcelain dish must be used. Remove the sample from the original container and place in the clean secondary container. While in

the secondary container thoroughly mix sample around until appearing uniform in consistency. Upon completion the sample is re-packed into the original container. Refer to SOP QA034, current revision for more information on sample homogenization. Using a wooden spatula weigh out approximately 1.0 gram of a homogeneous sample on a top loading balance and place in the digestion vessel.

7.2 The sample identification must be accurately recorded on the digestion vessel and sample digestion log. In addition to the samples, a serial dilution (performed at the analytical bench), a post digestion spike (performed at the analytical bench), a matrix spike (MS), matrix spike duplicate (MSD), blank spike, duplicate (DUP) and a method blank should be set up with each batch of 20 samples. Refer to Table 1 for the spiking solution levels to use for each matrix spike, matrix spike duplicate, and blank spike. For the method blank and blank spike, 1.0 g of Teflon chips should be used. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements.

7.3 Add 2.5 ml of concentrated nitric acid to all quality control and samples. Cover all samples and matrix QC with ribbed watch glasses. Keep all samples covered throughout entire digestion procedure except during reagent additions.

7.4 Pre heat the Hot Block to 90 to 95°C. Place the labeled digestion vessels into the heating apparatus. Heat the samples at a gentle reflux for 10-15 minutes at 90 to 95°C. Allow the samples to cool.

7.5 Add an additional 2.5 ml of concentrated nitric acid to all quality control and samples. Heat the samples at a gentle reflux for an additional 30 minutes. Allow samples to cool.

NOTE: If brown fumes are generated, which indicates oxidation of sample by HNO3, then repeat step 7.5 until no brown fumes are present.

7.6 Heat at 90 to 95°C without boiling until sample volume is reduced to approximately 2.5mls. Do not allow sample to go to dryness.

7.7 Allow samples to cool. Add 2 ml of DI water and 3 ml of 30% hydrogen peroxide to each sample and reflux until effervescence subsides.

7.6 Continue to add 30% hydrogen peroxide in 1ml aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. Do not add more than a total of 10 mls of 30% hydrogen peroxide.

7.8 Heat at 90 to 95°C for 2 hours. Do not allow sample to go to dryness.

7.9 Allow samples to cool. Add 5 ml of concentrated HCl and reflux for an additional 15 minutes.

7.10 Allow the sample to cool. Dilute to final volume of 50 mls using DI water, cap and shake vessel. The sample is now ready for analysis by ICAP. If particulate matter is present, uncap the vessel and filter using Fisher Brand disposable syringe and 0.45 micron (um) filter or equivalent. The method blank and blank spike for the filtered sample's prep group must be filtered as well. All samples are filtered at the analytical bench.

8.0 QC REQUIREMENTS

For each digestion batch of 20 samples, a serial dilution (performed at the analytical bench), a post digestion spike (performed at the analytical bench), a matrix spike (MS), a matrix spike duplicate (MSD), a duplicate (DUP), a blank spike (LCS), and a method blank should be prepared. Re-digestion is suggested for QC that does not meet the SGS Accutest - Orlando QC limits. The appropriate lab supervisor or lab manager will notify the analyst of samples that need re-digestion. Please refer to TABLE 1 in this SOP for spiking volumes and concentrations. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements.

9.0 GLASSWARE CLEANING

All glassware should be washed with soap and tap water and then soaked in a 5% nitric acid bath. It should then be rinsed at least 3 times with de-ionized water. Refer to SOP GN196, current revision for further information regarding glassware cleaning.

10.0 DOCUMENTATION REQUIREMENTS

All digestion information should be completed in the Metals Digestion Log. The information required includes: the sample identification (including bottle number), the initial sample weight, the final sample volume, the acids (including the lot number and manufacturer), the spiking solutions used, the observed temperature, the corrected temperature, the thermometer ID, the digestion vessel lot number, the filter lot number, the Teflon chips lot number, analysts signature, and the digestion date. The analyst should write additional information such as unusual sample characteristics in the comment section.

11.0 SAFETY

The analyst should follow normal safety procedures as outlined in the SGS Accutest - Orlando Laboratory Safety Manual which includes the uses of safety glasses and lab coats. In addition, all acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact supervisor.

12.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

12.1 Pollution Prevention

Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids must be followed. All method users must be familiar with the waste management practices described in Section 12.2.

12.2 Waste Management

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

13.0 GENERIC DEFINITIONS

13.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or 24 hours whichever comes first.

13.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

13.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. A CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

13.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

13.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the reporting level.

13.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

13.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

13.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the precision and bias of a method in a given sample matrix.

13.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

13.10 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

13.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

14.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Statistical control limits are stored in the LIMS for QA purposes only. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

15.0 Hot block Maintenance

Clean surface area of hot block periodically to prevent sample and reagent build up on the surface of the block. If the hot block cannot maintain a temperature between 90-95 degree C or the user experiences any other type of mechanical or electronic error a service representative will need to be contacted. Any hot block that is not functioning properly must be tagged as “Out of Service”.

TABLE 1: ICP METALS SPIKING LEVELS
(Suggested levels, may vary depending on instrumentation used)

ELEMENT	INITIAL CONC (ppm)	VOLUME USED (ml)	FINAL CONC (mg/l)	FINAL VOL. (ml)
Ba	200	0.50	2.0	50
Be	5	0.50	.05	50
Cd	5	0.50	.05	50
Cr	20	0.50	.20	50
Cu	25	0.50	.25	50
Co	50	0.50	0.50	50
Mn	50	0.50	0.50	50
V	50	0.50	0.50	50
Zn	50	0.50	0.50	50
As	200	0.50	2.0	50
Se	200	0.50	2.0	50
Pb	50	0.50	0.50	50
Tl	200	0.50	2.0	50
Sb	50	0.50	0.50	50
Mo	100	0.25	0.50	50
Sn	100	0.25	0.50	50
Al	200/5000	0.5/0.25	27	50
Fe	200/5000	0.5/0.25	26	50
Mg	5000	0.25	25	50
Ca	5000	0.25	25	50
K	5000	0.25	25	50
Na	5000	0.25	25	50
Ag	5	0.50	0.05	50
Ni	50	0.50	0.50	50
Sr	100	0.25	0.50	50
Ti	100	0.25	0.50	50

APPENDIX A

1.0 Application

Appendix A designed to supplement SOPs MET104.xx and MET105.xx for the preparation of soil samples for compliance with DoD and certain state-specific projects

2.0 Background

A theory of particulate sampling was developed by geologist Pierre Gy to improve the quality of data gathered in support of mineral exploration and mining. The MIS approach described herein is based upon Gy's theories and is applicable to environmental sampling at contaminated sites.

A large portion of sampling error is a result of compositional and distributional heterogeneity.

Compositional heterogeneity describes the variability of contaminant concentrations between the particles that make up the population in the sample. This type of heterogeneity results in fundamental error (FE).

Distributional heterogeneity occurs when particles are not randomly distributed across the population due to slight spatial variations. Spatial variability will be missed if all samples are collected from one place. This type of heterogeneity results in grouping and segregation error (GSE).

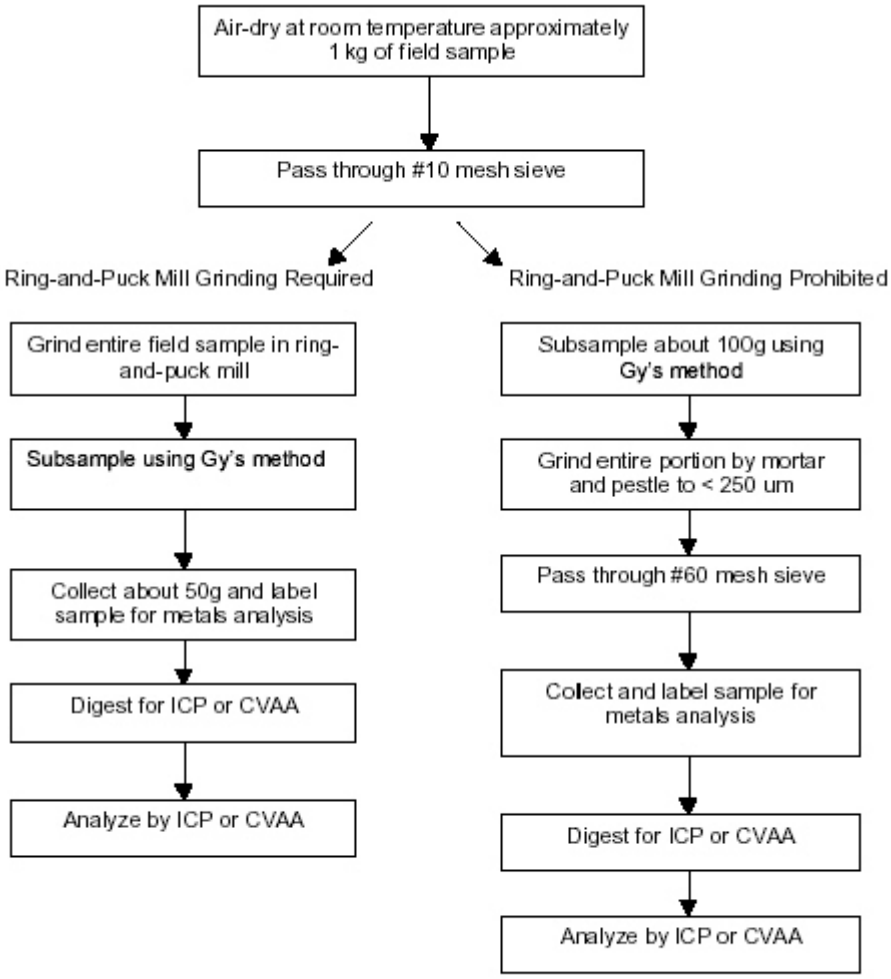
Gy found that fundamental error is directly proportionate to maximum particle size and inversely proportionate to sample size, therefore it is beneficial to collect and analyze a sample of sufficient size that consists of particulate matter where majority of contamination is present. In order to manage FE under 15%, particulate matter size must be under 2 mm and minimum sample mass above 30g.

To minimize GSE, it is imperative to collect sample increments randomly and in enough locations to capture the spatial variability, even within sample that already has been collected from the field.

3.0 Subsampling for Metals

Some projects require that metals analysis be performed on the multi-incremental sample that was collected for 8330B. The technique used should be listed in the project QAPP or SOW. Consult the client if this information is not available.

See flow chart below for various subsampling techniques:



If Ring and Puck Mill grinding is required, then proceed with the grinding procedure listed in SOP OP046 for explosives. The metallic components from the Ring and Puck Mill may introduce chromium and iron into the sample.

After grinding, place a baking tray on the downdraft table. Transfer the entire sample to the tray. Shape the sample into an elongated pile with flattened top surface that it is approximately 1 cm thick. Using a rectangular scoop, collect multiple top-to-bottom cuts across the sample (see figure below). A minimum of 4 cuts should be made through each sample. Combine the cuts in an appropriately labeled container. Minimum sample size should be 50 grams. Close the jar and repeat this procedure for each sample including the MB.

Transfer the samples to the metals department for analysis.

If Ring and Puck Mill grinding is not required then follow the procedure listed below.

Transfer the sample to a large ziplock bag after it has been air dried and sieved. Sample should be transferred over the downdraft tables to minimize dust contamination. Seal the bag and thoroughly mix the sample.

Place a baking tray on the downdraft table. Transfer the entire sample to the tray. Shape the sample into an elongated pile with flattened top surface that it is approximately 1 cm thick. Using a rectangular scoop, collect multiple top-to-bottom cuts across the sample (see figure below). A minimum of 4 cuts should be made through each sample. Combine the cuts in an appropriately labeled container. Minimum sample size should be 50 grams. Close the jar and repeat this procedure for each sample including the MB.

Return the remaining sample to the ziplock bag or mixing bowl.

Grind each sample and MB to a particle size less than 250 um with a non-metallic mortar and pestle.

Place a baking tray on the downdraft table. Sieve each sample through a #60 sieve onto a tray.

Collect and label the samples. Transfer the samples to the metals department for analysis.

For digestion withdraw approximately 5 g of sieved material. If mortar-and-pestle grinding was specified per QAPjP, 1 g is sufficient. Follow digestion procedure outlined in the body of this SOP.

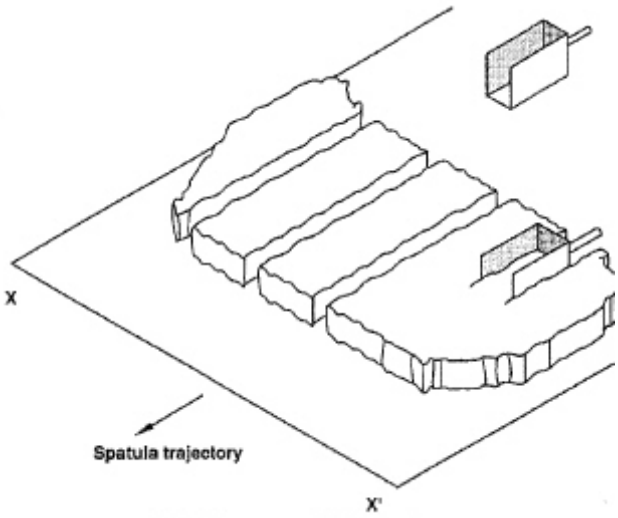


FIG. 1 Transversal Subsampling

ATTACHMENT 2
FIELD FORMS

Tetra Tech EM Inc.
Oakland Office

1999 Harrison Street, Suite 500
Oakland, CA 94612
510.302.6300 Phone
510.433.0830 Fax

Chain of Custody Record No. _____

	Lab PO#:	Lab:
Project name:	TtEMI technical contact:	Field samplers:
Project (CTO) number:	TtEMI project manager:	Field samplers' signatures:

Preservative Added

No./Container Types

Analysis Required

Sample ID	Sample Location (Pt. ID)	Date	Time	Matrix	MS / MSD	40 ml VOA	1 liter Amber	500 ml Poly	Sleeve	Glass Jar				VOA	SVOA	Pest/PCBs	Metals	TPH Purgeables	TPH Extractables									

	Name (print)	Company N e	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks:

Fed Ex #:

Tetra Tech EM Inc.

Daily Quality Control Report

Project Name:	**Date:**
Project Number:	**Day:**
Weather:	**Wind:**
Temperature:	**Humidity:**

Personnel on Site

Equipment on Site

Work Performed (Including Sampling)

Quality Control Activities

Health and Safety Levels and Activities

Problems Encountered / Corrective Action Taken

Tetra Tech EM Inc.

Daily Quality Control Report

Deviations from Field Work Plan

Additional Notes

Anticipated Activities for Tomorrow

Distribution:	**Submitted By:**
	Signature / **Date**

TETRA TECH EM INC.

SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

DO:

Bldg./Site:

Project Name:

Boring Number:	Date Started:
Drilling Method: (*Circle one*) HSA Continuous Core/Direct Push/Hand Auger	Date Completed:
Air Rotary/Mud Rotary/Dual Tube Percussion/Sonic/Vacuum	Logged By:
Outer Diameter of Boring:	Drilling Subcontractor:
Inner Diameter of Well Casing:	Driller:
Depth to Water (ft./bgs.)	Location Sketch:

Time	Depth (ft) bgs	Drive Interval	Recovered Interval	Sample ID	V.B. utility type, dia. / Blow count (per 6 inches)	Description	USCS soil symbol	Well construction	OVM (ppm)

TETRA TECH EM INC.

SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

DO:

Bldg./Site:

Project Name:

Time	Depth (ft) bgs	Drive Interval	Recovered Interval	Sample ID	Blow count (per 6 inches) / V.B. utility type, dia.	Description	USCS soil symbol	Well construction	OVM (ppm)

ATTACHMENT 3
LABORATORY CERTIFICATIONS

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

BC Laboratories, Inc.

4100 Atlas Court, Bakersfield, CA 93308

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.0 July 2013 and is accredited is accordance with the:

United States Department of Defense
Environmental Laboratory Accreditation Program
(DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
March 22, 2010	April 2, 2016	May 31, 2018
Revision Date:	*Accreditation No.:*	*Certificate No.:*
June 24, 2016	66175	L16-140-R1

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM BRANCH

CERTIFICATE OF ENVIRONMENTAL LABORATORY ACCREDITATION

Is hereby granted to

BC Laboratories, Inc.

4100 Atlas Court

Bakersfield, CA 93308

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **1186**

Expiration Date: **05/31/2016**

Effective Date: **06/01/2014**

Richmond, California
subject to forfeiture or revocation

David Mazzera, Ph.D., Assistant Division Chief
Division of Drinking Water and Environmental Management

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
Accredited Fields of Testing

BC Laboratories, Inc.
4100 Atlas Court
Bakersfield, CA 93308
Phone: (661) 327-4911

Certificate No.: 1186
Renew Date: 5/31/2014

Field of Testing: 101 - Microbiology of Drinking Water

101.010	001	Heterotrophic Bacteria	SM9215B
101.020	001	Total Coliform	SM9221A,B
101.021	001	Fecal Coliform	SM9221E (MTF/EC)
101.060	002	Total Coliform	SM9223
101.060	003	E. coli	SM9223
101.120	001	Total Coliform (Enumeration)	SM9221A,B,C
101.130	001	Fecal Coliform (Enumeration)	SM9221E (MTF/EC)
101.160	001	Total Coliform (Enumeration)	SM9223

Field of Testing: 102 - Inorganic Chemistry of Drinking Water

102.030	001	Bromide	EPA 300.0
102.030	003	Chloride	EPA 300.0
102.030	005	Fluoride	EPA 300.0
102.030	006	Nitrate	EPA 300.0
102.030	010	Sulfate	EPA 300.0
102.045	001	Perchlorate	EPA 314.0
102.050	001	Cyanide	EPA 335.4
102.060	001	Nitrate calc.	EPA 353.2
102.061	001	Nitrite	EPA 353.2
102.070	001	Phosphate, Ortho	EPA 365.1
102.100	001	Alkalinity	SM2320B
102.120	001	Hardness	SM2340B
102.130	001	Conductivity	SM2510B
102.140	001	Total Dissolved Solids	SM2540C
102.145	001	Total Dissolved Solids	EPA 160.1
102.192	001	Cyanide, amenable	SM4500-CN G
102.234	001	Nitrite	SM4500-NO3 F
102.262	001	Total Organic Carbon	SM5310C
102.263	001	DOC	SM5310C
102.270	001	Surfactants	SM5540C
102.520	001	Calcium	EPA 200.7
102.520	002	Magnesium	EPA 200.7
102.520	003	Potassium	EPA 200.7
102.520	004	Silica	EPA 200.7
102.520	005	Sodium	EPA 200.7
102.520	006	Hardness (calc.)	EPA 200.7

102.550	001	Chlorine, Free, Combined, Total	SM4500-Cl F (20th)

Field of Testing: 103 - Toxic Chemical Elements of Drinking Water

103.130	001	Aluminum	EPA 200.7
103.130	003	Barium	EPA 200.7
103.130	005	Cadmium	EPA 200.7
103.130	007	Chromium	EPA 200.7
103.130	008	Copper	EPA 200.7
103.130	009	Iron	EPA 200.7
103.130	011	Manganese	EPA 200.7
103.130	012	Nickel	EPA 200.7
103.130	015	Silver	EPA 200.7
103.130	017	Zinc	EPA 200.7
103.130	018	Boron	EPA 200.7
103.140	001	Aluminum	EPA 200.8
103.140	002	Antimony	EPA 200.8
103.140	003	Arsenic	EPA 200.8
103.140	004	Barium	EPA 200.8
103.140	005	Beryllium	EPA 200.8
103.140	006	Cadmium	EPA 200.8
103.140	007	Chromium	EPA 200.8
103.140	008	Copper	EPA 200.8
103.140	009	Lead	EPA 200.8
103.140	010	Manganese	EPA 200.8
103.140	011	Mercury	EPA 200.8
103.140	012	Nickel	EPA 200.8
103.140	013	Selenium	EPA 200.8
103.140	014	Silver	EPA 200.8
103.140	015	Thallium	EPA 200.8
103.140	016	Zinc	EPA 200.8
103.140	017	Boron	EPA 200.8
103.140	018	Vanadium	EPA 200.8
103.150	002	Antimony	EPA 200.9
103.150	003	Arsenic	EPA 200.9
103.150	005	Cadmium	EPA 200.9
103.150	006	Chromium	EPA 200.9
103.150	009	Lead	EPA 200.9
103.150	012	Selenium	EPA 200.9
103.150	014	Thallium	EPA 200.9
103.160	001	Mercury	EPA 245.1
103.310	001	Chromium (VI)	EPA 218.6

Field of Testing: 104 - Volatile Organic Chemistry of Drinking Water

104.030	001	1,2-Dibromoethane	EPA 504.1
104.030	002	1,2-Dibromo-3-chloropropane	EPA 504.1

104.035	001	1,2,3-Trichloropropane	SRL 524M-TCP
104.040	000	Volatile Organic Compounds	EPA 524.2
104.040	001	Benzene	EPA 524.2
104.040	007	n-Butylbenzene	EPA 524.2
104.040	008	sec-Butylbenzene	EPA 524.2
104.040	009	tert-Butylbenzene	EPA 524.2
104.040	010	Carbon Tetrachloride	EPA 524.2
104.040	011	Chlorobenzene	EPA 524.2
104.040	015	2-Chlorotoluene	EPA 524.2
104.040	016	4-Chlorotoluene	EPA 524.2
104.040	019	1,3-Dichlorobenzene	EPA 524.2
104.040	020	1,2-Dichlorobenzene	EPA 524.2
104.040	021	1,4-Dichlorobenzene	EPA 524.2
104.040	022	Dichlorodifluoromethane	EPA 524.2
104.040	023	1,1-Dichloroethane	EPA 524.2
104.040	024	1,2-Dichloroethane	EPA 524.2
104.040	025	1,1-Dichloroethene	EPA 524.2
104.040	026	cis-1,2-Dichloroethene	EPA 524.2
104.040	027	trans-1,2-Dichloroethene	EPA 524.2
104.040	028	Dichloromethane	EPA 524.2
104.040	029	1,2-Dichloropropane	EPA 524.2
104.040	033	cis-1,3-Dichloropropene	EPA 524.2
104.040	034	trans-1,3-Dichloropropene	EPA 524.2
104.040	035	Ethylbenzene	EPA 524.2
104.040	037	Isopropylbenzene	EPA 524.2
104.040	039	Naphthalene	EPA 524.2
104.040	041	N-propylbenzene	EPA 524.2
104.040	042	Styrene	EPA 524.2
104.040	044	1,1,2,2-Tetrachloroethane	EPA 524.2
104.040	045	Tetrachloroethene	EPA 524.2
104.040	046	Toluene	EPA 524.2
104.040	048	1,2,4-Trichlorobenzene	EPA 524.2
104.040	049	1,1,1-Trichloroethane	EPA 524.2
104.040	050	1,1,2-Trichloroethane	EPA 524.2
104.040	051	Trichloroethene	EPA 524.2
104.040	052	Trichlorofluoromethane	EPA 524.2
104.040	054	1,2,4-Trimethylbenzene	EPA 524.2
104.040	055	1,3,5-Trimethylbenzene	EPA 524.2
104.040	056	Vinyl Chloride	EPA 524.2
104.040	057	Xylenes, Total	EPA 524.2
104.045	001	Bromodichloromethane	EPA 524.2
104.045	002	Bromoform	EPA 524.2
104.045	003	Chloroform	EPA 524.2

104.045	004	Dibromochloromethane	EPA 524.2
104.045	005	Trihalomethanes	EPA 524.2
104.050	002	Methyl tert-butyl Ether (MTBE)	EPA 524.2
104.050	004	tert-Amyl Methyl Ether (TAME)	EPA 524.2
104.050	005	Ethyl tert-butyl Ether (ETBE)	EPA 524.2
104.050	006	Trichlorotrifluoroethane	EPA 524.2
104.050	007	tert-Butyl Alcohol (TBA)	EPA 524.2
104.050	008	Carbon Disulfide	EPA 524.2
104.050	009	Methyl Isobutyl Ketone	EPA 524.2

Field of Testing: 105 - Semi-volatile Organic Chemistry of Drinking Water

105.040	000	Chlorinated Pesticides	EPA 508
105.040	003	Chlordane (total)	EPA 508
105.040	007	Endrin	EPA 508
105.040	008	Heptachlor	EPA 508
105.040	009	Heptachlor Epoxide	EPA 508
105.040	010	Hexachlorobenzene	EPA 508
105.040	011	Hexachlorocyclopentadiene	EPA 508
105.040	012	Lindane	EPA 508
105.040	013	Methoxychlor	EPA 508
105.040	015	Toxaphene	EPA 508
105.040	016	PCBs as Aroclors (screen)	EPA 508
105.070	001	Bentazon	EPA 515.1
105.070	002	2,4-D	EPA 515.1
105.070	003	Dalapon	EPA 515.1
105.070	005	Dinoseb	EPA 515.1
105.070	006	Pentachlorophenol	EPA 515.1
105.070	007	Picloram	EPA 515.1
105.070	008	2,4,5-TP	EPA 515.1
105.090	001	Alachlor	EPA 525.2
105.090	003	Atrazine	EPA 525.2
105.090	004	Benzo(a)pyrene	EPA 525.2
105.090	008	Di(2-ethylhexyl) Adipate	EPA 525.2
105.090	009	Di(2-ethylhexyl) Phthalate	EPA 525.2
105.090	013	Endrin	EPA 525.2
105.090	014	Heptachlor	EPA 525.2
105.090	015	Heptachlor Epoxide	EPA 525.2
105.090	016	Hexachlorobenzene	EPA 525.2
105.090	017	Hexachlorocyclopentadiene	EPA 525.2
105.090	018	Lindane	EPA 525.2
105.090	019	Methoxychlor	EPA 525.2
105.090	022	Molinate	EPA 525.2
105.090	023	Pentachlorophenol	EPA 525.2
105.090	025	Simazine	EPA 525.2

105.090	028	Thiobencarb	EPA 525.2
105.090	030	Adipates	EPA 525.2
105.090	031	Phthalates	EPA 525.2
105.090	032	Other Extractables	EPA 525.2
105.140	001	Endothall	EPA 548.1
105.150	001	Diquat	EPA 549.2
105.201	001	Haloacetic Acids (HAA5)	EPA 552.3

Field of Testing: 106 - Radiochemistry of Drinking Water

106.092	001	Uranium	EPA 200.8

Field of Testing: 107 - Microbiology of Wastewater

107.010	001	Heterotrophic Bacteria	SM9215B
107.020	001	Total Coliform	SM9221B
107.040	001	Fecal Coliform	SM9221C,E (MTF/EC)
107.245	001	E. coli	SM9223

Field of Testing: 108 - Inorganic Chemistry of Wastewater

108.020	001	Conductivity	EPA 120.1
108.090	001	Residue, Volatile	EPA 160.4
108.110	001	Turbidity	EPA 180.1
108.112	001	Boron	EPA 200.7
108.112	002	Calcium	EPA 200.7
108.112	003	Hardness (calc.)	EPA 200.7
108.112	004	Magnesium	EPA 200.7
108.112	005	Potassium	EPA 200.7
108.112	006	Silica	EPA 200.7
108.112	007	Sodium	EPA 200.7
108.120	001	Bromide	EPA 300.0
108.120	002	Chloride	EPA 300.0
108.120	003	Fluoride	EPA 300.0
108.120	004	Nitrate	EPA 300.0
108.120	008	Sulfate	EPA 300.0
108.183	001	Cyanide, Total	EPA 335.4
108.200	001	Ammonia	EPA 350.1
108.211	001	Kjeldahl Nitrogen	EPA 351.2
108.232	001	Nitrate-nitrite	EPA 353.2
108.232	002	Nitrite	EPA 353.2
108.260	001	Phosphate, Ortho	EPA 365.1
108.266	001	Phosphorus, Total	EPA 365.4
108.323	001	Chemical Oxygen Demand	EPA 410.4
108.362	001	Phenols, Total	EPA 420.4
108.381	001	Oil and Grease	EPA 1664A
108.390	001	Turbidity	SM2130B
108.410	001	Alkalinity	SM2320B
108.420	001	Hardness (calc.)	SM2340B

108.440	001	Residue, Total	SM2540B
108.441	001	Residue, Filterable	SM2540C
108.442	001	Residue, Non-filterable	SM2540D
108.443	001	Residue, Settleable	SM2540F
108.464	001	Chlorine	SM4500-Cl F
108.473	001	Cyanide, amenable	SM4500-CN G
108.490	001	pH	SM4500-H+ B
108.498	001	Ammonia	SM4500-NH3 H (18th)
108.531	001	Dissolved Oxygen	SM4500-O G
108.542	001	Phosphate, Ortho	SM4500-P F
108.580	001	Sulfide	SM4500-S= D
108.581	001	Sulfide	SM4500-S= E (18th)
108.590	001	Biochemical Oxygen Demand	SM5210B
108.591	001	Carbonaceous BOD	SM5210B
108.602	001	Chemical Oxygen Demand	SM5220D
108.611	001	Total Organic Carbon	SM5310C
108.640	001	Surfactants	SM5540C

Field of Testing: 109 - Toxic Chemical Elements of Wastewater

109.010	001	Aluminum	EPA 200.7
109.010	002	Antimony	EPA 200.7
109.010	003	Arsenic	EPA 200.7
109.010	004	Barium	EPA 200.7
109.010	005	Beryllium	EPA 200.7
109.010	007	Cadmium	EPA 200.7
109.010	009	Chromium	EPA 200.7
109.010	010	Cobalt	EPA 200.7
109.010	011	Copper	EPA 200.7
109.010	012	Iron	EPA 200.7
109.010	013	Lead	EPA 200.7
109.010	015	Manganese	EPA 200.7
109.010	016	Molybdenum	EPA 200.7
109.010	017	Nickel	EPA 200.7
109.010	019	Selenium	EPA 200.7
109.010	021	Silver	EPA 200.7
109.010	023	Thallium	EPA 200.7
109.010	024	Tin	EPA 200.7
109.010	026	Vanadium	EPA 200.7
109.010	027	Zinc	EPA 200.7
109.020	001	Aluminum	EPA 200.8
109.020	002	Antimony	EPA 200.8
109.020	003	Arsenic	EPA 200.8
109.020	004	Barium	EPA 200.8
109.020	005	Beryllium	EPA 200.8

109.020	006	Cadmium	EPA 200.8
109.020	007	Chromium	EPA 200.8
109.020	008	Cobalt	EPA 200.8
109.020	009	Copper	EPA 200.8
109.020	010	Lead	EPA 200.8
109.020	011	Manganese	EPA 200.8
109.020	012	Molybdenum	EPA 200.8
109.020	013	Nickel	EPA 200.8
109.020	014	Selenium	EPA 200.8
109.020	015	Silver	EPA 200.8
109.020	016	Thallium	EPA 200.8
109.020	017	Vanadium	EPA 200.8
109.020	018	Zinc	EPA 200.8
109.020	022	Tin	EPA 200.8
109.025	002	Antimony	EPA 200.9
109.025	003	Arsenic	EPA 200.9
109.025	004	Beryllium	EPA 200.9
109.025	005	Cadmium	EPA 200.9
109.025	006	Chromium	EPA 200.9
109.025	010	Lead	EPA 200.9
109.025	012	Nickel	EPA 200.9
109.025	013	Selenium	EPA 200.9
109.025	014	Silver	EPA 200.9
109.025	016	Tin	EPA 200.9
109.190	001	Mercury	EPA 245.1
109.311	001	Thallium	EPA 279.2
109.811	001	Chromium (VI)	SM3500-Cr D (18th/19th)

Field of Testing: 110 - Volatile Organic Chemistry of Wastewater

110.010	000	Halogenated Volatiles	EPA 601
110.020	000	Aromatic Volatiles	EPA 602
110.040	040	Halogenated Hydrocarbons	EPA 624
110.040	041	Aromatic Compounds	EPA 624
110.040	042	Oxygenates	EPA 624
110.040	043	Other Volatile Organics	EPA 624

Field of Testing: 111 - Semi-volatile Organic Chemistry of Wastewater

111.060	000	Polynuclear Aromatics	EPA 610
111.101	032	Polynuclear Aromatic Hydrocarbons	EPA 625
111.101	034	Phthalates	EPA 625
111.101	036	Other Extractables	EPA 625
111.170	030	Organochlorine Pesticides	EPA 608
111.170	031	PCBs	EPA 608
111.210	000	Carbamates	EPA 632
111.273	001	Oil and Grease	EPA 1664A

Field of Testing: 114 - Inorganic Chemistry of Hazardous Waste

114.010	001	Antimony	EPA 6010B
114.010	002	Arsenic	EPA 6010B
114.010	003	Barium	EPA 6010B
114.010	004	Beryllium	EPA 6010B
114.010	005	Cadmium	EPA 6010B
114.010	006	Chromium	EPA 6010B
114.010	007	Cobalt	EPA 6010B
114.010	008	Copper	EPA 6010B
114.010	009	Lead	EPA 6010B
114.010	010	Molybdenum	EPA 6010B
114.010	011	Nickel	EPA 6010B
114.010	012	Selenium	EPA 6010B
114.010	013	Silver	EPA 6010B
114.010	014	Thallium	EPA 6010B
114.010	015	Vanadium	EPA 6010B
114.010	016	Zinc	EPA 6010B
114.020	001	Antimony	EPA 6020
114.020	002	Arsenic	EPA 6020
114.020	003	Barium	EPA 6020
114.020	004	Beryllium	EPA 6020
114.020	005	Cadmium	EPA 6020
114.020	006	Chromium	EPA 6020
114.020	007	Cobalt	EPA 6020
114.020	008	Copper	EPA 6020
114.020	009	Lead	EPA 6020
114.020	010	Molybdenum	EPA 6020
114.020	011	Nickel	EPA 6020
114.020	012	Selenium	EPA 6020
114.020	013	Silver	EPA 6020
114.020	014	Thallium	EPA 6020
114.020	015	Vanadium	EPA 6020
114.020	016	Zinc	EPA 6020
114.103	001	Chromium (VI)	EPA 7196A
114.106	001	Chromium (VI)	EPA 7199
114.140	001	Mercury	EPA 7470A
114.141	001	Mercury	EPA 7471A
114.221	001	Cyanide, Total	EPA 9012A
114.240	001	Corrosivity - pH Determination	EPA 9040B
114.241	001	Corrosivity - pH Determination	EPA 9045C

Field of Testing: 115 - Extraction Test of Hazardous Waste

115.020	001	Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311
115.030	001	Waste Extraction Test (WET)	CCR Chapter11, Article 5, Appendix II

115.040	001	Synthetic Precipitation Leaching Procedure (SPLP)	EPA 1312

Field of Testing: 116 - Volatile Organic Chemistry of Hazardous Waste

116.020	031	Ethanol and Methanol	EPA 8015B
116.030	001	Gasoline-range Organics	EPA 8015B
116.040	041	Methyl tert-butyl Ether (MTBE)	EPA 8021B
116.040	062	BTEX	EPA 8021B
116.080	000	Volatile Organic Compounds	EPA 8260B
116.080	120	Oxygenates	EPA 8260B
116.100	001	Total Petroleum Hydrocarbons - Gasoline	LUFT GC/MS
116.100	010	BTEX and MTBE	LUFT GC/MS
116.110	001	Total Petroleum Hydrocarbons - Gasoline	LUFT

Field of Testing: 117 - Semi-volatile Organic Chemistry of Hazardous Waste

117.010	001	Diesel-range Total Petroleum Hydrocarbons	EPA 8015B
117.015	001	Diesel-range Total Petroleum Hydrocarbons	LUFT GC/MS
117.016	001	Diesel-range Total Petroleum Hydrocarbons	LUFT
117.110	000	Extractable Organics	EPA 8270C
117.111	071	Pesticides	EPA 8270C
117.140	000	Polynuclear Aromatic Hydrocarbons	EPA 8310
117.170	000	Nitroaromatics and Nitramines	EPA 8330
117.210	000	Organochlorine Pesticides	EPA 8081A
117.220	000	PCBs	EPA 8082
117.240	000	Organophosphorus Pesticides	EPA 8141A
117.250	000	Chlorinated Herbicides	EPA 8151A

Field of Testing: 120 - Physical Properties of Hazardous Waste

120.040	001	Reactive Cyanide	Section 7.3 SW-846
120.050	001	Reactive Sulfide	Section 7.3 SW-846
120.070	001	Corrosivity - pH Determination	EPA 9040B
120.080	001	Corrosivity - pH Determination	EPA 9045C

Field of Testing: 126 - Microbiology of Recreational Water

126.010	001	Total Coliform (Enumeration)	SM9221A,B,C
126.030	001	Fecal Coliform (Enumeration)	SM9221E

LABORATORY ACCREDITATION BUREAU a division of A-S-B

Certificate of Accreditation

ISO/IEC 17025:2005 Certificate Number L2229

SGS Accutest - Orlando

4405 Vineland Road, Suite C-15
Orlando FL 32811

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: December 15, 2018

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 14th of January 2016

*See the laboratory's Scope of Accreditation for details of accredited parameters
**Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).
Form 403.14 – Rev 1 7/3/13

CALIFORNIA
Water Boards

STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

CERTIFICATE OF ENVIRONMENTAL ACCREDITATION

Is hereby granted to

SGS Accutest- Orlando

4405 Vineland Road, Suite C-15

Orlando, FL 32811

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site inspection, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **2937**

Expiration Date: **6/30/2018**

Effective Date: **7/29/2016**

Sacramento, California
subject to forfeiture or revocation

Christine Sotelo, Chief
Environmental Laboratory Accreditation Program

APPENDIX E
SITE CHARACTERIZATION HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

AREA OF INVESTIGATION 14

December 2017

Prepared for:

National Aeronautics and Space Administration,
Ames Research Center,
Moffett Field, California

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

Site Name: NASA Ames Area of Investigation (AOI) 14	**Site Contact: Kevin Bricknell**	**Telephone: 510-302-6306**
Location: Moffett Field – Mountain View, CA	**Client Contact: Kimberly Finch**	**Telephone: 650-604-1294**
EPA ID No.	**Prepared By: Kevin Bricknell** **Approved By: Dave Brown 1/10/17**	**Date Prepared: 1/7/17, Revised 12/12/2017**
Project No. 103IG4704	**Dates of Activities: 12/10/17 – 3/31/18** (HASP is not valid for periods longer than 12 months)	**Emergency Response** ☐ Yes ☒ No

Objectives:

The design characterization study includes two phases: the pilot study and the full-scale investigation.

The pilot study work is planned to begin January 2018, with mobilization activities beginning in December 2017. The goal of the pilot study is determine the appropriate confidence interval to apply to each of the decision unit (DU) results through evaluation of relative standard deviation as a percentage (RSD) of triplicate (set of three field replicates) ISM (incremental sampling methodology) results in three predetermined FSFA IAGs. 30 increments will be included in each ISM soil sample. (2 week process).

The full-scale investigation study is planned to begin after the pilot study has been performed (mid-January 2018). The goal of the full-scale investigation is to characterize concentrations of COCs (contaminant of concern) in the DUs (decision units) in the FSFA (former soil fill area) and adjacent locations in the SP (storm water pond) bottom to identify those DUs where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in soil or sediment. (6 week process). The data collected from this investigation will determine which soil may be left on site and which soil must be off-hauled from the site during the subsequent removal.

Site Type: *Check as many as applicable.*

☐ Active	☐ Landfill	☐ Inner-City
☐ Inactive	☐ Railroad	☐ Rural
☒ Secured	☐ Residential	☐ Remote
☐ Unsecured	☒ Industrial	☐ Other (*specify*)

Project Scope of Work and Site Background:

NASA Ames AOI 14 consists of three peninsulas jutting into storm water retention ponds (FSFA, N217, and N217A). Based on the results of the streamlined risk evaluation, soil at the N217 and N217A peninsulas does not pose unacceptable risk and therefore the N217 and N217A peninsulas are not included in the design site characterization effort. FSFA is an 8-acre site that has a flat top surface with roads, exposed soil surfaces, and vegetation. The site consists of a heterogeneous mixture of gravel, sand, silt, clay and miscellaneous construction debris that was deposited on site due to construction that was taking place nearby from 1968-1987. The native soil underneath the fill material is primarily clay. The sites are elevated about the surrounding surface impoundments. Tt staff will not walk on side slopes or near water, and will stay on relatively flat surfaces. Vegetation and wetland wildlife are expected. May encounter old debris. The site location map shows the 3 peninsulas.

Both the pilot study and full-scale investigation will involve the collection of ISM samples. The pilot study will consist of collecting ISM samples from three IAGs (investigation area grid) with 30 increments in triplicate, from multiple depth intervals (of which there will be a maximum of 13 total). Each increment will be a boring advanced using DPT (direct-push technology) to the bottom of fill (estimated between 8 and 18 feet below ground surface). The full-scale investigation will involve collecting 30-increment ISM samples at 21 IAGs in a gridded pattern from multiple depth intervals. The collection methods for the full-scale investigation will be the same as for the pilot study, with the exception of the IAGs located on the perimeter of the FSFA as well as the two within the SP (storm water pond). For the IAGs located on the perimeter of the FSFA, two additional sampling methods will be used: (1) a portion of direct-push borings will be advanced at 30-45 degrees from vertical using DTP angle-hole methods to bottom of fill, and (2) a hand auger will be used to collect soil samples on the side slopes to a maximum depth of 4 feet bgs. At SP IAGs, samples will be collected to a depth of 1 foot using a hand auger or soil corer from the stormwater pond bottom.

Health and Safety Approver Comments or Additional Instructions:

None

Health and Safety Plan Approver Signature: Dave Brown

Date: 12/08/17 (Updated)

Note: A minimum of two persons with appropriate training and medical surveillance must be on site for any fieldwork subject to Level 2 HASP requirements.

Establishment of Work Zones; including exclusion, contamination reduction, and support zones; is required for ALL HAZWOPER projects. For heavy equipment (i.e. drilling operations), exclusions zone will be established around each equipment or drilling location based on site conditions and or noise levels (DCN 2-04, Hearing Conservation Program) at drilling operations (i.e. a circular exclusion zone based on noise levels >85 dbA from the drill rig or a minimum of 20 feet around the rig, whichever is greater). Work zones will be delineated using cones, barrier tape or similar visual indicators.
ALL investigation-derived waste shall be drummed and remain onsite pending characterization for subsequent disposal.

Spill control shall be conducted in accordance with the requirements of SWP 5-14, *Spill and Discharge Control Practices*.
All requirements in the NASA Ames Health and Safety Manual (APR 8715.1) shall be followed during this investigation. (https://procure.arc.nasa.gov/).
A safety bulletin board shall be erected at the site (or within the construction trailer per APR 8715.1, Chapter 27, part 27.3 Forms, "Notices and Permits", and all permits shall be posted.

Wind Speed and Direction (approach from upwind) Use www.weather.com or www.wunderground.com		**Temperature (ºF)**	**Relative Humidity (%)**	**Probability of Precipitation (%)**	**Weather Forecast (such as partly cloudy, snow, etc.)**
Speed (mph):	**From Direction:**				

Capture weather information daily on Tailgate Safety Briefing form or in site logbook

On-Site Supplies: ☒ First Aid Kit ☒ Fire Extinguisher ☐ Air Horn ☐ Oral Thermometer ☐ Noise Dosimeter

Known or Anticipated Site Hazards or Concerns:

☐ Work on active roadway	☒ Overhead utilities	☐ Energized electrical systems
☐ Work over or near water	☒ Buried Utilities	☒ Portable hand tool use
☐ Explosion or fire hazard	☐ Surface or underground storage tanks	☒ Portable electrical tool use
☐ Oxygen deficiency	☒ General slips, trips, falls	☐ Machine guarding
☐ Unknown or poorly characterized chemical hazards	☐ Uneven, muddy, rugged terrain	☒ Portable fire extinguisher use
☒ Inorganic chemicals	☐ Lift (man lift, cherry picker) use	☒ Driving personal vehicles
☒ Organic chemicals	☐ Industrial truck (forklift) use	☐ All-terrain vehicle use
☐ Asbestos	☐ Wood or metal ladder use	☒ Injury and Illness Prevention Program (California only)
☐ Respirable particulates	☐ Dangerous goods shipped by air	☐ Ergonomics (California only)
☐ Respirable silica	☐ Elevated work (over 6' high)	☐ Work in strip or shaft mines
☐ Blasting and explosives	☒ Heavy equipment use or operation	☒ Client-specific safety requirements (APR 8715.1)
☒ Non-ionizing radiation (lasers, UV) (must conform to APR 8715.1, Chapter 8)	☐ Construction work	☐ Confined space entry and/or rescue
☐ Ionizing radiation (alpha, beta, gamma, etc.)	☐ Excavation or trenching	☐ Methamphetamine lab
☒ Heat stress	☐ Benching, shoring, bracing	☐ Biological hazards (i.e. ticks, snakes, poisonous plants)
☒ Cold stress	☐ Scaffold use	☐ Mold
☒ Sun Exposure	☒ High noise	☐ *Other (insert)*

Explosion or Fire Potential: ☐ High ☐ Medium ☒ Low ☐ Unknown

Chemical Products Tetra Tech EM Inc. Will Use or Store On Site: (Attach a Material Safety Data Sheet [MSDS] for each item.)

- ☒ Alconox or Liquinox
- ☐ Hydrochloric acid (HCl)
- ☒ Nitric acid (HNO_3)
- ☐ Sodium hydroxide (NaOH)
- ☐ Calibration gas (Methane)
- ☐ Calibration gas (Isobutylene)
- ☐ Calibration gas (4-gas mixture)
- ☒ Eyewash solution (potable water)
- ☐ Hydrogen gas
- ☐ Household bleach (NaOCl)
- ☐ Sulfuric acid (H_2SO_4)
- ☐ Hexane
- ☐ Isopropyl alcohol
- ☐ HazCat Kit
- ☐ Mark I Kits (*number?*) _____
- ☐ Other (*specify*) _____

WARNING: Eyewash solution shall be readily available on ALL projects where corrosives (acids or bases) are used, including sample preservatives

Applicable Safety Programs and Safe Work Practices (SWP). Attach to HASP:

- ☒ DCN 2-04 Hearing Conservation Program (always checked)
- ☐ DCN 4-05 Trenching and Excavation Safety
- ☐ DCN 4-08 Asbestos Protection Program
- ☐ DCN 4-09 Haulage and Earth Moving
- ☐ DCN 4-10 Lead Protection Program
- ☒ SWP DCN 5-01 General Safe Work Practices
- ☒ SWP DCN 5-02 General Safe Work Practices HAZWOPER
- ☐ SWP DCN 5-03 Safe Work Practices for Office Employees
- ☐ SWP DCN 5-04 Safe Drilling Practices
- ☒ SWP DCN 5-05 Safe Direct Push (GeoProbe) Practices
- ☐ SWP DCN 5-06 Working Over or Near Water
- ☒ SWP DCN 5-07 Use of Heavy Equipment (must comply with CA Manual on Uniform Traffic Control Devices [http://www.dot.ca.gov/hq/traffops/engineering/mutcd/ca_mutcd2014.htm])
- ☐ SWP DCN 5-08 Special Site Hazards (Firearms, Remote Sites, Mines, aircraft, etc.)
- ☐ SWP DCN 5-09 Safe Electrical Work Practices
- ☐ SWP DCN 5-10 Fall Protection Practices
- ☐ SWP DCN 5-11 Portable Ladder Safety
- ☐ SWP DCN 5-12 Drum and Container Handling Practices
- ☐ SWP DCN 5-13 Flammable Hazards and Ignition Sources
- ☒ SWP DCN 5-14 Spill and Discharge Control Practices (always checked)
- ☒ SWP DCN 5-15 Heat Stress
- ☒ SWP DCN 5-16 Cold Stress
- ☒ SWP DCN 5-17 Biohazards
- ☐ SWP DCN 5-18 Underground Storage Tank Removal Practices
- ☐ SWP DCN 5-19 Safe Lifting Procedures
- ☐ SWP DCN 5-22 Hydrographic Data Collection
- ☐ SWP DCN 5-23 Permit-Required Confined Space Entry Practices
- ☐ SWP DCN 5-24 Non-Permit-Required Confined Space Entry Practices
- ☒ SWP DCN 5-26 Prevention of Sun Exposure
- ☐ SWP DCN 5-27 Respirator Cleaning Practices
- ☐ SWP DCN 5-28 Safe Use Practices for Use of Respirators
- ☐ SWP DCN 5-35 Underground Utilities, including 5-35F, Ground Disturbance Permit

Tasks Performed At Job Site that are <u>NOT</u> Covered by SWPs

NOTE: Many AHA's can be found on the Health & Safety intranet site at: https://int.tetratech.com/sites/EMI/hs/Activity%20Hazard%20Analysis%20Documents/Forms/AllItems.aspx

Attach Activity Hazard Analysis (AHA) for each non-covered task

- ☐ (non-covered task)
- ☐ (non-covered task)
- ☐ (non-covered task)
- ☐ (non-covered task)
- ☐ (non-covered task)

Tetra Tech Employee Training and Medical Requirements:

Basic Training and Medical

- ☒ Initial 40 Hour Training
- ☒ 8-Hour Supervisor Training (one-time)
- ☒ Current 8-Hour Refresher Training
- ☐ Current Medical Clearance (including respirator use)
- ☒ Current First Aid Training and CPR Training
- ☐ Current Respirator Fit-Test

Other Specific Training and Medical Surveillance Requirements

- ☐ Confined Space Training
- ☐ Level A Training
- ☐ Radiation Training
- ☐ OSHA 10-hour Construction Safety Training
- ☐ OSHA 30-hour Construction Safety Training
- ☐ Asbestos Awareness Training
- ☐ Asbestos B-Reader X-Ray
- ☐ Blood Lead Level and ZPP Pre, during and Post-Project
- ☐ Urinary Arsenic Level Pre and Post-Project
- ☐ Other _____
- ☐ Other _____

☒ SWP DCN 5-36 Drill Rigs

Materials Present or Suspected at Site	Highest Observed Concentration (specify units and sample medium)	Exposure Limit (specify ppm or mg/m^3)	IDLH Level (specify ppm or mg/m^3)	Primary Hazards of the Material (explosive, flammable, corrosive, toxic, volatile, radioactive, biohazard, oxidizer, or other)	Symptoms and Effects of Acute Exposure	Photoionization Potential (eV)
lead		PEL = 0.050 mg/m^3 REL = 0.050 mg/m^3 TLV = 0.050 mg/m^3 [Skin] Hazard ☐	100 mg/m^3	Toxic	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight lost, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertention	N/A
4,4-DDT (dichlorodiphenyltrichlorethane)		PEL = 1 mg/m^3 REL = 0.5 mg/m^3 TLV = 1 mg/m^3 [Skin] Hazard ☐	500 mg/m^3	Combustible solid; incompatibilities and Reactivities; strong oxidizers, alkalis	Irritation eyes, skin; paresthesia tongue, lips, face; tremor; anexity, dizziness, confusion, malaise (vague feeling of discomfort), headache, lassitude (weakness, exhaustion); convulsions; paresis hands; vomiting; [potential occupational carcinogen]	N/A
Aroclor 1254, PCB (polychlorinated biphenyls)		PEL = 0.5 mg/m^3 REL = 0.001 mg/m^3 TLV = [Skin] Hazard ☒	5 mg/m^3	Nonflammable Liquid, but exposure in a fire results in the formations of black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-pdioxins.	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen]	N/A
Aroclor 1260, PCB (polychlorinated biphenyls)		PEL = 0.5 mg/m^3 REL = 0.001 mg/m^3 TLV = [Skin] Hazard ☒	5 mg/m^3	Nonflammable Liquid, but exposure in a fire results in the formations of black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-pdioxins.	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen]	N/A
Aroclor 1268, PCB (polychlorinated biphenyls)		PEL = 0.5 mg/m^3 REL = 0.001 mg/m^3 TLV = [Skin] Hazard ☒	5 mg/m^3	Nonflammable Liquid, but exposure in a fire results in the formations of black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-pdioxins.	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen]	N/A
		PEL = REL = TLV = [Skin] Hazard ☐				
		PEL = REL = TLV = [Skin] Hazard ☐				

Specify Information Sources: NIOSH Pocket Guide to Hazardous Chemicals, September 2005 and American Conference of Governmental Industrial Hygienists (ACGIH). "Threshold Limit Values and Biological Exposure Indices for 2013."

Note: In the Exposure Limit column, include Ceiling (C) and Short-Term Exposure Limits (STEL) if they are available. Also, use the following short forms and abbreviations to complete the table above.

A = Air
Ca = Carcinogenic
eV = Electron volt
U = Unknown

IDLH = Immediately dangerous to life or health
mg/m^3 = Milligram per cubic meter
NA = Not available
NE = None established

PEL = Permissible exposure limit
ppm = Part per million
REL = Recommended exposure limit
S = Soil

TLV = Threshold limit value
GW = Groundwater
SW = Surface water
Sed = Sediment

Note: If no contingency level of protection is selected, all employees covered under this plan must evacuate the immediate site area if air contaminant levels require upgrading PPE. Level A field work typically requires a Level 3 HASP. This information is available on the chemical hazards page of this HASP.

Field Activities Covered Under this HASP (see Activity Hazard Analyzes at the end of the Level II HASP):

Task Description	Level of Protection[1] Primary	Level of Protection[1] Contingency	Date of Activities
1 Mobilization	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
2 Surveyor Oversight	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
3 Utility Clearance Oversight	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
4 DPT Drilling Oversight	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
5 Hand Auger Drilling Oversight	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
6 Incremental Soil and Sediment Sample Processing	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
7 Hand Auger or Soil Coring	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18
8 Decontamination	☐ A ☐ B ☐ C ☒ D	☐ A ☐ B ☐ C ☒ D	12/10/17 – 3/31/18

Site Personnel and Responsibilities (include subcontractors):

Employee Name and Office Code / Location	Task(s)	Responsibilities
Kevin Bricknell / Oakland **Jason Brodersen / Oakland** **Dayna Aragon / Oakland** **Kerry Hosken / Oakland** **Cora Lemar / Oakland** **Katie Henry / Oakland** **Michelle Kolb / Rancho Cordova** **Kurt Schmiegel / Rancho Cordova** **Jeff Eddo / San Diego** **Heather Reynolds / San Diego** **Sean Cole / San Diego**	Pre-pilot study mobilization tasks include surveying and marking the locations of the IAG corners, conducting utility location, and mobilizing the mobile trailer(s) and equipment. The pilot study will consist of collecting ISM samples from three IAGs with 30 increments in triplicate, from multiple depth intervals using a DPT (direct-push technology) rig. Within each IAG (investigation area grid), 13 subsurface DUs (decision units) will be established at different depth horizons. Each IAG will be made up of one surface DU (0 to 2 feet bgs), up to four 4-foot subsurface DUs (2 to 6, 6 to 10, 10 to 14, and 14 to 18 feet bgs), and up to eight 2-foot DUs (2 to 4, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 feet bgs), depending on the depth of fill. The full-scale investigation will involve collecting ISM samples from 21 IAGs (investigation area grid) with the selected number of increments in a gridded pattern from multiple depth intervals. The subsurface DU intervals and collection methods for the full-scale investigation will be the same as for the pilot study, with the exception that in the IAGs located on the perimeter of the FSFA, alternative sampling methods will be used to collect material from the FSFA side slopes in the incremental samples.	• Project Manager (Kevin Bricknell): Manages the overall project, makes site safety and health coordinator (SSC) aware of pertinent project developments and plans, and maintains communications with client as necessary. Additionally, For projects lasting longer than one consecutive week on-site, the PM is responsible for conducting one field audit using Form AF-1. • Field Team Leader (Dayna Aragon, Kerry Hosken): Directs field activities, makes SSC aware of pertinent project developments and plans, and maintains communications with the Project Manager and the client as necessary. • Site Safety Coordinator (SSC) (Primary: Michelle Kolb, Kurt Schmiegel; Alternate: Cora Lemar, Kerry Hosken, Dayna Aragon): Ensures that appropriate personal protective equipment (PPE) is available, enforces proper use of PPE by on-site personnel and subcontractors; suspends investigative work if personnel are or may be exposed to an immediate health hazard; implements and enforces the HASP; identifies and controls site hazards when possible; communicates site hazards to all personnel; and reports any deviations observed from anticipated conditions described in the health and safety plan to the health and safety representative. The SSC (or alternate) shall be on-site during all times when work is being performed. • Field Geologist: (Jeff Eddo, Heather Reynolds, Sean Cole): Determines depth of fill at each boring, oversees drillers. • Field Personnel (Cora Lemar, Katie Henry, Jason Brodersen, Kerry Hosken, Dayna Aragon): Completes tasks as directed by the project manager, field team leader, and SSC, and follows the HASP and all SWPs and guidelines established in the

	Two methods will be used for the perimeter of the FSFA: -A portion of the direct-push borings will be advanced at 30 to 45 degrees from vertical using DPT (direct push technology) angle-hole methods to the bottom of fill - A hand auger will be used to collect soil on the side slopes to a maximum depth of 4 feet bgs At the SP (stormwater ponds) IAGs, samples will be collected to a depth of 1 foot using a hand auger or soil corer from the stormwater pond bottom. The soil collected using these alternative methods will be incorporated into the ISM samples at appropriate depth horizons. NOTE: the subcontractor will be conducting the drilling and hand augering at Fill IAGs. Tetra Tech will be responsible for collecting and compostiting the ISM samples, and for conducting the hand augering or soil coring at the SPIAGs.	Tetra Tech, Inc., Health and Safety Manual. • Tetra Tech-hired subcontractor personnel on site (Gregg Drilling, F3 Surveying, Utility Locator [TBD]): Completes tasks as outlined in the project scope of work in accordance with the contract. Participates in all Tetra Tech on-site safety meetings and follows all procedures and guidelines established in this HASP, as well as the company health and safety plan and program. Note: all names, certifications, and contact information will be included in a HASP amendment when the identities of each position is confirmed (including the certification of the drill rig operator).

Note:
1. See next page for details on levels of protection

NOTE: Contingency level of protection section should be completed only if the upgraded level of protection is immediately available at the job site. If no contingency level of protection is denoted, all employees covered under this HASP must evacuate the immediate site area if air contaminant levels would require an upgrade of PPE.

Protective Equipment: (Indicate type or material as necessary for each task.)

Task	Primary Level of Protection (A,B,C,D)	PPE Component Description (Primary)	Contingency Level of Protection (A, B, C, D)	PPE Component Description (Contingency)
1	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '
2	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '
3	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '
4	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '
5	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '	D	Respirator type: N/A Cartridge type (if applicable): N/A CPC material: Tyvek as needed Glove material(s): Nitrile Boot material: Steel Toe Other: '

Respirator Notes:
Respirator cartridges may only be used for a maximum time of 8 hours or one work shift, whichever is less, and must be discarded at that time. For job sites with organic vapors, respirator cartridges may be used as described in this note as long as the concentration is less than 200 parts per million (ppm), the boiling point is greater than 70 °Celsius, and the relative humidity is less than 85 percent. If any of these levels are exceeded, a site-specific respirator cartridge change-out schedule must be developed and included in the HASP using Tetra Tech Form RP-2 (Respiratory Hazard Assessment Form)

Notes:
All levels of protection must include eye, head, and foot protection.
CPC = Chemical protective clothing
Thermoluminescent Dosimeter (TLD) Badges must be worn during all field activities on sites with radiation hazards. TLDs must be worn under CPC.

Monitoring Equipment: All monitoring equipment on site must be calibrated before and after each use and results recorded in the site logbook

Instrument (Check all required)	Task	Instrument Reading	Action Guideline	Comments
☐ Combustible gas indicator model:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	0 to 10% LEL	Monitor; evacuate if confined space	
		10 to 25% LEL	Potential explosion hazard; notify SSC	
		>25% LEL	Explosion hazard; interrupt task; evacuate site; notify SSC	
☐ Oxygen meter model:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	>23.5% Oxygen	Potential fire hazard; evacuate site	
		23.5 to 19.5% Oxygen	Oxygen level normal	
		<19.5% Oxygen	Oxygen deficiency; interrupt task; evacuate site; notify SSC	
☐ Radiation survey meter model:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Normal background	Proceed	Annual exposure not to exceed 1,250 mrem per quarter Background reading must be taken in an area known to be free of radiation sources.
		Two to three times background	Notify SSC	
		>Three times background	Radiological hazard; interrupt task; evacuate site; notify RSO	
☐ Photoionization detector model: ☐ 11.7 eV ☐ 10.6 eV ☐ 10.2 eV ☐ 9.8 eV ☐ Other (specify): _____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Any response above background to 5 ppm above background	Level B is recommended Level C[a] may be acceptable	These action levels are for unknown gases or vapors. After the contaminants are identified, action levels should be based on the specific contaminants involved.
		> 5 to 500 ppm above background	Level B	
		> 500 ppm above background	Level A	
☐ Flame ionization detector model:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Any response above background to 5 ppm above background	Level B is recommended Level C[a] may be acceptable	These action levels are for unknown gases or vapors. After the contaminants are identified, action levels should be based on the specific contaminants involved.
		>5 to 500 ppm above background	Level B	
		>500 above background	Level A	
☐ Detector tube models:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Specify: < 1/2 the PEL > 1/2 the PEL	Specify:	The action level for upgrading the level of protection is one-half of the contaminant's PEL. If the PEL is reached, evacuate the site and notify a safety specialist
☐ Other (specify):	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Specify:	Specify:	

Notes:
eV= electron volt LEL=Lower explosive limit mrem=Millirem PEL=Permissible exposure limit ppm=Part per million
a. Level B is required when chemical hazards are present, but are uncharacterized. Level C may be acceptable for certain tasks in some situations. If you are uncertain, consult your Safety Manager.

Project-Specific Industrial Hygiene Requirements

OSHA-Regulated Chemicals*:

Check any present on the job site in any medium (air, water, soil)

- ☐ No chemicals below are located on the job site
- ☐ Friable Asbestos
- ☐ Silica, crystalline
- ☐ alpha-Napthylamine
- ☐ Methyl chloromethyl ether
- ☐ 3,3'-Dichlorobenzidine (and its salts)
- ☐ bis-Chloromethyl ether
- ☐ beta-Napthylamine
- ☐ Benzidine
- ☐ 4-Aminodiphenyl
- ☐ Ethyleneimine
- ☐ beta-Propiolactone
- ☐ 2-Acetylaminoflourene
- ☐ 4-Dimethylaminoazobenzene
- ☐ N-nitrosomethylamine
- ☐ Vinyl chloride
- ☐ Inorganic arsenic
- ☒ Lead
- ☐ Chromium (VI)
- ☐ Cadmium
- ☐ Benzene
- ☐ Coke oven emissions
- ☐ 1,2-Dibromo-3-chloropropane
- ☐ Acrylonitrile
- ☐ Ethylene oxide
- ☐ Formaldehyde
- ☐ Methylenedianiline
- ☐ 1,3-Butadiene
- ☐ Methylene chloride

* NOTE: Many states, including California and New Jersey, have chemical-specific worker protection requirements and standards for many chemicals and known or suspected carcinogens.

Emergency Contacts:	**Telephone No.**
WorkCare and Incident Intervention	888.449.7787, or 800.455.6155
Tetra Tech EMI 24-hour Anonymous Hazard Reporting Line	866.383.8070
U.S. Coast Guard National Response Center	800.424.8802
InfoTrac	800.535.5053
Poison Control	800.222.1222
Fire department	911
Police department	911

Personnel Call-Down List:

Job Title or Position:	**Name**	**Cell Phone:**
Safety Manager:	Dave Brown	619-321-6722
Project Manager:	Kevin Bricknell	415-290-3580
Field Team Leader:	Dayna Aragon	805-452-2822
Site Safety Coordinator (SSC):	Dayna Aragon	805-452-2822
Subcontractor SSC:	To Be Determined	

Medical and Site Emergencies:

Signal a site or medical emergency with three blasts of a loud horn (car horn, fog horn, or similar device). Site personnel should evacuate to the area of safe refuge designated on the site map.

Hospital Name: El Camino Hospital
Address: 2500 Grant Rd., Mountain View, CA

General Phone: (650)-940-7000
Emergency Phone: 911
Ambulance Phone: 911

Hospital called to verify emergency services are offered? YES ☒ NO ☐

Step-by-step Route to Hospital: (see Page 11 of 12 for route map)

Note: This page must be posted on site.

Decontamination Procedures

The site safety coordinator overseas implementation of project decontamination procedures and is responsible for ensuring they are effective.

Personnel Decontamination

Level D Decon - ☐ Wet ☒ Dry

Level C Decon - ☐ Wet ☐ Dry

Level B Decon – Briefly outline the level B decontamination methods to be used on a separate page attached to this HASP.

Level A Decon – A Level 3 HASP is required. Notify your Safety Manager.

Equipment Decontamination

All tools, equipment, and machinery from the Exclusion Zone (hot) or Contamination Reduction Zone (warm) are decontaminated in the CRZ before they are removed to the Support Zone (cold). Equipment decontamination procedures are designed to minimize the potential for hazardous skin or inhalation exposure, cross-contamination, and chemical incompatibilities.

Respirator Decontamination

Respirators are decontaminated in compliance with SWP 5-27 and should be included with this HASP.

Waste Handling for Decontamination

Procedures for decontamination waste disposal meet all applicable local, state, and federal regulations.

Decontamination Equipment

- ☐ Washtubs
- ☒ Buckets
- ☒ Scrub brushes
- ☒ Pressurized sprayer
- ☒ Detergent [Alconox or Liquinox]
- ☐ Solvent [Type]
- ☐ Household bleach solution

  Concentration/Dilution: _____
- ☐ Deionized water
- ☒ Disposable sanitizer wipes
- ☒ Potable eyewash/drench/wash water
- ☐ Wire brush
- ☒ Spray bottle
- ☐ Tubs / pools
- ☐ Banner/barrier tape
- ☒ Plastic sheeting
- ☐ Tarps and poles
- ☒ Trash bags
- ☐ Trash cans
- ☐ Duct tape
- ☒ Paper towels
- ☐ Folding chairs
- ☐ Other

Emergency Response Planning

During the pre-work briefing and daily tailgate safety meetings, all on-site employees will be trained in the provisions of emergency response planning, site communication systems, and site evacuation routes.

In the event of an emergency that necessitates evacuation of a work task area or the site, the following procedures will take place.

- The Tetra Tech SSC will contact all nearby personnel using the on-site communications to advise the personnel of the emergency.
- The personnel will proceed along site roads to a safe distance upwind from the hazard source.
- The personnel will remain in that area until the SSC or an authorized individual provides further instructions.

In the event of a severe spill or a leak, site personnel will follow the procedures listed below.

- Evacuate the affected area and relocate personnel to an upwind location.
- Inform the Tetra Tech SSC, a Tetra Tech office, and a site representative immediately.
- Locate the source of the spill or leak, and stop the flow if it is safe to do so.
- Begin containment and recovery of spilled or leaked materials.
- Notify appropriate local, state, and federal agencies.

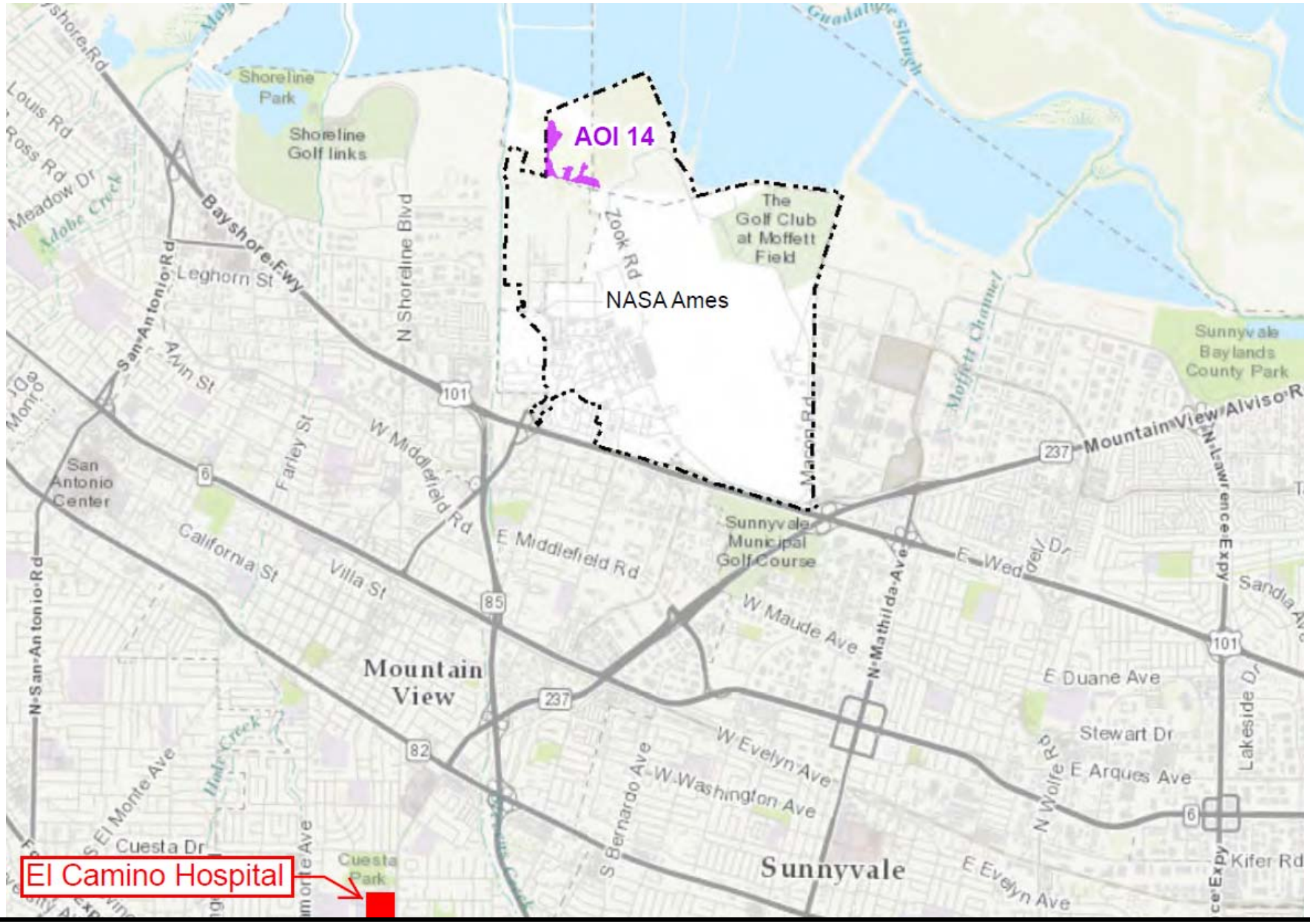
In the event of severe weather, site personnel will follow the procedures listed below.

- Site work shall not be conducted during severe weather, including high winds and lightning.
- In the event of severe weather, stop work, lower any equipment (drill rigs) and evacuate the affected area.
- Severe weather may cause heat or cold stress. Refer to SWPs 5-15 and 5-16 for additional information.

All personnel working on Tetra Tech projects are expected to and responsible for reporting ANY unsafe conditions, behaviors or incidents -- including injuries, illnesses, fires, spills/releases, property damages and near-misses -- they face or encounter while performing their work. According to TtEMI's reporting procedures, for non-emergency incidents you should:

- Notify WorkCare and Incident Intervention at 888.449.7787, or 800.455.6155
- Notify your Office, Project or Safety Manager via phone immediately.
- Complete a "Tetra Tech Incident Report" (Form IR) within 24 hours and send it to your Safety Manager. If an injury or illness has occurred, the Form IR-A must also be completed.
- Additional reports may be necessary

Site Map (May be drawn after crews arrive onsite or inserted using aerial photographs (https://maps.google.com/), site figures, etc.):



Hospital Route Map (attach or insert):

Driving Instructions

El Camino Hospital
THE HOSPITAL OF SILICON VALLEY

From San Francisco via Highway 101
Exit at Highway 85 South
Exit at Grant Road/El Camino Real North
Cross El Camino Real
El Camino Hospital 1 mile on right

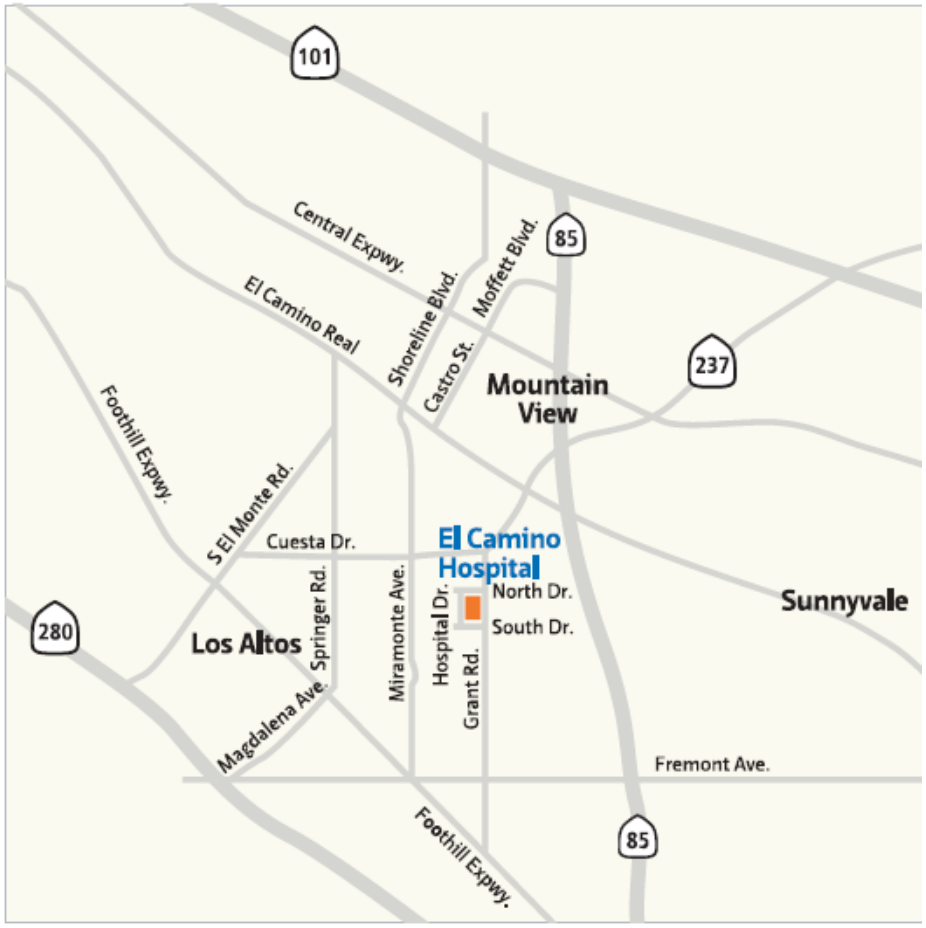
From San Francisco via Highway 280
Take Magdalena Exit
At stop sign, turn left onto Magdalena
Right on Foothill Expressway
Left on Grant Road
Hospital 2 miles on left

From San Jose via Highway 101
Exit at Highway 237 West (not East)
Highway 237 becomes Grant Road
Cross El Camino Real
Hospital 1 mile on right

From San Jose via Highway 280
Take Foothill Exit
Right on Foothill Expressway
Right on Grant Road
Hospital 2 miles on left

From East Bay via Dumbarton Bridge
Take Highway 84 West across Dumbarton Bridge
Turn on Willow Road
Take Highway 101 South
Exit at Highway 85 South
Exit at Grant Road/El Camino Real North
Cross El Camino Real
Hospital 1 mile on right

From East Bay via Hwy 880 and Hwy 237
Take Highway 880 South towards San Jose
Take Highway 237 West towards Mountain View
237 becomes Grant Road
Cross El Camino Real
Hospital 1 mile on right



©2009 El Camino Hospital B-0613_MVDrive Oct09

Note: A dry-run should be conducted to establish a physical location associated with the map included in the HASP. Verbal verification from the hospital emergency room should also be obtained to ensure that the hospital will accept chemically-contaminated patients

APPROVAL AND SIGN-OFF FORM

Project No: _____

I have read, understood, and agree with the information set forth in this Health and Safety Plan and will follow the direction of the Site Safety Coordinator (SSC) as well as procedures and guidelines established in the Tetra Tech, Inc., Health and Safety Manual. I understand the training and medical requirements for conducting field work and have met these requirements.

Tetra Tech has prepared this plan solely for the purpose of the health and safety protection of Tetra Tech employees. Subcontractors, visitors, and others at the site, while required to read and follow the provisions outlined in this plan at a minimum, should refer to their safety program for specific information related to their health and safety protection.

Name	Company / Agency / Organization	Signature	Date

I have read, understood, and agree with the information set forth in this HASP and will comply with and enforce this HASP, as well as procedures and guidelines established in the Tetra Tech, Inc., Health and Safety Manual.
A Post-Project Field Team Check-In SHALL be conducted and documented below to ensure that ALL incidents and near-misses were reported at project completion.

Name	Project-Specific Position	Signature	Date
	Project Manager		
	Field Team Leader		
	Site Safety Coordinator		
	Subcontractor SSC		
	Required Post-Project Field Team Check-In		

Tetra Tech has prepared this plan solely for the purpose of the health and safety protection of Tetra Tech employees. Subcontractors, visitors, and others at the site, while required to read, acknowledge and follow the provisions outlined in this plan at a minimum, should refer to their safety program for specific information related to health and safety.

Note: Use Additional sheets as necessary to ensure that all personnel sign and affirm this document.

Emergency Contacts

WorkCare - For issues requiring an Occupational Health Physician; assistance is available 24 hours per day, 7 days per week.

InfoTrac - For issues related to incidents involving the transportation of hazardous chemicals; this hotline provides accident assistance 24 hours per day, 7 days per week

U.S. Coast Guard National Response Center - For issues related to spill containment, cleanup, and damage assessment; this hotline will direct spill information to the appropriate state or region

Poison Control Center – For known or suspected poisoning.

Limitations:

The Level-Two HASP is not appropriate in some cases:

- Projects involving unexploded ordnance (UXO), radiation sources as the primary hazard, or known chemical/biological weapons site must employ the Level 3 HASP
- Projects of duration longer than 90 days may need a Level 3 HASP (consult your RSO)

Decontamination:

Decontamination Solutions for Chemical and Biological Warfare Agents[a]: PPE and equipment can be decontaminated using 0.5 percent bleach (1 gallon laundry bleach to 9 gallons water) for biological agents (15 minutes of contact time for anthrax spores; 3 minutes for others) followed by water rinse for chemical and biological agents. In the absence of bleach, dry powders such as soap detergents, earth, and flour can be used. The powders should be applied and then wiped off using wet tissue paper. Finally, water and water/soap solutions can be used to physically remove or dilute chemical and biological agents. Do not use bleach solution on bare skin; use soap and water instead. Protect decontamination workers from exposure to bleach.

Decontamination for Radiological and Other Chemicals: Primary decontamination should use Alconox and water unless otherwise specified in chemical specific information resources. The effectiveness of radiation decontamination should be checked using a radiation survey instrument. Decontamination procedures should be repeated until the radiation meter reads less than 100 counts per minute over a 100-square-centimeter area when the probe is held 1 centimeter from the surface and moving slower than 2.5 centimeters per second.

Decontamination Corridor: The decontamination setup can be adjusted to meet the needs of the situation. The decontamination procedures can be altered to meet the needs of the specific situation when compound- and site-specific information is available.

Decontamination Waste: All disposable equipment, clothing, and decontamination solutions will be double-bagged or containerized in an acceptable manner and disposed of with investigation-derived waste.

Decontamination Personnel: Decontamination personnel should dress in the same level of PPE or one level below the entry team PPE level.

All investigation-derived waste should be left on site with the permission of the property owner and the EPA on-scene coordinator. In some instances, another contractor will dispose of decontamination waste and investigation-derived waste. DO NOT place waste in regular trash. DO NOT dispose of waste until proper procedures are established.

Notes:

[a] Source: Jane's Information Group. 2002. *Jane's Chem-Bio Handbook*. Page 39.

TETRA TECH

Daily Tailgate Safety Meeting Form

Date: _____ Time: _____ Job Number: 103IG4704 Task 1.2

Client: NASA Site Location: NASA Ames AOI 14

Scope of Work: Design Site Characterization

Safety Topics Presented

Planned Field Activities for the Day: _____

Protective Clothing / Equipment: Level D PPE (Steel-Toed Boots, Reflective Vest, Safety Glasses; Ear Plugs and Hard Hat when near drill rigs)

Chemical Hazards: Lead, Pesticides (DDTs), PCBs

Physical Hazards: Trips, slips, falls, overhead hazards, sun exposure, heat stress, cold stress, pinch points

Special Equipment: DPT Rigs

Decontamination Procedures: Between IAGs, decontaminate equipment with Alconox and water

Other: _____

Emergency Procedures: Call 911

Hospital: El Camino Hospital Phone: (650)-940-7000 Ambulance Phone: 911

Hospital Address and Route: 2500 Grant Rd., Mountain View, CA

Employee Questions / Comments: _____

Attendees

Name (printed)	Signature

Meeting Conducted By: _____

Site Safety and Health Officer Project Field Manager

TETRA TECH

TETRA TECH EM INC.

HEALTH AND SAFETY PLAN AMENDMENT

Site Name: _____

Amendment Date: _____

Purpose or Reason for Amendment: _____

_____

_____

Required Additional Safe Work Practices or Activity Hazard Analyses:_____

_____

Required Changes in PPE: _____

_____

_____

Action Level Changes: _____

_____

_____

_____

_____

AMENDMENT APPROVAL

RSO or Designee	_____	_____	_____
	Name	Signature	Date
Site Safety and Health Officer	_____	_____	_____
	Name	Signature	Date

Date presented during daily site safety meeting: _____

TETRA TECH, INC.

FIELD AUDIT CHECKLIST

Project Name: _____ Project No.: _____

Field Location: _____ Completed by: _____

Project Manager: _____ Site Safety Coordinator: _____

General Items		In Compliance?		
Health and Safety Plan Requirements		Yes	No	NA
1	Approved health and safety plan (HASP) on site or available			
2	Names of on-site personnel recorded in field logbook or daily log			
3	HASP compliance agreement form signed by all on-site personnel			
4	Material Safety Data Sheets on site or available			
5	Designated site safety coordinator physically present on jobsite			
6	Daily tailgate safety meetings conducted and documented on Form HST-2			
7	Documentation available proving compliance with HASP requirements for medical examinations, fit testing, and training (including subcontractors)			
8	HASP onsite matches scope of work being conducted			
9	Emergency evacuation plan in place and hospital located			
10	Exclusion, decontamination, and support zones delineated and enforced			
11	HASP attachments present onsite (VPP sheet, audit checklist, AHA, etc.)			
12	Illness and injury prevention program reports completed (California only)			
Emergency Planning				
13	Emergency telephone numbers posted			
14	Emergency route to hospital posted			
15	Local emergency providers notified of site activities			
16	Adequate safety equipment inventory available			
17	First aid provider and supplies available			
18	Eyewash solution available when corrosive chemicals are present			
Air Monitoring				
19	Monitoring equipment specified in HASP available and in working order			
20	Monitoring equipment calibrated and calibration records available			
21	Personnel know how to operate monitoring equipment and equipment manuals available on site			
22	Environmental and personnel monitoring performed as specified in HASP			

Safety Items		In Compliance?		
Personal Protection		Yes	No	NA
23	Splash suit, if required			
24	Chemical protective clothing, if required			
25	Safety glasses or goggles (always required)			
26	Gloves, if required			
27	Overboots, if required			
28	Hard hat (always required)			
29	High visibility vest, if required			
30	Hearing protection, if required			
31	Full-face respirator, if required			
Instrumentation				
32	Combustible gas meter and calibration notes			
33	Oxygen meter and calibration notes			
34	Organic vapor analyzer and calibration notes			
Supplies				
35	Decontamination equipment and supplies			
35	Fire extinguishers			
37	Spill cleanup supplies			
Corrective Action Taken During Audit:				

Note: NA = Not applicable

_____
Auditor's Signature

_____
Site Safety Coordinator's Signature

_____
Date

TETRA TECH ACTIVITY HAZARD ANALYSIS

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	1 Mobilization and Demobilization		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC)
(Use highest code)
L (4)

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

1 *MOBILIZATION AND DEMOBILIZATION*

This AHA applies to mobilization and demobilization. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Drive to/from job site	VEHICLE ACCIDENT	• Ensure driver is "authorized" per the Tetra Tech Vehicle Safety Program • Practice defensive driving whenever traveling in a vehicle • Do not use cell phones while driving unless a hands-free device is used	**L (4)**
Set up field base/support zone	TRAFFIC HAZARD	• Wear high-visibility safety vests when in traffic areas or areas with heavy equipment • Set up field base in non-traffic areas if possible • Watch for oncoming traffic, using a spotter if traffic is heavy	**L (4)**
	BACK STRAIN/SPRAIN	• Practice proper lifting techniques (lift with the legs) • Wear leather gloves, if needed, when handling field base components • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Set up necessary work zones	EMPLOYEE EXPOSURE	• Plan and demarcate zones appropriate for the site and the type of work/contaminants on-site • If specified in the site-specific APP/SSHP, use caution tape, cones, or other barriers to differentiate work zones	**L (4)**
Fill out necessary paperwork	STRESS AND MISTAKES	• Before conducting work, ensure all proper paperwork and access issues have been dealt with accordingly	**L (4)**

1	***MOBILIZATION AND DEMOBILIZATION***	
This AHA applies to mobilization and demobilization. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.		
Equipment to be Used • Hands-free device for cell phone • Leather gloves if needed during site set-up • Hand truck or other lifting aid • Reflective safety vest when around vehicle traffic	**Inspection Requirements** • Inspection of vehicles to ensure road worthiness	**Training Requirements** • Tetra Tech Vehicle Safety Program • Safe Lifting Procedures • Valid state driver's license

Approved By/Date: 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	2 Surveyor Oversight		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code **L(4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

2 *SURVEYOR OVERSIGHT*

This AHA applies to the oversight of the surveying and demarcation of soil sampling locations before drilling and sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Survey soil sampling locations	MARK INCORRECT SOIL SAMPLING LOCATION	• Inspect locating equipment for calibration and proper working order • Obtain all coordinates for sampling locations ahead of time	**L (4)**
	VEHICULAR TRAFFIC MAY PUT WORKERS IN PERIL	• Workers shall wear clearly visible safety vests • Safety cones shall be used to alert oncoming traffic • Spotters shall be used if traffic is nearby	**L (4)**
	MARKING PAINTS MAY EXPOSE WORKERS TO HARMFUL SOLVENTS	• The manufacturer's use and safety instructions shall be followed • Ensure the area is well ventilated • Follow material safety data sheet for the paint being used • Never point spray nozzles at people • Always use down spray nozzle spray cans	**M (3)**
	POTENTIAL TO TRIP ON SURFACE CONSTTRUCTION DEBRIS	• Watch out for construction debris and material from previous improvements	**L (4)**
	POTENTIAL FOR PINCHING OR CRUSHING BODY PARTS	• Wear gloves and steel toed shoes • Concentrate on the demarcation of sampling locations	**L (4)**
	BIOLOGICAL HAZARDS, SUCH AS INSECTS OR SPIDERS	• Wear proper personal protective equipment, including gloves	**L (4)**

2 *SURVEYOR OVERSIGHT*

This AHA applies to the oversight of the surveying and demarcation of soil sampling locations before drilling and sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

Equipment to be Used	Inspection Requirements	Training Requirements
• Personal protection equipment – Long pants and shirts with sleeves – Safety vest • Safety cones where vehicular traffic is present • Gloves	• Driver Vehicle Inspection Report	• 40 Hour Hazardous Waste Operations and Emergency Response

Approved By/Date: 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	3 Utility Clearance Oversight		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code **L(4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

3 *UTILITY CLEARANCE OVERSIGHT*

This AHA applies to the oversight of the clearing of utilities before drilling and soil sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Clear and mark utilities at each intrusive area	MARK INCORRECT SOIL SAMPLING LOCATION	• Obtain and review all pertinent utility drawings • Contact Underground Surface Alert for utility clearance • Obtain all intrusive permits and make required contacts • Inspect locating equipment for calibration and proper working order • Obtain all coordinates for sampling locations ahead of time	**L (4)**
	VEHICULAR TRAFFIC MAY PUT WORKERS IN PERIL	• Workers shall wear clearly visible safety vests • Safety cones shall be used to alert oncoming traffic • Spotters shall be used if traffic is nearby	**L (4)**
	MARKING PAINTS MAY EXPOSE WORKERS TO HARMFUL SOLVENTS	• The manufacturer's use and safety instructions shall be followed • Ensure the area is well ventilated • Follow material safety data sheet for the paint being used • Never point spray nozzles at people • Always use down spray nozzle spray cans	**M (3)**
	POTENTIAL TO TRIP ON SURFACE CONSTTRUCTION DEBRIS	• Watch out for construction debris and material from previous improvements	**L (4)**
	POTENTIAL FOR PINCHING OR CRUSHING BODY PARTS	• Wear gloves and steel toed shoes • Concentrate on the demarcation of sampling locations	**L (4)**
	BIOLOGICAL HAZARDS, SUCH AS INSECTS OR SPIDERS	• Wear proper personal protective equipment, including gloves	**L (4)**

3 UTILITY CLEARANCE OVERSIGHT		
This AHA applies to the oversight of the clearing of utilities before drilling and soil sampling activities. It has been developed and approved by the Director of Health and Safety for Tetra Tech. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.		
Equipment to be Used • Personal protection equipment – Long pants and shirts with sleeves – Safety vest • Safety cones where vehicular traffic is present • Gloves	**Inspection Requirements** • Driver Vehicle Inspection Report	**Training Requirements** • 40 Hour Hazardous Waste Operations and Emergency Response

Approved By/Date: 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	4 Hand Auger Drilling Oversight		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code): **L (4)**

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Risk Assessment Code (RAC) Matrix

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

4 *HAND AUGER DRILLING OVERSIGHT*

This AHA applies to the oversight of hand auger drilling operations, which will be conducted by subcontractors. Hand auger drilling will be used to collect soil samples at a maximum depth of 4 feet bgs on the side and toe of slope. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Identify requirements prior to beginning of work	LOSS OF LIVES, HEALTH, AND PROPERTY	• Obtain and review all pertinent utility drawings, included site layout plan • Obtain all intrusive permits and make required contacts	**L (4)**
Soil boring with hand auger	POTENTIAL FOR INJURY	• Hand auger equipment shall be operated only by qualified personnel. • Drilling equipment shall be operated, inspected, and maintained as specified in the manufacturer's operating manual.	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (5)**
	NUISANCE DUST	• Wear dust mask if appropriate • Stay upwind of all dust	**L (4)**
	EXPOSURE HAZARDS TO SITE CHEMICALS OF CONCERN	• Wear dusk mask, safety glasses, and other appropriate PPE, if necessary • Stay upwind of all dust	**L (4)**
	LIFTING HAND AUGER / BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots	**L (4)**

TETRA TECH

4 HAND AUGER DRILLING OVERSIGHT			
This AHA applies to the oversight of hand auger drilling operations, which will be conducted by subcontractors. Hand auger drilling will be used to collect soil samples at a maximum depth of 4 feet bgs on the side and toe of slope. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.			
Removal and cleaning of auger sections	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LIFTING HAND AUGER / BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**

4 HAND AUGER DRILLING OVERSIGHT		
Equipment to be Used • Personal protection equipment – Steel toe boots – Hard hat – Safety vest – Safety glasses – Nitrile gloves/leather work gloves	**Inspection Requirements** • Additional requirements may be provided by the subcontractor	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour OSHA Construction Safety and Health Training (SSC only)

Approved By/Date: 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	5 Direct Push Technology Drilling Oversight		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

5 *DIRECT PUSH TECHNOLOGY OVERSIGHT*

This AHA applies to the oversight of Direct Push Technology (DPT) drilling operations, which will be conducted by subcontractors. DPT drilling will be conducted to determine soil quality at various depths within the IAGs (investigation area grids). The maximum depth of the drilling operations will be to the bottom of fill (estimated at 16 feet bgs). The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Identify requirements prior to beginning of work	LOSS OF LIVES, HEALTH, AND PROPERTY	• Obtain and review all pertinent utility drawings, included site layout plan • Obtain all intrusive permits and make required contacts • Inspect equipment per proper equipment checklist. Inspection shall be performed by a competent person. • Machinery and Mechanized Equipment Certification Form shall be completed and certified	**M (3)**
	LACK OF TRACTOR / TRAILER INSPECTIONS, CITATIONS, TICKETS	• Ensure driver has current license and training certificates or an affidavit from the company indicating such certifications	**L (4)**
Moving equipment into place between ground intrusion points	POTENTIAL FOR INJURY	• Ensure driver is trained and current in certification. Ensure equipment is inspected as required by Cal-OSHA regulations. Operation Rules must be posted and followed (required by Cal-OSHA regulations). • Ensure equipment is operated properly; refer to the operator's manual, which must be onsite	**M (3)**
	EQUIPMENT COULD HIT SOMEONE OR SOMETHING	• Use spotters when positioning equipment. Ensure spotters know how to communicate with operator.	**M (3)**
	MOVING EQUIPMENT / CRUSHING DAMAGE	• Travel at slow speeds when people are walking near equipment • Wear safety vests when around moving equipment • Maintain a safe distance from moving equipment	**M (3)**

5	*DIRECT PUSH TECHNOLOGY OVERSIGHT*		
This AHA applies to the oversight of Direct Push Technology (DPT) drilling operations, which will be conducted by subcontractors. DPT drilling will be conducted to determine soil quality at various depths within the IAGs (investigation area grids). The maximum depth of the drilling operations will be to the bottom of fill (estimated at 16 feet bgs). The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.			
PRINCIPAL STEPS	**POTENTIAL HAZARDS**	**PREVENTATIVE ACTIONS**	**RAC**
Set up of rig	ACCIDENTS RESULTING IN DEATHS, INJURIES, AND PROPERTY DAMAGE	• Don't restrict fire lanes or traffic lanes without approval • Don't set up equipment that would impede or block access to emergency equipment or devices, such as fire hydrants, valves, etc. • Don't place heavy equipment over manholes, vaults, valve boxes, and similar underground structures	**L (4)**
Towering up	PINCH POINTS / CRUSHING DAMAGE	• Use caution around moving equipment • Wear leather work gloves	**M (3)**
	POWER LINES / ELECTROCUTION	• Survey shall be conducted to identify overhead electrical hazards and potential ground hazards, such as underground utilities • Look up for clearance before towering up • Remain 100 feet from power lines	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LOSS OF HEARING	• Wear adequate hearing protection (ear muffs [preferred] or ear plugs) • Consider rule of thumb for implementing ear protection; if you cannot talk to someone one arm's length away without raising your voice, you should wear ear protection.	**L (4)**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with knees and in pairs • Wear hard hats and steel toed boots • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person	**M (3)**
Soil boring	POTENTIAL FOR INJURY	• Drilling equipment shall be operated only by qualified (by training and experience) personnel who are authorized. • Drilling equipment shall be operated, inspected, and maintained as specified in the manufacturer's operating manual.	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LOSS OF HEARING	• Wear adequate hearing protection (ear muffs [preferred] or ear plugs) • Consider rule of thumb for implementing ear protection; if you cannot talk to someone one arm's length away without raising your voice, you should wear ear protection.	**L (4)**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots	**L (4)**
Removal and cleaning of rod sections	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**M (3)**

5	*DIRECT PUSH TECHNOLOGY OVERSIGHT*		
This AHA applies to the oversight of Direct Push Technology (DPT) drilling operations, which will be conducted by subcontractors. DPT drilling will be conducted to determine soil quality at various depths within the IAGs (investigation area grids). The maximum depth of the drilling operations will be to the bottom of fill (estimated at 16 feet bgs). The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.			
PRINCIPAL STEPS	**POTENTIAL HAZARDS**	**PREVENTATIVE ACTIONS**	**RAC**
	LIFTING AUGER SECTIONS / CRUSHING AND BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**

TETRA TECH

5 *DIRECT PUSH TECHNOLOGY OVERSIGHT*		
This AHA applies to the oversight of Direct Push Technology (DPT) drilling operations, which will be conducted by subcontractors. DPT drilling will be conducted to determine soil quality at various depths within the IAGs (investigation area grids). The maximum depth of the drilling operations will be to the bottom of fill (estimated at 16 feet bgs). The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.		
Equipment to be Used • Personal protection equipment – Steel toe boots – Hard hat – Safety vest – Safety glasses – Nitrile gloves/leather work gloves • DPT drill rig	**Inspection Requirements** • Safety inspection checklist for construction equipment • Additional requirements may be provided by the subcontractor	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour Construction Training (SSC only)

Approved By/Date: 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	6 Investigation Area Grid (ISM) Soil Sample Processing		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

6 *INVESTIGATION AREA GRID (ISM) SOIL SAMPLE PROCESSING*

This AHA applies to the collection of ISM soil samples from cores extracted from the subsurface. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Set up sampling equipment	INJURY FROM DRILL RIG MOVING PARTS	• Set up away from drill rig • Stay clear of all moving parts of drill rig • Remove or bind all loose clothing • Wear proper PPE: Steel-toe boots, hard hat, safety glasses and Nitrile gloves	**L (4)**
	SLIPS, TRIPS, AND FALLS	• Visually inspect both sampling area and path to drill area for obstructions • Ensure all debris has been removed	**L (4)**
	BACK SPRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Sample collection and analysis	EXPOSURE TO CHEMICALS OF CONCERN	• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
	BROKEN GLASS WOUNDS FROM JARS	• Dispose of all broken shards immediately	**L (4)**
	SLIPS, TRIPS, AND FALLS	• Ensure all debris has been removed	**L (4)**
	SLIPS, TRIPS, AND FALLS	• Ensure all debris has been removed	**L (5)**

6 INVESTIGATION AREA GRID (ISM) SOIL SAMPLE PROCESSING			
This AHA applies to the collection of ISM soil samples from cores extracted from the subsurface. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.			
PRINCIPAL STEPS	**POTENTIAL HAZARDS**	**PREVENTATIVE ACTIONS**	**RAC**
Store samples in coolers with ice, and load coolers and waste water (IDW) into vehicle	BACK STRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Clean work area between core arrivals	SLIPS, TRIPS, AND FALLS	• Dispose of all broken plastic shards • Keep footing area free of field equipment that might trip someone	**L (4)**
		• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
Clean work area between core arrivals	SLIPS, TRIPS, AND FALLS	• Dispose of all broken plastic shards • Keep footing area free of field equipment that might trip someone	
		• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	
Fill sample jars or containers with soil	BROKEN GLASS WOUNDS FROM VIALS OR BOTTLES	• Wear Nitrile gloves, safety glasses, and use splash guard if necessary	**L (4)**
		• Dispose of all broken shards immediately	**L (4)**
Store samples in coolers and load coolers into vehicle	SLIPS, TRIPS, AND FALLS	• Ensure all debris has been removed	**L (4)**
	BACK STRAINS	• Lift with knees and use proper lifting technique • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**
Close lid on drum or container and lock	IMPROPERLY CLOSED CONTAINERS	• Ensure container is closed by visual and hand inspection	**L (4)**
Equipment to be Used • Personal protection equipment – Steel toed boots – Nitrile gloves – Safety glasses • Safety/utility knife • Wrench suited for sealing drum • PID	**Inspection Requirements** • None	**Training Requirements** • 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour Construction Training (SSC only)	

6	*INVESTIGATION AREA GRID (ISM) SOIL SAMPLE PROCESSING*

This AHA applies to the collection of ISM soil samples from cores extracted from the subsurface. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

Approved By/Date: _____ 1/06/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	12/08/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	7 Hand Augering or Soil Coring		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code): **L (4)**

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Risk Assessment Code (RAC) Matrix

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

7 *HAND AUGERING OR SOIL CORING*

This AHA applies to the hand auger and soil coring operations, which will be conducted by Tetra Tech. Hand auger or soil coring will be used to collect sediment samples at a maximum depth of 1 foot bgs within the storm water ponds. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Identify requirements prior to beginning of work	LOSS OF LIVES, HEALTH, AND PROPERTY	• Obtain and review all pertinent utility drawings, included site layout plan • Obtain all intrusive permits and make required contacts	**L (4)**
Soil boring with hand auger	POTENTIAL FOR INJURY	• Hand auger equipment shall be operated only by qualified personnel. • Drilling equipment shall be operated, inspected, and maintained as specified in the manufacturer's operating manual.	**L (4)**
	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (5)**
	NUISANCE DUST	• Wear dust mask if appropriate • Stay upwind of all dust	**L (4)**
	EXPOSURE HAZARDS TO SITE CHEMICALS OF CONCERN	• Wear dusk mask, safety glasses, and other appropriate PPE, if necessary • Stay upwind of all dust	**L (4)**
	LIFTING HAND AUGER / BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots	**L (4)**

Removal and cleaning of auger sections	FLYING DEBRIS OR CUTTINGS / EYE DAMAGE	• Wear safety glasses	**L (4)**
	LIFTING HAND AUGER / BACK STRAIN	• Lift with the knees and in pairs • Wear steel toe boots • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids whenever possible	**L (4)**

7 *HAND AUGERING OR SOIL CORING*

Equipment to be Used	**Inspection Requirements**	**Training Requirements**
• Personal protection equipment – Steel toe boots – Hard hat – Safety vest – Safety glasses – Nitrile gloves/leather work gloves	• Additional requirements may be provided by the subcontractor	• 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour OSHA Construction Safety and Health Training (SSC only)

Approved By/Date: 12/08/2017

Tetra Tech Health and Safety Representative

TETRA TECH

ACTIVITY HAZARD ANALYSIS

Date:	1/06/2017	**Project:**	NASA Ames AOI 14
Prepared By:	Dayna Aragon	**Project Location:**	Mountain View, CA
Activity:	8 Decontamination Procedures		
Competent Persons:	Dayna Aragon, Kerry Hosken, Cora Lemar, Michelle Kolb, Kurt Schmiegel, Heather Reynolds, Jeff Eddo, Sean Cole, Katie Henry		

Overall Risk Assessment Code (RAC) (Use highest code **L (4)**

Risk Assessment Code (RAC) Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E (1)	E (1)	H (2)	H (2)	M (3)
Critical	E (1)	H (2)	H (2)	M (3)	L (4)
Marginal	H (2)	M (3)	M (3)	L (4)	L (5)
Negligible	M (3)	L (4)	L (4)	L (5)	L (5)

8 *DECONTAMINATION PROCEDURES*

This AHA applies to the decontamination of sampling equipment. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

When field tools used for sampling are decontaminated, a three-tiered wash station should be prepared. This station typically includes three buckets, each dedicated to its specific role. Bucket one will be used for a pre-wash with water. Bucket two will contain a soap/Alcohol wash for scrubbing field tools with a brush. Bucket three will contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use Nitrile gloves when handling field tools during decontamination.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Mixing soap solution	CONCENTRATED SOAP MY BE IRRITATING TO THE SKIN	• Wear Nitrile gloves • Follow manufacturers' use instructions	**L (4)**
Set up the three-tiered wash station, using buckets or a container large enough so water does not spill out during the washing of the field tools.	SPILLS AND SPLASHES	• Wear Nitrile gloves • Use splash guard if necessary • Wear eye protection	**L (4)**
Using gloves take each field tool out and begin with the first tier of the wash station, prewash. Place the tool inside the prewash water and ensure large particles and/or dirt are generally removed.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
After prewash, place field tool into soapy/Alconox wash container. Use brush to clean field tool if necessary.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**
After soapy wash, place field tool in final rinse container. May use spray bottle to spray the field tool. If using spray bottle, aim inside final rinse container.	SPILLS AND SPLASHES	• Wear Nitrile gloves and use splash guard if necessary	**L (4)**

TETRA TECH

8 *DECONTAMINATION PROCEDURES*

This AHA applies to the decontamination of sampling equipment. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

When field tools used for sampling are decontaminated, a three-tiered wash station should be prepared. This station typically includes three buckets, each dedicated to its specific role. Bucket one will be used for a pre-wash with water. Bucket two will contain a soap/Alcohol wash for scrubbing field tools with a brush. Bucket three will contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use Nitrile gloves when handling field tools during decontamination.

PRINCIPAL STEPS	POTENTIAL HAZARDS	PREVENTATIVE ACTIONS	RAC
Replace lid on wash containers and return to transporting vehicles	BUCKETS ARE HEAVY AND MAY POSE LIFTING INJURIES	• Use proper lifting techniques (lift with legs) • Get help with heavy or awkwardly shaped loads • Limit each lift to no more than 50 pounds per person • Use hand trucks and other lifting aids when possible	**L (4)**

8 *DECONTAMINATION PROCEDURES*

This AHA applies to the decontamination of sampling equipment. The AHA contains potential hazards posed by each major step in this task, lists procedures to control hazards, and presents required safety equipment, inspections, and training.

When field tools used for sampling are decontaminated, a three-tiered wash station should be prepared. This station typically includes three buckets, each dedicated to its specific role. Bucket one will be used for a pre-wash with water. Bucket two will contain a soap/Alcohol wash for scrubbing field tools with a brush. Bucket three will contain clean deionized water for a final rinse. Spray bottles containing clean deionized water or soapy water may also be used in conjunction with the buckets for spraying down the field tools. Always use Nitrile gloves when handling field tools during decontamination.

Equipment to be Used	Inspection Requirements	Training Requirements	
• Personal protection equipment – Steel toed boots – Nitrile gloves – Safety glasses • Buckets with lids • Scrubber • Spray bottles	None	• 40-Hour Hazardous Waste Operations and Emergency Response • 8-Hour Refresher • 30-Hour Construction Training (SSC only)	

Approved By/Date: _____ 1/06/2017

Tetra Tech Health and Safety Representative

CERTIFICATIONS

Compliance Solutions

"Today's Training... Tomorrow's Solution"

10515 E 40th Ave, Suite 116, Denver Colorado 80239 800-711-2706

Student Affiliation:
Tetra Tech EM, Inc.
13039

Certificate of Completion

This is to certify that

Dayna Yocum

has successfully completed the classroom requirements for

40 Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, October 26, 2007

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *75473093*

Neval Gupta
Vice President

Dawn Brownlee
Instructor

Compliance SolutionsOccupational Trainers, Inc.
Certificate of Completion

Student Name: Dayna Yocum

Company: Tetra Tech EM, Inc.

I Certify that the above named student has completed the

40 Hour HAZWOPER

29 CFR 1910.120(e)

Date of Issue: 10/26/2007

By: _____

Dawn Brownlee **Instructor**

AdvanceOnline Solutions Online Institute

Certificate of Completion

Dayna Aragon

has met the online course completion requirements for

HAZWOPER 8-Hour Refresher

in accordance with 29 CFR 1910.120 and 1926.65

On-site Supervisor's Signature

3/22/2017

Date

Certificate ID 1386116-307

Date 3/21/2017 10:28:00 AM
Time Online 08:53:03
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

CLICKSAFETY®

TEMPORARY CERTIFICATE OF COMPLETION

This acknowledges that

DAYNA YOCUM

Has successfully completed

OSHA 30 Hour Construction

The course was developed by ClickSafety.
Official OSHA completion card to follow within 6 weeks

Serial Number: 3756623

Completed: 2/7/2010

AMERICAN SAFETY & HEALTH INSTITUTE

www.ashinstitute.org

Recognition of Participation

DAYNA ARAGON

has attended the following
American Safety & Health Institute Training Program

Infant, Child, Adult CPR with AED & First Aid

Your emergency care training helps prepare you to be a confident responder in an emergency.

The Loss Prevention Group, Inc. 1814 Franklin Street, Suite 618, Oakland, CA 94612
Training Center

March 16, 2016
Class Date

(877) 457-4669
Training Center Telephone

This is not a document of successful completion. Verification that a participant has met the required knowledge and skill objectives of the course is documented by a separately issued certification card.

© 2007 American Safety & Health Institute

ASHI and the ASHI logo are registered trademarks of American Safety & Health Institute

PRN3002 (6/07)

CPR and AED
Certification Card

2010

Dayna Aragon

has successfully completed and competently performed the required knowledge and skill objectives for this program.

- ☐ Adult
- ☐ Child and Infant
- ☑ Adult, Child, and Infant

Card is void if more than one box is checked.

AMERICAN SAFETY & HEALTH INSTITUTE

ASHI-Approved Certification Card

MARCUS BRONFELD
Authorized Instructor (Print Name)

67416
Registry No.

3/16/2016
Class Completion Date

3/31/2018
Expiration Date

510 836 6011
Training Center Phone No.

129631
Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content conforms to the *2010 AHA Guidelines for CPR and ECC*, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion. More frequent reinforcement of skills is recommended.

Basic First Aid
Certification Card

2010

Dayna Aragon

has successfully completed and competently performed the required knowledge and skill objectives for this program.

- ☐ Adult
- ☐ Pediatric
- ☑ Adult and Pediatric

AMERICAN SAFETY & HEALTH INSTITUTE

ASHI-Approved Certification Card

MARCUS BRONFELD
Authorized Instructor (Print Name)

67410
Registry No.

3/16/2016
Class Completion Date

3/31/2018
Expiration Date

510 836 6011
Training Center Phone No.

129631
Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content covers adult and pediatric first aid and conforms to the *2010 AHA Guidelines for CPR and ECC*, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion. More frequent reinforcement of skills is recommended.

Compliance Solutions

"Today's Training... Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

Student Affiliation:
Tetra Tech EMI
17041

Certificate of Completion

This is to certify that

Sean Cole

has been tested and successfully meets the training requirements for

40-Hour HAZWOPER
as per 29 CFR 1910.120(e)

Presented
Friday, January 25, 2013

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *754856567*

Neval Gupta
Vice President

Anthony Rodriguez
Instructor

Certificate of Training

Sean Cole

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech, Inc.

Date Course Completed: **May 18, 2017**
(expires one year from the date of training)

Dave Brown
Safety Manager

Certificate Of Completion

American Safety Council

SEAN COLE

Has diligently and with merit completed the

40-Hour EM 385-1-1 on 11/8/2015

Director: **Jeff Pairan**

Certificate of Training

Sean Cole

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER Initial Site Supervisor Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Site Supervisor Training for Compliance with OSHA in accordance with 29 CFR 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech

Date Course Completed: **May 12, 2015**

Dave Brown, CHST
Safety Manager

AdvanceOnline Solutions Online Institute

Certificate of Completion

Sean Cole

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Course ID A0310
Certificate ID 307_1153182
Instructor Rick Gleason
Continuing Education Units 3.0
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 3.0 CEUs for this program.

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

Date 11/8/2015 4:34:00 PM
Time Online 31:25:13
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

American Red Cross

Sean Cole

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 11/01/2017

conducted by: American Red Cross

Instructor: Kyle Patrick Taylor

ID: GVCS82

Scan code or visit:

redcross.org/confirm

WORK STATUS REPORT

Employer Copy

TYPE OF EXAMINATION: **TT - Periodic Env Field Worker Exam**
EXAM CLASSIFICATION: **Periodic Examination**

EMPLOYEE:	**Cole, Sean**	**COMPANY:**	**TT/EMI**
ID:		**POSITION:**	**Not Indicated**
DATE OF EXAM:	**08/03/2017**	**LOCATION:**	**TT/EMI-San Diego**
EXPIRATION DATE:	**08/03/2019**	**SITE:**	

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	No	Undecided
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any contraindication for work in accordance with 29 CFR §1910.95(g)1926.52 (Hearing Conservation)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

Status

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: Peter P. Greaney, M.D. Date: 08/11/17

Signature: Peter P Greaney MD

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

Compliance Solutions

"Today's Training... Tomorrow's Solution"

10515 E 40th Ave, Suite 116, Denver Colorado 80239 800-711-2706

Student Affiliation:
Tetra Tech EM, Inc.
17041

Certificate of Completion

This is to certify that

Jeffrey D. Eddo

has successfully completed the classroom requirements for

40 Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, November 09, 2007

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: 75473885

Neval Gupta
Vice President

Jeffrey Kline
President/CEO

AdvanceOnline Solutions Online Institute

Certificate of Completion

Jeffrey Eddo

has met the online course completion requirements for

HAZWOPER 8-Hour Refresher

in accordance with 29 CFR 1910.120 and 1926.65

Certificate ID 307_1430003
Continuing Education Units 0.8
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 0.8 CEUs for this program.

Date 7/19/2017 9:03:00 PM
Time Online 10:11:27
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

AdvanceOnline Solutions Online Institute

Certificate of Completion

Jeffrey D. Eddo

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Struck and Caught Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Certificate ID: 307_401118
Instructor: Gleason, Rick
Continuing Education Units: 3.0

Date: 5/7/2010 1:08:41 AM
Time Online: 30:33:30

AdvanceOnline Solutions, Inc.
5858 Westheimer Road, Suite 405
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

AdvanceOnline Solutions, Inc. has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 8405 Greensboro Drive, Suite 800, McLean, VA 22102.

AUTHORIZED IACET PROVIDER

Student Affiliation:
Tetra Tech EMI
17041

Compliance Solutions
"Today's Training...Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

Certificate of Completion

This is to certify that

Jeffrey D. Eddo

has been tested and successfully meets the training requirements for

OSHA Site Supervisor
as per 29 CFR 1910.120

Presented
Sunday, April 19, 2015

Compliance Solutions Occupational Trainers, Inc.

Neval Gupta
Vice President

Jeffrey E. Kline
President/CEO

Certificate Number: *754901045*

Eddo, Jeff

From:	EnjoyCPR Feedback <no-reply@wufoo.com>
Sent:	Monday, November 27, 2017 4:44 PM
To:	Eddo, Jeff
Subject:	Request a Card/Certification Form
Follow Up Flag:	Follow up
Flag Status:	Flagged

Thanks for your submission and your order is on it's way! Your information will be processed and if application, certifications will go out within 20 business days of your original class date. Electronic certification copies will be sent within 1-2 business days.

Request a Card/Certification Form

Select a Choice *	Didn't ever receive my certification card
Class Date: *	Saturday, July 22, 2017
Name *	Jeffrey Eddo
Email *	jeff.eddo@tetratech.com
Instructor Name *	Bill
Shipping Address *	4739 Birchwood Circle Carlsbad, CA 92008 United States
Please select the type of class(es) you attended. *	Basic Adult/Pediatric CPR & AED Basic First Aid

Compliance Solutions

"Today's Training... Tomorrow's Solution"

10515 E 40th Ave, Suite 116, Denver Colorado 80239 800-711-2706

Student Affiliation:
Tetra Tech EM, Inc.
13039

Certificate of Completion

This is to certify that

Katie Kirchner

has successfully completed the classroom requirements for

40 Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, November 18, 2005

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *74017*

Neval Gupta
Vice President

Erik Eriksen
Instructor

Certificate of Training

Katie Henry

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech

Date Course Completed: **January 26, 2017**
(expires one year from the date of training)

Dave Brown
Safety Manager

G 2010

Basic First Aid

Certification Card

Katie Henry

has successfully completed and competently performed the required knowledge and skill objectives for this program.

- ☐ Adult
- ☐ Pediatric
- ☑ Adult and Pediatric

AMERICAN SAFETY & HEALTH INSTITUTE

ASHI-Approved Certification Card

MARCUS BRONFELD
Authorized Instructor (Print Name)

67410
Registry No.

1/28/2016
Class Completion Date

1/31/2018
Expiration Date

570 836 6011
Training Center Phone No.

129631
Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content covers adult and pediatric first aid and conforms to the *2010 AHA Guidelines for CPR and ECC*, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion. More frequent reinforcement of skills is recommended.

G 2010

CPR and AED

Certification Card

Katie Henry

has successfully completed and competently performed the required knowledge and skill objectives for this program.

- ☐ Adult
- ☐ Child and Infant
- ☑ Adult, Child, and Infant

Card is void if more than one box is checked.

AMERICAN SAFETY & HEALTH INSTITUTE

ASHI-Approved Certification Card

MARCUS BRONFELD
Authorized Instructor (Print Name)

67410
Registry No.

1/28/2016
Class Completion Date

1/31/2018
Expiration Date

570 836 6011
Training Center Phone No.

129631
Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content conforms to the *2010 AHA Guidelines for CPR and ECC*, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion. More frequent reinforcement of skills is recommended.

NES

www.nesglobal.net

Certificate of Completion

Michelle Kolb

has successfully completed training in

40-Hour Hazardous Waste Operations 29 CFR 1910.120

presented by

NES, Inc.

1141 Sibley Street Folsom, CA 95630

Instructor - Kiel McClintock

11/03/14 *11/07/14*

Date *Contact Hours* 40

Certificate of Training

Michelle Kolb

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech

Date Course Completed: **May 23, 2016**
(expires one year from the date of training)

Dave Brown
Safety Manager

Certificate of Training

Michelle Kolb

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech, Inc.

Date Course Completed: **May 23, 2017**
(expires one year from the date of training)

Dave Brown
Safety Manager

Certificate of Training

Michelle Kolb

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER Initial Site Supervisor Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Site Supervisor Training for Compliance with OSHA in accordance with 29 CFR 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech

Date Course Completed: **May 8, 2015**

Dave Brown, CHST
Safety Manager

AdvanceOnline Solutions Online Institute

Certificate of Completion

Michelle Kolb

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Course ID A0310
Certificate ID 307_1408036
Instructor Rick Gleason
Continuing Education Units 3.0
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 3.0 CEUs for this program.

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

Date 5/30/2017 11:52:00 PM
Time Online 33:19:10
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

American Red Cross

Michelle Kolb

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 04/24/2017

conducted by: American Red Cross

Instructor: Jillian Winchester Ebeling

ID: 0ZVSBZ

Scan code or visit:

redcross.org/confirm

Student Affiliation:
Tetra Tech EM Inc
13039

Compliance Solutions
"Today's Training...Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

Certificate of Completion

This is to certify that

Cora LeMar

has been tested and successfully meets the training requirements for

40-Hour HAZWOPER
as per Title 8CCR 5192(e)(3)(A) & 29 CFR 1910(e)

Presented
Friday, December 09, 2016

Compliance Solutions Occupational Trainers, Inc.

Neval Gupta
Vice President

Keith Warwick
Instructor

Certificate Number: *754932631*

AdvanceOnline Solutions Online Institute

Certificate of Completion

Cora LeMar

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Course ID A0310
Certificate ID 307_1468208
Instructor Rick Gleason
Continuing Education Units 3.0
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 3.0 CEUs for this program.

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

Date 12/8/2017 11:04:00 AM
Time Online 30:15:36
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

American Red Cross

Certificate of Completion

Cora LeMar

has successfully completed requirements for

Adult and Pediatric First Aid/CPR/AED - valid 2 Years

conducted by
American Red Cross

Date Completed: 01/12/2017
Instructors: GERALD FERMIN

Certificate ID: 0ZEX7F

To verify, scan code or visit:
redcross.org/confirm

ALL AMERICAN ENVIRONMENTAL SERVICES, INC.

This is to certify that

HEATHER SCOTT

has successfully completed

"HAZARDOUS WASTE SITE WORKER" 40-HOUR COURSE
SATISFYING OSHA 29 CFR 1910.120 (e) (3) (i)

at

ALL AMERICAN SCHOOL OF OCCUPATIONAL SAFETY AND HEALTH
HANOVER, MARYLAND

School Director

JANUARY 7, 8, 10 & MAY 9 & 10, 2013
40S-1305A

Certificate of Training

Heather Reynolds

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech, Inc.

Date Course Completed: **May 18, 2017**
(expires one year from the date of training)

Dave Brown
Safety Manager

AdvanceOnline Solutions Online Institute

Certificate of Completion

Heather Reynolds

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Managing Safety and Health, Struck-by and Caught-In or Between Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, GHS Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Course ID A0310
Certificate ID 307_1330812
Instructor Rick Gleason
Continuing Education Units 3.0
AdvanceOnline Solutions, Inc. is authorized by IACET to offer 3.0 CEUs for this program.

AdvanceOnline Solutions, Inc. is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

ACCREDITED IACET PROVIDER

Date 11/21/2016 11:18:00 PM
Time Online 32:56:56
AdvanceOnline Solutions, Inc.
2400 Augusta Drive, Suite 465
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

Do It Right!
CPR and First Aid Training

www.doitrightcpr.com 619-961-3593

BLS Adult. Child. Infant First Aid/CPR/AED course
was completed according to the
American Heart Association guidelines

Issue Date
5/2017
Expiation Date
5/2019

Heather Reynolds

Anita Davis
AHA Instructor

student signature

Compliance Solutions

"Today's Training... Tomorrow's Solution"

3980 Quebec St, 2nd Floor Denver, CO 80207-1833 800-711-2708

Student Affiliation:
Arcadis-US
200801194

Certificate of Completion

This is to certify that

Kurt Schmiegel

has been tested and successfully meets the training requirements for

40-Hour HAZWOPER

29 CFR 1910.120(e)

Presented

Friday, August 20, 2010

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *754814753*

Neval Gupta
Vice President

Christopher Johnson
Instructor

Certificate of Training

Kurt Schmiegel

is hereby awarded this certificate to acknowledge completion of the
8-hour HAZWOPER and Site Supervisor Refresher Course

Hazardous Waste Operations and Emergency Response (HAZWOPER) Refresher Training for Compliance with OSHA 29 CFR 1910.120(e)(8), including supervisor training in accordance with 1910.120(e)(2) & (e)(4)

prepared and instructed by

Tetra Tech, Inc.

Date Course Completed: **May 23, 2017**
(expires one year from the date of training)

Dave Brown
Safety Manager

AdvanceOnline Solutions Online Institute

Certificate of Completion

Kurt T. Schmiegel

has met the online course completion requirements for

OSHA 30-Hour Construction Safety

This student has completed the formal instruction for the 30-Hour Construction Outreach Program. Topics covered in this program were Introduction to OSHA, Struck and Caught Hazards, Personal Protective Equipment, Hearing Conservation, Respiratory Protection, Lead and Crystalline Silica, Asbestos, Hazard Communication, Electrical Safety, Hand and Power Tools, Fall Protection, Ladder Safety, Excavations, Scaffolds, Crane Safety, Heavy Equipment, Forklift Safety, Materials Handling, Permit-Required Confined Spaces, Fire Safety, Welding and Cutting, Concrete and Masonry, Steel Erection, and Ergonomics.

Certificate ID: 1632_460485
Instructor: Gleason, Rick
Continuing Education Units: 3.0

AdvanceOnline Solutions, Inc. has been approved as an Authorized Provider by the International Association for Continuing Education and Training (IACET), 8405 Greensboro Drive, Suite 800, McLean, VA 22102.

AUTHORIZED IACET PROVIDER

Date: 9/8/2010 12:33:46 PM
Time Online: 30:35:58

AdvanceOnline Solutions, Inc.
5858 Westheimer Road, Suite 405
Houston, Texas 77057
www.advanceonline.com
Phone: (713) 621-1100

AdvanceOnline SOLUTIONS

Compliance Solutions

"Today's Training... Tomorrow's Solution"

3980 Quebec St, 2nd Floor Denver, CO 80207-1633 800-711-2706

Student Affiliation:
ARCADIS-US
200801194

Certificate of Completion

This is to certify that

Kurt Schmiegel

has been tested and successfully meets the training requirements for

OSHA Site Supervisor

29 CFR 1910.120

Presented

Friday, May 06, 2011

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: 754825106

Neval Gupta
Vice President

Jeffrey Kline
President/CEO

HEARTSAVER FIRST AID CPR AED

Heartsaver®
First Aid CPR AED

American Heart Association.

PEEL HERE

KURT SCHMIEGEL

This card certifies that the above individual has successfully completed the objectives and skills evaluations in accordance with the curriculum of the AHA Heartsaver First Aid CPR AED Program. Optional completed modules are those **NOT** marked out:

~~Child CPR AED~~ ~~Infant CPR~~ ~~Written test~~

MAR 03 2016
Issue Date

MAR 31 2018
Recommended Renewal Date

HEARTSAVER FIRST AID CPR AED

Training Center Name OHIO

TC ID # OH20246

TC Info Cintas First Aid & Safety (916)419-1099

Course Location Location 169-Sacramento, CA 95834

Instructor Name Brian Zamora, ID# 08150350048

Inst. ID #

Holder's Signature

© 2011 American Heart Association Tampering with this card will alter its appearance. 90-1815

Strike through the modules ***NOT*** completed.

This card contains unique security features to protect against forgery.

90-1815 3/11

APPENDIX F
STORMWATER POLLUTION PREVENTION PLAN

STORM WATER POLLUTION PREVENTION PLAN

AREA OF INVESTIGATION 14

RISK LEVEL 1

December 2017

Prepared for:

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

STORM WATER POLLUTION PREVENTION PLAN

for

Area of Investigation 14

RISK LEVEL ***1***

Legally Responsible Person (LRP):

National Aeronautics and Space Administration
Ames Research Center, Moffett Field, CA
Garrett Michael Turner, P.E., PMP
(650) 604-1406

Approved Signatory:

Approved Signatory if designated by LRP
Phone Number

Project Address:

National Aeronautics and Space Administration
Ames Research Center, Moffett Field, CA
37.430211, -122.063768

SWPPP Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, CA 94612
Anne Simpson

SWPPP Preparation Date:

December 2017

Estimated Project Dates:

Start of Construction	**December 2017**	Completion of Construction	**December 2018**

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... **viii**
QUALIFIED SWPPP DEVELOPER ..... **x**
LEGALLY RESPONSIBLE PERSON ..... **xi**
AMENDMENT LOG ..... **xii**
SECTION 1 SWPPP REQUIREMENTS **1**
1.1 INTRODUCTION 1
1.2 PERMIT REGISTRATION DOCUMENTS 2
1.3 SWPPP AVAILABILITY AND IMPLEMENTATION 2
1.4 SWPPP AMENDMENTS 2
1.5 RETENTION OF RECORDS 4
1.6 REQUIRED NON-COMPLIANCE REPORTING 4
1.7 ANNUAL REPORT 4
1.8 CHANGES TO PERMIT COVERAGE 6
1.9 NOTICE OF TERMINATION 6
SECTION 2 PROJECT INFORMATION **7**
2.1 PROJECT AND SITE DESCRIPTION 7
2.1.1 Site Description 7
2.1.2 Project Description 7
2.1.3 Existing Conditions 9
2.1.4 Existing Drainage 10
2.1.5 Final Stabilization 10
2.1.6 Geology and Groundwater 11
2.2 PERMITS AND GOVERNING DOCUMENTS 11
2.3 STORM WATER RUN-ON FROM OFFSITE AREAS 11
2.4 FINDINGS OF THE CONSTRUCTION SITE SEDIMENT AND RECEIVING WATER RISK DETERMINATION 12
2.5 CONSTRUCTION SCHEDULE 13
2.6 POTENTIAL CONSTRUCTION ACTIVITY AND POLLUTANT SOURCES 13
2.7 IDENTIFICATION OF NON-STORM WATER DISCHARGES 14
2.8 REQUIRED SITE MAP INFORMATION 14

TABLE OF CONTENTS (CONTINUED)

SECTION 3 BEST MANAGEMENT PRACTICES 16
3.1 SCHEDULE FOR BMP IMPLEMENTATION 16
3.2 EROSION AND SEDIMENT CONTROL 17
3.2.1 Erosion Control 17
3.2.2 Sediment Controls 20
3.3 NON-STORM WATER CONTROLS AND WASTE AND MATERIALS MANAGEMENT 22
3.3.1 Non-Storm Water Controls 22
3.3.2 Materials Management and Waste Management 24
3.4 POST-CONSTRUCTION STORM WATER MANAGEMENT MEASURES 28
SECTION 4 BMP INSPECTION AND MAINTENANCE 30
SECTION 5 TRAINING 31
SECTION 6 RESPONSIBLE PARTIES AND OPERATORS 32
6.1 RESPONSIBLE PARTIES 32
6.2 CONTRACTOR LIST 33
SECTION 7 CONSTRUCTION SITE MONITORING PROGRAM 34
7.1 PURPOSE 34
7.2 APPLICABILITY OF PERMIT REQUIREMENTS 34
7.3 WEATHER AND RAIN EVENT TRACKING 34
7.3.1 Weather Tracking 35
7.3.2 Rain Gauges 35
7.4 MONITORING LOCATIONS 35
7.5 SAFETY AND MONITORING EXEMPTIONS 35
7.6 VISUAL MONITORING 36
7.6.1 Routine Observations and Inspections 36
7.6.1.1 Routine BMP Inspections 37
7.6.1.2 Non-Storm Water Discharge Observations 38
7.6.2 Rain Event-Triggered Observations and Inspections 38
7.6.2.1 Visual Observations Prior to a Forecasted Qualifying Rain Event 38
7.6.2.2 BMP Inspections during an Extended Storm Event 38
7.6.2.3 Visual Observations Following a Qualifying Rain Event 39

TABLE OF CONTENTS (CONTINUED)

7.6.3 Visual Monitoring Procedures 39
7.6.4 Visual Monitoring Follow-Up and Reporting 40
7.6.5 Visual Monitoring Locations 40
7.7 WATER QUALITY SAMPLING AND ANALYSIS 41
7.7.1 Sampling and Analysis Plan for Non-Visible Pollutants in Storm Water Runoff Discharges 41
7.7.1.1 Sampling Schedule 41
7.7.1.2 Sampling Locations 42
7.7.1.3 Monitoring Preparation 44
7.7.1.4 Analytical Constituents 44
7.7.1.5 Sample Collection 45
7.7.1.6 Sample Analysis 45
7.7.1.7 Data Evaluation and Reporting 47
7.7.2 Sampling and Analysis Plan for Non-Storm Water Discharges 47
7.7.2.1 Sampling Schedule 48
7.7.2.2 Sampling Locations 48
7.7.2.3 Monitoring Preparation 49
7.7.2.4 Analytical Constituents 50
7.7.2.5 Sample Collection 50
7.7.2.6 Sample Analysis 52
7.7.2.7 Data Evaluation and Reporting 52
7.7.3 Sampling and Analysis Plan for Other Pollutants Required by the Regional Water Board 52
7.7.4 Training of Sampling Personnel 52
7.7.5 Sample Collection and Handling 53
7.7.5.1 Sample Collection 53
7.7.5.2 Sample Handling 54
7.7.5.3 Sample Documentation Procedures 55
7.8 Quality Assurance and Quality Control 56
7.8.1 Field Logs 56
7.8.2 Clean Sampling Techniques 56

TABLE OF CONTENTS (CONTINUED)

7.8.3 Chain of Custody 57
7.8.4 QA/QC Samples 57
7.8.4.1 Field Duplicates 57
7.8.4.2 Equipment Blanks 58
7.8.4.3 Field Blanks 58
7.8.4.4 Travel Blanks 58
7.8.5 Data Verification 59
7.9 RECORDS RETENTION 60
SECTION 8 REFERENCES 62

TABLES

1.1 LIST OF CHANGES TO BE FIELD DETERMINED 3

2.1 SUMMARY OF SEDIMENT RISK 13

2.2 SUMMARY OF RECEIVING WATER RISK 13

2.3 REQUIRED MAP INFORMATION 15

3.1 BMP IMPLEMENTATION SCHEDULE 16

3.2 TEMPORARY EROSION CONTROL BMPS 19

3.3 TEMPORARY SEDIMENT CONTROL BMPS 21

3.4 TEMPORARY NON-STORM WATER BMPS 23

7.1 SUMMARY OF VISUAL MONITORING AND INSPECTIONS 37

7.2 SITE DRAINAGE AREAS 40

7.3 CONTRACTOR STAGING/LAYDOWN DISCHARGE LOCATIONS 41

7.4 POTENTIAL NON-VISIBLE POLLUTANT SAMPLE LOCATIONS – CONTRACTOR YARD 43

7.5 POTENTIAL NON-VISIBLE POLLUTANT SAMPLE LOCATIONS – AREAS OF HISTORICAL CONTAMINATION 43

7.6 NON-VISIBLE POLLUTANT SAMPLE LOCATIONS – BACKGROUND (UNAFFECTED SAMPLE) 44

7.7 POTENTIAL NON VISIBLE POLLUTANTS AND WATER QUALITY INDICATOR CONSTITUENTS 45

7.8 SAMPLE COLLECTION, PRESERVATION, AND ANALYSIS FOR MONITORING NON VISIBLE POLLUTANTS 46

7.9 NON STORM WATER DISCHARGE SAMPLE LOCATIONS 49

7.10 POTENTIAL NON STORM WATER DISCHARGE POLLUTANTS AND WATER QUALITY INDICATOR CONSTITUENTS 50

7.11 SAMPLE COLLECTION, PRESERVATION AND ANALYSIS FOR MONITORING POLLUTANTS IN NON-STORM WATER DISCHARGES ... 51

CSMP ATTACHMENTS

1	WEATHER REPORTS
2	MONITORING RECORDS
3	EXAMPLE FORMS
4	FIELD METER INSTRUCTIONS
5	SUPPLEMENTAL INFORMATION

APPENDICES

A	CONSTRUCTION GENERAL PERMIT
B	SITE MAPS
C	RISK LEVEL DETERMINATION
D	CONSTRUCTION SCHEDULE
E	CONSTRUCTION ACTIVITIES. MATERIALS USED, AND ASSOCIATED POLLUTANTS
F	CASQA STORMWATER BMP HANDBOOK PORTAL: CONSTRUCTION FACT SHEETS
G	BMP INSPECTION FORM
H	TRAINING REPORTING FORM
I	RESPONSIBLE PARTIES
J	CONTRACTORS AND SUBCONTRACTORS

FIGURES – APPENDIX B

1 AOI 14 SITE LOCATION

2 AOI 14 SITE MAP

3 SITE CHARACTERIZATION PROPOSED INVESTIGATION AREA GRIDS

4 SITE FEATURES AND PROPOSED LAYOUT OF BEST MANAGEMENT PRACTICES

5 PROPOSED FINAL GRADING PLAN

6 WETLAND AND WATERS OF THE U.S. AND BURROWING OWL PRESERVES

7 AREAS OF POTENTIALLY OCCURRING FEDERALLY LISTED SPECIES—WESTERN SNOWY PLOVER AND CALIFORNIA LEAST TERN

8 AREAS OF POTENTIALLY OCCURRING FEDERALLY LISTED SPECIES—CALIFORNIA CLAPPER RAIL AND SALT MARSH HARVEST MOUSE

ACRONYMS AND ABBREVIATIONS

µg/L	Microgram per liter
amsl	Above mean sea level
AOI	Area of investigation
ATS	Active Treatment System
BAT/BCT	Best available technology/best control technology
bgs	Below ground surface
BMP	Best management practice
BOD	Biochemical oxygen demand
CASQA	California Stormwater Quality Association
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R	Code of Federal Regulations
CGP	California General Permit
CoC	Chain of custody
CPESC	Certified Professional in Erosion and Sediment Control
CPSWQ	Certified Professional in Storm Water Quality
CSMP	Construction Site Monitoring Program
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
FSFA	Former soil fill area
GIS	Geographic information systems
g/L	Gram per liter
IAG	Investigation area grid
ISM	Incremental sampling methodology
K	Soil erodibility factor
L	Liter
LRP	Legally responsible person
LS	Slope length factor (L) and slope steepness factor (S)
MBAS	Methylene-blue active substances
MROSD	Midpeninsula Regional Open Space District
mg/L	Milligrams per liter
mL	Milliliter
MPN	Most probable number
NASA	National Aeronautics and Space Administration
NASA Ames	NASA Ames Research Center
NOAA	National Oceanographic and Atmospheric Administration
NOT	Notice of termination
NPDES	National Pollutant Discharge Elimination System
NSWD	Non-storm water discharges
NTU	Nephelometric turbidity units
PCB	Polychlorinated biphenyl
PSMHRP	Protected Species Mitigation and Habitat Restoration Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

QA/QC	Quality assurance/quality control
QAPrP	Quality Assurance Program Plan
QISP	Qualified Industrial Stormwater Practitioner
QSD	Qualified SWPPP Developer
QSP	Qualified SWPPP Practitioner
R	Rainfall-runoff erosivity factor
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act
Regional Water Board	Regional Water Quality Control Board
RUSLE	Revised universal soil loss equation
SDS	Safety data sheets
SMARTS	Storm Water Multi-Application and Reporting System
SWAMP	Surface Water Ambient Monitoring Program
SWPPP	Storm Water Pollution Prevention Plan
SWRP	Storm Water Retention Pond
SWRCB	State Water Resources Control Board
TBD	To be determined
TMDL	Total maximum daily load
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound

QUALIFIED SWPPP DEVELOPER

Approval and Certification of the Storm Water Pollution Prevention Plan

Project Name:	*Area of Investigation 14*
Project Number/ID [if applicable]:	N/A

"This Storm Water Pollution Prevention Plan and Attachments were prepared under my direction to meet the requirements of the California Construction General Permit (SWRCB Orders No. 2009-009-DWQ as amended by Order 2010-0014-DWQ and Order 2012-0006-DWQ). I certify that I am a Qualified SWPPP Developer in good standing as of the date signed below."

Anne Simpson	12/7/2017
QSD Signature	*Date*
Anne Simpson	517
QSD Name	*QSD Certificate Number*
Environmental Scientist, CPESC, CPSWQ, QSD/P, QISP	(805) 739-2650
Title and Affiliation	*Telephone Number*
Anne.Simpson@tetratech.com	
Email	

LEGALLY RESPONSIBLE PERSON

Approval and Certification of the Storm Water Pollution Prevention Plan

Project Name: Area of Investigation 14

Project Number/ID [if applicable]: N/A

"I certify under penalty of law that this document and all Attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Garrett Michael Turner, P.E., PMP

Legally Responsible Person

Garrett Michael Turner

Signature of [Authorized Representative of] Legally Responsible Person or Approved Signatory

11 December 2017

Date

Garrett Michael Turner, P.E., PMP

Name of [Authorized Representative of] Legally Responsible Person or Approved Signatory

(650) 604-1406

Telephone Number

AMENDMENT LOG

Project Name: NASA Ames AOI 14

Project Number/ID [if applicable]: N/A

Amendment No.	Date	Brief Description of Amendment (include section and page number)	Prepared by QSD:
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#
			Name: QSD#

SECTION 1 SWPPP REQUIREMENTS

1.1 INTRODUCTION

This Storm Water Pollution Prevention Plan (SWPPP) is designed to comply with California's *General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (General Permit) Order No. 2009-0009-DWQ*, as amended in 2010 and 2012 (National Pollutant Discharge Elimination System [NPDES] No. CAS000002), issued by the State Water Resources Control Board (SWRCB) for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal action at Area of Investigation (AOI) 14. The removal action will consist of additional site characterization using incremental sampling methodology (ISM), excavation and off-site disposal of soil and sediment with concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. A copy of the General Permit is provided in Appendix A.

This SWPPP has been prepared following the SWPPP Template provided on the California Stormwater Quality Association (CASQA) *Best Management Practice Handbook Portal: Construction* (CASQA, 2012). In accordance with Section XIV of the General Permit, this SWPPP is designed to address the following:

- Pollutants and their sources, including sources of vegetation, fill material, construction debris, or sediment associated with construction, construction site erosion and other activities associated with construction activity, are controlled.

- Where not otherwise required to be under a Regional Water Quality Control Board (Regional Water Board) permit, all non-storm water discharges are identified and either eliminated, controlled, or treated.

- Site best management practices (BMP) are effective and result in the reduction or elimination of pollutants in storm water discharges and authorized non-storm water discharges from construction activity to the Best Available Technology/Best Control Technology (BAT/BCT) standard.

AOI 14 is located at the northern end of National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames) in Moffett Field, California, at latitude 37.430405 and longitude -122.063723. NASA Ames is in Santa Clara County, approximately 35 miles southeast of San Francisco and 10 miles northwest of San Jose (see Figure 1 in Appendix B). NASA Ames is separated from San Francisco Bay by former salt evaporation ponds. The City of Mountain View is adjacent to the western and southern boundaries of NASA Ames, and the City of Sunnyvale is adjacent to the southern and eastern boundaries.

The Project's location is shown on Figure 2 in Appendix B. The property is owned and developed by NASA. The western boundary of AOI 14 borders the portion of the storm water

retention pond (SWRP) located within the Midpeninsula Regional Open Space District (MROSD).

1.2 PERMIT REGISTRATION DOCUMENTS

This SWPPP has been prepared following the requirements of the General Permit. Because AOI 14 is a CERCLA site and only required to meet substantive requirements for on-site action, submission of the General Permit to the SWRCB is not required. Permit Registration Documents will not be submitted to the State Water Board; however, this SWPPP was prepared in accordance with General Permit requirements. The SWPPP will meet the requirements of the General Permit and will be fully implemented.

1.3 SWPPP AVAILABILITY AND IMPLEMENTATION

The SWPPP will be available at the construction site during working hours (see Section 7.5 for working hours) while construction is occurring and will be made available upon request by a NASA inspector or regulatory agency. When the original SWPPP is retained by a crewmember in a construction vehicle and is not at the construction site, current copies of the BMPs and maps/drawings will be left with the field crew, and the original SWPPP will be made available via a request by radio/telephone. (Construction General Permit Section XIV, Part C).

The SWPPP will be implemented concurrently with the start of ground-disturbing activities.

1.4 SWPPP AMENDMENTS

The SWPPP should be revised:

- If there is a violation of the substantive requirements of the General Permit.
- When there is a reduction or increase in total disturbed acreage (General Permit Section II, Part C).
- BMPs do not meet the objectives of reducing or eliminating pollutants in storm water discharges.
- There is a change in construction or operations that may affect the discharge of pollutants to surface waters, groundwater(s), or a municipal separate storm sewer system (MS4).
- When there is a change in the Project duration that changes the Project's risk level.
- When deemed necessary by the Qualified SWPPP Developer (QSD). The QSD has determined that the changes listed in Table 1.1 can be field determined by the

Qualified SWPPP Practitioner (QSP). All other changes will be made by the QSD as formal amendments to the SWPPP.

The following items will be included in each amendment:

- Who requested the amendment;
- The location of the proposed change;
- The reason for the change;
- The original BMP proposed, if any; and
- The new BMP proposed.

Amendments will be logged at the front of the SWPPP. The SWPPP text will be revised and/or hand annotated as necessary to properly convey the amendment. SWPPP amendments must be made by a QSD. The following changes have been designated by the QSD as "to be field determined" and constitute minor changes that the QSP may implement based on field conditions.

Table 1.1 List of Changes to be Field Determined

Candidate Changes For Field Location Or Determination By QSP[1]	Check Changes That Can Be Field Located Or Field Determined By QSP
Increase quantity of an Erosion or Sediment Control Measure	*X*
Relocate/add stockpiles or stored materials	*X*
Relocate or add toilets	*X*
Relocate vehicle storage and/or fueling locations	*X*
Relocate areas for waste storage	*X*
Relocate water storage and/or water transfer location	*X*
Changes to access points (entrance/exits)	*X*
Change type of Erosion or Sediment Control Measure	*X*
Changes to location of erosion or sediment control	*X*
Minor changes to schedule or phases	*X*
Changes in construction materials	*X*

1 Any field changes not identified for field location or field determination by the QSP must be approved by the QSD.

1.5 RETENTION OF RECORDS

Paper or electronic records of documents required by this SWPPP will be retained for a minimum of 3 years from the date generated or date submitted, whichever is later, for the following items:

- Routine Inspection
- Employee Training Records

These records will be available at the Site until construction is complete. Records assisting in the determination of compliance with the substantive requirements of the General Permit will be made available to NASA within a reasonable time (generally 24 hours), upon request.

1.6 REQUIRED NON-COMPLIANCE REPORTING

If a General Permit discharge violation occurs, the QSP will immediately notify the Legally Responsible Person (LRP). The LRP will include information on the violation with the Annual Report (see Section 1.7). Corrective measures will be implemented immediately following identification of the discharge or written notice of non-compliance from the Regional Water Board. Discharges and corrective actions must be documented and include the following items:

- The date, time, location, nature of operation, and type of unauthorized discharge.
- The cause or nature of the notice or order.
- The BMPs deployed before the discharge event or prior to receiving notice or order.
- The date of deployment and type of BMPs deployed after the discharge event or after receiving the notice or order, including additional measures installed or planned to reduce or prevent reoccurrence.

1.7 ANNUAL REPORT

The General Permit requires that permittees prepare, certify, and submit an Annual Report no later than September 1 of each year. The Annual Report will be prepared and submitted to NASA's Water Compliance Program Manager. Reporting requirements are identified in Section XVI of the General Permit. Annual reports will be submitted to NASA, in lieu of Storm Water Multiple Applications and Report Tracking System (SMARTS), in accordance with information required by the online forms published by the State Water Board.

Annual reporting requirements from Section XVI of the General Permit that is reflected in the online forms consists of the following:

- All dischargers will prepare and electronically submit an Annual Report no later than September 1 of each year.

- The discharger will retain an electronic or paper copy of each Annual Report for a minimum of 3 years after the date the annual report is filed.

- The discharger will include storm water monitoring information in the Annual Report consisting of:

  - A summary and evaluation of all sampling and analysis results, including copies of laboratory reports;

  - The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as "less than the method detection limit");

  - A summary of all corrective actions taken during the compliance year;

  - Identification of any compliance activities or corrective actions that were not implemented;

  - A summary of all violations of the General Permit;

  - The names of individual(s) who performed the facility inspections, sampling, visual observation (inspections), and/or measurements;

  - The date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation (rain gauge); and

  - The visual observation and sample collection exception records and reports specified in Appendix A.

- The discharger shall provide training information in the Annual Report consisting of:

  - Documentation of all training for individuals responsible for all activities associated with compliance with this General Permit;

  - Documentation of all training for individuals responsible for BMP installation, inspection, maintenance, and repair; and

- Documentation of all training for individuals responsible for overseeing, revising, and amending the SWPPP.

1.8 CHANGES TO PERMIT COVERAGE

The General Permit allows for a reduction or increase in the total acreage covered under the General Permit when a portion of the Project is complete and/or conditions for termination of coverage have been met, when ownership of a portion of the project is purchased by a different entity, or when new acreage is added to the Project. This SWPPP will be amended to reflect the change in acreage within 30 days of a reduction or increase in total disturbed area. The amendments will be included in the Amendment Log. The revised SWPPP will be submitted electronically to NASA in lieu of SMARTS.

1.9 NOTICE OF TERMINATION

The Notice of Termination (NOT) will not be filed in SMARTS because the Site will not be covered under the General Permit.

However, all the following conditions of the NOT will be met:

- Final stabilization has been reached (70 percent final cover as estimated using Revised Universal Soil Loss Equation [RUSLE] method, or other method, as per the General Permit).
- The site does not pose any additional sediment discharge risk from what it posed prior to the commencement of construction activity.
- There is no potential for construction-related storm water pollutants to be discharged into site runoff.
- Construction materials and wastes have been disposed of properly.
- All construction-related equipment, materials, and any temporary BMPs no longer needed are removed from the site.

A NOT, consisting of a final Site Map and representative photographs of the Site that demonstrate that final stabilization has been achieved, will be submitted to NASA within 90 days of completion of construction.

SECTION 2 PROJECT INFORMATION

2.1 PROJECT AND SITE DESCRIPTION

2.1.1 SITE DESCRIPTION

The AOI 14 Project comprises approximately 6 acres of disturbed area, which is approximately 75 percent of the total former soil fill area (FSFA) peninsula. Figure 2, the AOI 14 Site Map, in Appendix B, shows the FSFA. Entry to the FSFA is from south via an access road that meets the North Perimeter Road. The FSFA is surrounded by a SWRP. A silt fence installed in 2013 separates the FSFA from the SWRP. The installation of the silt fence was consulted with U.S. Fish and Wildlife Service (USFWS) to monitor potential impacts to endangered species, habitat, and natural resources present in the area. The removal action within the FSFA consists of additional site characterization using ISM, excavation and off-site disposal of soil and sediment with concentrations of contaminants exceeding cleanup goals, temporary stockpiling of soil with concentrations of contaminants below cleanup goals within the FSFA, and restoration of the excavated areas using stockpiled soil to create appropriate ecological habitat.

Construction debris and fill were placed in the FSFA from 1968 through 1987. Previous investigation results show that lead, pesticides, and total polychlorinated biphenyls (PCB) detected in fill in the northern portion of the FSFA pose potential current and future unacceptable risks to human and ecological receptors. The FSFA is estimated to contain approximately 65,000 cubic yards of artificial fill material and construction debris. The fill will be sampled and analyzed for contaminants. If concentrations exceed cleanup goals (specified in the Action Memorandum for AOI 14; Tetra Tech 2017), the soil and sediment will be disposed of off-site. Soil and sediment with contaminant concentrations less than cleanup goals will remain on site and may be used for final grading. Excavated soil and sediment may be stockpiled within the removal action boundary shown on Figure 2 in Appendix B. No fill material will be imported to the site during the removal action as only stockpiled soil will be used to promote drainage.

2.1.2 PROJECT DESCRIPTION

Project activities include:

- Pre-construction such as: site characterization consisting of a pilot study and full-scale investigation to define the limits of excavation.

- Construction activities such as: excavation of contaminated material, disposal at an off-site facility, and site restoration with regrading.

Site characterization using ISM will be used to characterize soil in excavation units, which are referred to as investigation area grids (IAG) (Figure 3 in Appendix B). Thirty soil borings will be advanced within each IAG (using direct-push technology or hand augers). Samples will be

collected from depth intervals throughout the borings, and these samples will be analyzed for lead, pesticides, and PCBs. The excavation areas, depths, and volumes will be determined based on the results of the site characterization and may include FSFA fill and sediment within the adjacent SWRP. The total volume of material to be excavated will be up to 65,000 (bank) cubic yards, which is based on the results of a geophysical investigation and results of discrete soil samples collected at the FSFA prior to 2016. However, the volume of material to be excavated may vary and will be determined based on the site characterization ISM sampling results. Based on the results of a geophysical investigation conducted in 2016, the artificial fill within the removal action boundary may extend to depths as great as 18 feet below ground surface (bgs) in the northern portion of the site and may be as shallow as 4 feet bgs in the southern portion of the site.

Before the Pilot Study and Full-Scale investigation, an exclusion fence will be installed and vegetation will be removed from the surface of the FSFA and slopes. The exclusion fence will be installed as close to the anticipated work areas as practicable and will extend around the entire FSFA, including the access road and contractor staging/laydown area on the southern end of the FSFA peninsula. This fence will not be higher than 3 feet to prevent raptor perching and will be made of a low-density polyethylene sheeting, such as visqueen, to prevent mice from entering the work area. The sheeting will be buried 4 inches below the ground to prevent burrowing animals from entering the project footprint. Support posts for this fence will face the work area. Vegetation in the work area and within 4 feet of the exclusion fence will be removed to discourage mice from entering the work area. Pickleweed will be removed by hand and in the presence of a USFWS-approved biologist. Prior to excavation activities, the exclusion fence could be relocated based on the anticipated excavation area.

Soil and sediment with contaminant concentrations greater than cleanup goals will be loaded into trucks for off-site disposal. It is assumed that approximately 48,000 (bank) cubic yards will be excavated, sampled, and disposed of at a nonhazardous waste landfill and that approximately 3,000 (bank) cubic yards will require disposal at a hazardous waste landfill. Clean material (with concentrations of contaminants less than cleanup goals) located above contaminated material will be removed and stockpiled for use during regrading after the contaminated material is removed. Based on the results of discrete soil sampling conducted prior to 2016, it is estimated that 11,000 (bank) cubic yards of uncontaminated FSFA soil will be used for grading.

Disturbed areas will be graded during and after excavation for storm water drainage. Bulldozers and road graders will move the temporarily stockpiled clean soil into excavated areas. Final grades will generally be sloped to minimize erosion and maximize the surface area of optimal pickleweed growth (typically from 0.5 to 3.5 feet above mean sea level [amsl]). Clean soil, rock, and other structures that do not pose a human health safety risk will be left in place. Any exposed rebar or other dangerous debris will be removed.

If excavation of sediment from the SWRP is necessary, the sediment will be excavated in a manner that promotes drainage to the extent practicable. Excavated areas within jurisdictional wetlands or waters of the state will not be backfilled.

The volume of clean material that will remain on site after excavation cannot be accurately calculated without the results of the site characterization; therefore, the final grading plan cannot be specified until the site characterization is complete and the final excavation areas are identified. After the excavation areas and volumes are determined based on site characterization results, the Contractor will prepare and submit a final grading plan to NASA Ames for review and approval. The final grading plan will follow these general guidelines:

- The final deposition of fill material will not extend beyond the toe of the slope of the FSFA.

- No material will be placed within the wetland boundary (described in the Removal Action Work Plan [RAWP]; Tetra Tech 2017b).

- Final side slopes will not be greater than 25 percent (1 foot vertical: 4 feet horizontal) unless approved by NASA Ames. If possible, the Contractor will reduce slopes to minimize erosion and maximize the surface area of optimal pickleweed growth. The slopes will be graded to drain storm water on the newly constructed peninsula into the existing storm water pond (minimum 3-percent grade).

- Upland areas will be restored to allow mice and other animals upland refuge during periods of high storm water elevation in the surrounding storm water pond. These upland areas will be connected to the existing upland area in the southern portion of the FSFA. The upland area will be at least 5 feet amsl.

Storm water controls (e.g., fiber rolls) on the slope and the existing silt fence will remain or be replaced when necessary until vegetation is established.

After regrading is finished, protected species habitat will be restored, and general site vegetation will be established as detailed in the RAWP. The final site restoration design will be determined by the extent of the excavation and disturbed areas. To the extent possible, final grades will be consistent with the surrounding storm water ponds, slopes, and uplands.

Due to construction phasing, the use of stockpiling in the southern portion of the removal action boundary is anticipated. Most excavation will occur in northern portion of site where maximum concentrations of contaminants have been detected.

2.1.3 EXISTING CONDITIONS

As of the initial date of this SWPPP, the FSFA is undeveloped, with ground surface elevations varying from approximately 4 feet amsl at the southern end to 11 feet amsl at the northern end of the Site. The FSFA is a former soil fill area with varying groundcover including grasses and low-lying brush. Historical sources of contamination include soil and construction debris contaminated with metals, PCBs, and pesticides.

2.1.4 EXISTING DRAINAGE

The Project is located on a peninsula surrounded by a SWRP to which the Site discharges. Directly adjacent to and north of the retention pond is Jagel Slough. The pond and slough are separated by an impoundment and the Moffett Field Bay Trail. San Francisco Bay lies directly north of Jagel Slough. The slough and the bay are separated by two impoundments. If the slough were to discharge to the bay, it would likely do so at a location with the coordinates 37.446975, -122.056990. Existing Site topography, drainage patterns, and storm water conveyance systems are shown on Figure 4 in Appendix B.

2.1.5 FINAL STABILIZATION

Disturbed areas will be graded during and after excavation for storm water drainage. Bulldozers and road graders will move the temporarily stockpiled clean soil into excavated areas. Final grades will generally be sloped to minimize erosion and maximize the surface area for optimal pickleweed growth (typically from 0.5 to 3.0 feet amsl). Fully biodegradable burlap-wrapped fiber rolls (i.e., not containing any plastic) will be placed at regular intervals on the slope face to aid in erosion prevention. Clean soil, rock, and other structures that do not pose a human health safety risk will be left in place.

The volume of clean material that will remain on site after excavation cannot be accurately calculated without the results of the site characterization; therefore, the final grading plan cannot be specified at this time. However, a proposed final grading plan has been prepared (Figure 5 in Appendix B). The existing silt fence will remain in place until vegetation has been established. To the extent possible, final grades will be consistent with the surrounding SWRP, slopes, and uplands. All regrading work will be performed within the removal action boundaries and not extend into any of the wetlands. Figure 6 in Appendix B shows wetlands at NASA Ames.

After regrading is finished, protected species habitat will be restored by revegetating with native species as specified in the Protected Species Mitigation and Habitat Restoration Plan (PSMHRP). Figures 6 through 8 in Appendix B show protected species' habitat at NASA Ames. The federally protected species (under the Endangered Species Act) are western snowy plover, California least tern, California clapper rail, and salt marsh harvest mouse; state special status and protected species include burrowing owls and California black rail, among others. For a complete list of federal and state protected species, please refer to the PSMHRP.

Restoration may be completed by hand, or a hydroseeder may be used to spray pickleweed seed and indigenous native species over the surface of the regraded soils to create a vegetative cover. Restoration will also include installing container plants that are a mix of commercially available native material and pickleweed that is nursery propagated from material collected on site. The final site restoration design will be determined by the extent of the excavation and disturbed areas. The Contractor will prepare a final site restoration plan and submit it to NASA Ames for review and approval. This plan will include removal of temporary BMPs (any BMPs containing plastic, and rumble plates), exclusion fencing, dumpsters, portable toilets, and construction

materials. Storm water controls (e.g., fiber rolls) on the slope and the existing silt fence will remain or be replaced when necessary until vegetation is established.

2.1.6 GEOLOGY AND GROUNDWATER

The fill at the Site is underlain by clay soil called bay mud. Unconfined water in the fill is separated from deeper underlying groundwater aquifer by the bay mud, which acts as an aquitard. The water table for the unconfined water reflects water levels in the surrounding storm water pond.

Groundwater occurs beneath the Site, below the bay mud, at approximately 13 feet bgs or 5 feet below mean sea level. It is assumed that groundwater flow is generally north toward San Francisco Bay.

2.2 PERMITS AND GOVERNING DOCUMENTS

In addition to the General Permit, the following documents have been taken into account while preparing this SWPPP:

- Regional Water Board requirements
- Federal Endangered Species Act
- State of California Endangered Species Act
- Clean Water Act Section 401, Water Quality Certifications and 404 Permits
- California Code of Regulations Title 22
- CERCLA

2.3 STORM WATER RUN-ON FROM OFFSITE AREAS

There is no anticipated run-on to this Site because the Site is surrounded by an existing SWRP, as shown on Figure 4 in Appendix B.

2.4 FINDINGS OF THE CONSTRUCTION SITE SEDIMENT AND RECEIVING WATER RISK DETERMINATION

A construction site risk assessment has been performed for the Project, and the resultant risk level is Risk Level 1.

Risk level 1 was determined using the following:

- The United States Environmental Protection Agency (EPA) *Rainfall Erosivity Factor Calculator for Small Construction Sites* to determine the R-value.
- SWRCB-provided geographic information system (GIS) layers to determine K [Soil Erodibility Factor] and LS [Slope Length and Steepness Factor] values.
- San Francisco Bay Basin Plan Table 2-1, *Existing and Potential Beneficial Uses of Water Bodies in the San Francisco Bay Region* and 2010 Integrated Report to determine receiving water risk).

Risk level 1 is based on project duration, location, proximity to impaired receiving waters, and soil conditions. Table 2.1 and Table 2.2 summarize the sediment and receiving water risk factors and document the sources of information used to derive the factors. The Sediment Risk for the Site is low for the project time period. The U.S. EPA's Rainfall Erosivity Factor Calculator for Small Construction Sites was used to derive the erosivity value (R value) and the SWRCB's GIS layers were used to determine the soil erodibility factor (K) and slope length factor and slope steepness factors (LS). A site-specific analysis was used to determine Receiving Water Risk. Runoff from the Site discharges into the surrounding SWRP. If the SWRP were to discharge, it would flow to Jagel Slough, and if Jagel Slough were to discharge, it would flow to San Francisco Bay, South (as designated by the 2010 Integrated Report). Jagel Slough has no 303(d) listings or designated beneficial uses. San Francisco Bay, South is not a 303(d)-listed waterbody impaired by sediment and does not have the designed beneficial use of "COLD"[1], as per the San Francisco Bay Basin Plan that includes amendments adopted through May 4, 2017 (Basin Plan); therefore, the Receiving Water Risk is low. The Sediment and Receiving Water Risk analysis is included in Appendix C.

[1] As per the General Permit's Risk Level Determination Worksheet (Appendix 1 of the CGP), a water body must have the beneficial uses of SPAWN *and* MIGRATORY *and* COLD to be a "high" receiving water risk water body. San Francisco Bay, South has the beneficial uses of SPAWN and MIGRATORY, but not COLD and thus, is low receiving water risk.

Table 2.1 Summary of Sediment Risk

RUSLE Factor	Value	Method for Establishing Value
R	42.20	Rainfall Erosivity Factor Calculator, https://www.epa.gov/npdes/rainfall-erosivity-factor-calculator-small-construction-sites#getTool
K	0.24	SWRCB GIS Layer
LS	0.20	SWRCB GIS Layer
Total Predicted Sediment Loss (tons per acre)		**2.0256**
Overall Sediment Risk Low Sediment Risk < 15 tons per acre Medium Sediment Risk >= 15 and < 75 tons per acre High Sediment Risk >= 75 tons per acre		☒ **Low** ☐ **Medium** ☐ **High**

Table 2.2 Summary of Receiving Water Risk

Receiving Water Name	303(d) Listed for Sediment-Related Pollutant(1)	TMDL for Sediment-Related Pollutant(1)	Beneficial Uses of COLD and SPAWN and MIGRATORY(1)
Jagel Slough to San Francisco Bay, South	☐ Yes ☒ No	☐ Yes ☒ No	☐ Yes ☒ No
Overall Receiving Water Risk			☒ **Low** ☐ **High**

1 If "yes" is selected for any option, the Receiving Water Risk is high.

Risk Level 1 sites are subject to narrative effluent limitations only, which require minimizing or preventing pollutants in storm water and authorized non-storm water discharges associated with construction activity through the use of controls, structures, and BMPs. Risk Level 1 sites are not subject to numerical effluent standards.

2.5 CONSTRUCTION SCHEDULE

Construction is anticipated to take place between December 2017 and December 2018. Modification or extension of the schedule (start and end dates) may affect risk determination and General Permit requirements, in which case, this SWPPP and the associated construction site risk assessment will be updated. The detailed schedule for planned work can be found in Appendix D.

2.6 POTENTIAL CONSTRUCTION ACTIVITY AND POLLUTANT SOURCES

Appendix E includes a list of construction activities and associated materials anticipated to be used on site during site characterization and excavation. These activities and associated materials could potentially contribute pollutants, other than sediment, to storm water runoff. The

anticipated activities and associated pollutants were used in Section 3 to select the BMPs for the Project. The locations of anticipated pollutants and associated BMPs are shown on Figures 4 and 5 in Appendix B.

For sampling requirements for non-visible pollutants associated with construction activity, refer to Section 7.7.1. For a complete list of on-site pollutants, refer to the Safety Data Sheets (SDS), which are retained onsite at the construction trailer.

2.7 IDENTIFICATION OF NON-STORM WATER DISCHARGES

Non-storm water discharges consist of discharges that do not originate from precipitation events. The General Permit provides allowances for specified non-storm water discharges that do not cause erosion or carry other pollutants. Non-storm water discharges into storm drainage systems or waterways, which are not authorized under the General Permit and listed in this SWPPP or authorized under a separate NPDES permit, are prohibited. Authorized non-storm water discharges from this project site consist of water used for dust suppression. BMPs are described in Section 3 of this SWPPP.

Activities at this Site that may result in unauthorized non-storm water discharges include spills and leaks from vehicles and equipment, such as fuel, oil, and lubricants. BMPs will be implemented to eliminate or control and dispose of all unauthorized non-storm water discharges. Discharges of construction materials and wastes, such as fuel or paint, resulting from dumping, spills, or direct contact with rainwater or storm water runoff, are prohibited.

2.8 REQUIRED SITE MAP INFORMATION

The Project's Site Maps showing the Project location, surface water boundaries, geographic features, construction site perimeter and general topography, and other requirements identified in Attachment B of the General Permit are provided in Appendix B. Table 2.3 identifies the map or sheet numbers where required elements are illustrated.

Table 2.3 Required Map Information

Included on Map/Plan Sheet No.[1]	Required Element
Figure 1	Project's vicinity
Figure 2	Site layout
Figure 2	Construction site boundaries
Figure 2	Drainage areas
Figures 2 and 4	Discharge locations
Figure 2	Site Map
Figures 3 and 5	Areas of soil disturbance (temporary or permanent)
Figures 3 and 5	Active areas of soil disturbance (cut or fill)
Figures 4 and 5	Locations of runoff BMPs
Figures 4 and 5	Locations of erosion control BMPs
Figures 4 and 5	Locations of sediment control BMPs
N/A	Active Treatment System (ATS) location (if applicable)
Figures 6, 7, and 8	Locations of sensitive habitats, watercourses, or other features that are not to be disturbed
Figure 5	Locations of all post-construction BMPs
Figure 4	Waste storage areas
Figure 4	Vehicle storage areas
Figure 4	Material storage areas
Figure 4	Entrance and Exits
Figure 4	Fueling Locations

1 Figures are located in Appendix B.

SECTION 3 BEST MANAGEMENT PRACTICES

3.1 SCHEDULE FOR BMP IMPLEMENTATION

The schedule for BMP implementation is summarized in Table 3.1.

Table 3.1 BMP Implementation Schedule

	BMP	Implementation	Duration
Erosion Control	EC-1, Scheduling	Prior to construction	Entirety of Project
	EC-2, Preservation of Existing Vegetation	Start of construction	Entirety of Project
	EC-4, Hydroseed	When area will no longer be disturbed	Two weeks after excavation is complete
	EC-15, Slope Roughening	When excavation is complete	End of Project
Sediment Control	SE-1, Silt Fence	Start of construction	Entirety of Project
	SE-5, Fiber Rolls	Upon final grading of slopes	Through final stabilization
	SE-7, Street sweeping	As needed	Throughout duration of project
Tracking Control	TC-1, Stabilized Construction Entrance and Exit	Prior to construction	Entirety of Project
	TC-3, Entrance Outlet Tire Wash	Prior to construction	Entirety of Project
Wind Erosion	WE-1, Wind Erosion Control	Upon soil movement	Entirety of Project
Non-Storm Water BMPs	NS-1, Water conservation practices NS-2, Dewatering Operation NS-5, Clear Water Diversion NS-6, Illicit connection/Discharge NS-9, 10, Vehicle and equipment fueling and maintenance	Beginning of construction	Entirety of Project

	BMP	Implementation	Duration
Temporary Materials Management	WM-01, Material Delivery & Storage WM-07, Contaminated Soil Management WM-09, Sanitary/Septic Waste Management WM-10, Liquid Waste Management	Beginning of construction	Entirety of Project

3.2 EROSION AND SEDIMENT CONTROL

Erosion and sediment controls are required by the General Permit to provide effective reduction or elimination of sediment-related pollutants in storm water discharges and authorized non-storm water discharges from the Site. Applicable BMPs are identified in this section for erosion control, sediment control, tracking control, and wind erosion control.

3.2.1 EROSION CONTROL

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in storm water runoff. Erosion control BMPs protect the soil surface by covering and/or binding soil particles.

The following practices will be implemented during this Project to provide effective temporary and final erosion control during construction:

- Preserve existing vegetation where required and when feasible.
- Control the area of soil-disturbing operations such that the Contractor is able to implement erosion control BMPs quickly and effectively.
- Stabilize non-active areas within 14 days of cessation of construction activities or sooner if stipulated by local requirements.
- Control erosion in concentrated flow paths by applying erosion control blankets, fiber rolls, erosion control seeding, or alternate methods.
- Prior to the completion of construction, apply permanent erosion control to remaining disturbed soil areas.

Sufficient erosion control materials will be maintained on site to allow implementation in conformance with this SWPPP.

The following temporary erosion control BMP selection table, Table 3.2, indicates the BMPs that will be implemented to control erosion on the Site. Fact Sheets for temporary erosion control BMPs are provided in Appendix F.

These temporary erosion control BMPs will be implemented in conformance with the following guidelines and as outlined in the BMP Fact Sheets provided in Appendix F. If there is a conflict between documents, Figure 4, Site Features and Proposed Layout of Best Management Practices (Appendix B) will take precedence over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site-specific details in Figure 4 will take precedence over standard details included in the figure, and the narrative in the body of the SWPPP will take precedence over guidance in the BMP Fact Sheets.

Scheduling

All BMPs will be on site year round. Construction activities will be planned and performed to minimize the area and duration of exposure of soil to erosion by wind, rain, runoff, and vehicle tracking. Grading of the Site will be phased to minimize the total area of exposed soil and duration of exposure.

Preservation of Existing Vegetation

Existing vegetation in undisturbed areas will be preserved to the extent possible.

Hydroseed

Temporary vegetation or seeding will be used on disturbed soil areas as temporary surface cover until soils can be prepared for revegetation and permanent vegetation is established. The vegetative cover seed mixture will be specified in the PSMHRP and Final Site Restoration Plan. If an area is inactive within 14 days of cessation of construction activities such as excavation and grading, temporary or final hydroseeding must be implemented.

Soil Preparation

Slopes will be roughened to the direction of runoff by track walking, sheepsfoot, rolling, imprinting, or other appropriate technique prior to hydroseeding. This action will be implemented in areas inactive for 14 days.

Wind Erosion Control

Plastic covers will be used on stockpiles to prevent wind erosion. The covers will be weighted with gravel bags to prevent them from blowing off. Water will be applied to disturbed areas for dust control.

Table 3.2 Temporary Erosion Control BMPs

CASQA Fact Sheet	BMP Name	Meets a Minimum Requirement[1]	BMP Used		If not used, state reason
			Yes	No	
EC-1	Scheduling	✓	YES		
EC-2	Preservation of Existing Vegetation	✓	YES		
EC-3	Hydraulic Mulch	✓[2]		NO	Hydroseed will be used
EC-4	Hydroseed	✓[2]	YES		
EC-5	Soil Binders	✓[2]		NO	Hydroseed will be used
EC-6	Straw Mulch	✓[2]		NO	Hydroseed will be used
EC-7	Geotextiles and Mats	✓[2]		NO	Not applicable to Project
EC-8	Wood Mulching	✓[2]		NO	Hydroseed will be used
EC-9	Earth Dike and Drainage Swales	✓[3]		NO	Not applicable to Project
EC-10	Velocity Dissipation Devices			NO	Not applicable to Project
EC-11	Slope Drains			NO	Not applicable to Project
EC-12	Stream Bank Stabilization			NO	Not applicable to Project
EC-14	Compost Blankets	✓[2]		NO	Not applicable to Project
EC-15	Soil Preparation-Roughening		YES		
EC-16	Non-Vegetated Stabilization	✓[2]		NO	Not applicable to Project
WE-1	Wind Erosion Control	✓	YES		

1 Applicability to this Project is determined by the QSD.
2 The QSD will verify implementation of one of the minimum measures listed or a combination thereof to achieve and maintain the Risk Level requirements.
3 Run-on from off site will be directed away from all disturbed areas; diversion of off-site flows may require design/analysis by a licensed civil engineer and/or additional environmental permitting.

3.2.2 SEDIMENT CONTROLS

Sediment controls are temporary or permanent structural measures that are intended to complement the selected erosion control measures and reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water. Table 3.3 indicates that BMPs that will be implemented to control sediment on the Site. Fact Sheets for temporary sediment control BMPs are provided in Appendix F.

These temporary sediment control BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix F. If there is a conflict between documents, Figure 4, Site Features and Proposed Layout of Best Management Practices (Appendix B) will take precedence over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in Figure 4 will take precedence over standard details included in the figure, and the narrative in the body of the SWPPP will take precedence over guidance in the BMP Fact Sheets.

Silt Fence

The perimeter of AOI 14 has an existing silt fence to prevent sediment from the FSFA from entering the adjacent storm water retention pond. This silt fence will be maintained and remain on site throughout the duration of the Project.

Sediment Basins

During period of heavy rain, when rumble plates are not sufficient in preventing off-site tracking or when significant contamination is encountered on site, an Entrance/Outlet Tire Wash will be implemented. This BMP will include a drainage ditch and sediment trap.

Fiber Rolls

Burlap-wrapped fiber rolls (no plastic netting-wrapped rolls) will be installed along the toe of the slope, face of the slope, and at grade breaks of the exposed slope.

Street Sweeping

Street sweeping at the nearest paved road to the Site, North Perimeter Road, will be conducted when off-site tracking occurs.

Stabilized Construction Entrance and Exit

Rumble plates will be used at the Site entrance and exit to prevent off-site tracking.

Table 3.3 Temporary Sediment Control BMPs

CASQA Fact Sheet	BMP Name	Meets a Minimum Requirement[1]	BMP Used		If not used, state reason
			Yes	No	
SE-1	Silt Fence	✓[2]	YES		
SE-2	Sediment Basin		YES		
SE-3	Sediment Trap			NO	Not applicable to Project
SE-4	Check Dams			NO	Not applicable to Project
SE-5	Fiber Rolls	✓[2]	YES		
SE-6	Gravel Bag Berm	✓		NO	Fiber rolls used for linear control.
SE-7	Street Sweeping	✓	YES		
SE-8	Sandbag Barrier			NO	Not applicable to Project
SE-9	Straw Bale Barrier			NO	Not applicable to Project
SE-10	Storm Drain Inlet Protection	✓		NO	Not applicable to Project (no storm drain inlets are located in the Project area)
SE-11	ATS			NO	Not applicable to Project
SE-12	Manufactured Linear Sediment Controls			NO	Not applicable to Project
SE-13	Compost Sock and Berm	✓		NO	Fiber rolls used for linear control.
SE-14	Biofilter Bags	✓		NO	Not applicable to Project
TC-1	Stabilized Construction Entrance and Exit	✓	YES		
TC-2	Stabilized Construction Roadway			NO	Not applicable to Project
TC-3	Entrance Outlet Tire Wash		YES		

1 Applicability to this Project is determined by the QSD
2 The QSD will verify implementation of one of the minimum measures listed or a combination thereof to achieve and maintain the Risk Level requirements.

Entrance Outlet Tire Wash

Tire wash will be conducted when rumble plates are not sufficient in preventing off-site tracking or when significant contamination is encountered on site, i.e., when vehicles or machinery have come in contact with known contaminated soil. Wash water will be contained and will not be allowed to discharge to natural areas (including wetlands).

3.3 NON-STORM WATER CONTROLS AND WASTE AND MATERIALS MANAGEMENT

3.3.1 NON-STORM WATER CONTROLS

Non-storm water discharges into storm drainage systems or waterways, which are not authorized under the General Permit, are prohibited. Non-storm water discharges for which a separate NPDES permit is required by the local Regional Water Board are prohibited unless coverage under the separate NPDES permit has been obtained for the discharge. The selection of non-storm water BMPs is based on the list of construction activities with a potential for non-storm water discharges identified in Section 2.7 of this SWPPP. Table 3.4 indicates the BMPs that will be implemented to control sediment on the Site. Fact Sheets for temporary non-storm water control BMPs are provided in Appendix F.

Non-storm water BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix F. If there is a conflict between documents, Figure 4, Site Features and Proposed Layout of Best Management Practices (Appendix B) will take precedence over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in Figure 4 will take precedence over standard details included in the figure, and the narrative in the body of the SWPPP will take precedence over guidance in the BMP Fact Sheets.

Water Conservation Practices

Water conservation practices will be considered when implementing dust suppression controls.

Dewatering Operations

Storm water that falls on the project footprint during excavation activities may accumulate behind the exclusion fence. Water that accumulates within the project footprint will be collected in small sumps, filtered to remove sediment, and pumped with a centrifugal or diaphragm pump into the SWRP or will be containerized and disposed of along with wastewater from the decontamination station if there is any reason to believe the water has come into contact with contaminated soil.

Table 3.4 Temporary Non-Storm Water BMPs

CASQA Fact Sheet	BMP Name	Meets a Minimum Requirement[1]	BMP Used		If not used, state reason
			Yes	No	
NS-1	Water Conservation Practices	✓	YES		
NS-2	Dewatering Operation	✓	YES		
NS-3	Paving and Grinding Operation			NO	Not applicable to Project
NS-4	Temporary Stream Crossing			NO	Not applicable to Project
NS-5	Clear Water Diversion	✓	YES		
NS-6	Illicit Connection/Discharge	✓	YES		
NS-7	Potable Water/Irrigation			NO	Not applicable to Project
NS-8	Vehicle and Equipment Cleaning	✓	YES		
NS-9	Vehicle and Equipment Fueling	✓	YES		
NS-10	Vehicle and Equipment Maintenance	✓	YES		
NS-11	Pile Driving Operation			NO	Not applicable to Project
NS-12	Concrete Curing			NO	Not applicable to Project
NS-13	Concrete Finishing			NO	Not applicable to Project
NS-14	Material and Equipment Use Over Water			NO	Not applicable to Project
NS-15	Demolition Removal Adjacent to Water			NO	Not applicable to Project
NS-16	Temporary Batch Plants			NO	Not applicable to Project

1 Applicability to this Project is determined by the QSD.

Clear Water Diversion

Storm water may accumulate in the SWRP surrounding the FSFA, particularly in the wet season from October through April. Water diversion efforts or temporary dams may be necessary to prevent storm water from entering the project footprint. Water diversion will include a combination of temporary dams and localized dewatering in areas targeted for excavation. Temporary dams may consist of plastic-partition-type (Porta Dam or equal) or bladder-type inflatable dams (Aqua Dam or equal). The temporary dams will be removed as soon as possible when they are no longer required or after excavation and regrading activities are complete.

Illicit Connection/Discharge

Unauthorized (illicit) discharges are prohibited and will be eliminated if observed during construction.

Vehicle and Equipment Cleaning

If necessary during period of rainfall or when significant contamination is present, equipment and vehicles, particularly tires, will be washed with a pressure washer in a designated upland area. Spill prevention kits will be kept in this area for any pollutants encountered during site activities as listed in Appendix E.

Vehicle and Equipment Fueling

Fuel will be kept on site to fuel machinery and generators. Use off-site fueling stations as much as possible. All on-site fueling will take place in designated upland areas only. Drip pans or absorbent pads are required during vehicle and equipment refueling. Spill prevention kits will be kept in the designated fueling areas.

Vehicle and Equipment Maintenance

Basic maintenance for machinery will be conducted on site in designated upland areas only. Use off-site maintenance facilities as much as possible. Drip pans or absorbent pads are required to be used while vehicles and machinery are being repaired or kept on site overnight.

3.3.2 MATERIALS MANAGEMENT AND WASTE MANAGEMENT

Materials management control practices consist of implementing procedural and structural BMPs for handling, storing, and using construction materials to prevent releases of those materials into storm water runoff. The amount and type of construction materials to be used at the Site will depend on the type of construction and length of the construction period. The materials may be used continuously, such as fuel for vehicles and equipment, or the materials may be used for a discrete period, such as soil binders for temporary stabilization. Waste management consists of

implementing procedural and structural BMPs for handling, storing, and ensuring proper disposal of wastes to prevent the release of those wastes into storm water runoff.

The Contractor is responsible for coordinating with the waste disposal vendor to profile or characterize fill material, construction debris, or sediment excavated for disposal. Previous laboratory data from samples collected at AOI 14 will be provided to the Contractor to forward to the waste disposal vendor. Waste materials generated during this Project may include vegetative matter from clearing and grubbing, construction debris removed from AOI 14, contaminated soil, contaminated sediment, contaminated wastewater, and other construction-related debris generated during the removal action. Wastes will be characterized and disposed of in accordance with appropriate regulations under Resource Conservation and Recovery Act (RCRA) and California Code of Regulations Title 22.

The Site will have a designated waste storage area and will be kept clean of litter and waste. Non-hazardous construction wastes will be collected from throughout the Site regularly and deposited at the designated waste storage areas. All waste materials will be removed from the storage areas by the Contractor or a licensed subcontractor on a weekly basis and disposed of or recycled in accordance with all federal, state, and local regulations. Dumpsters will be kept closed at all time except when in active use.

Materials and waste management pollution control BMPs will be implemented to minimize storm water contact with construction materials, wastes, and service areas and to prevent materials and wastes from being discharged off site. The primary mechanisms for storm water contact that will be addressed include:

- Direct contact with precipitation;
- Contact with storm water run-on and runoff;
- Wind dispersion of loose materials;
- Direct discharge to the storm drain system through spills or dumping; and
- Extended contact with some materials and wastes, such as asphalt cold mix and treated wood products, which can leach pollutants into storm water.

A list of construction activities is provided in Section 2.6. Table 3.5 indicates the BMPs that will be implemented to handle materials and control construction site wastes associated with these construction activities. Figure 4 (Appendix B) shows proposed locations for BMPs that will be implemented before and during the work. BMP Fact Sheets for Materials and Waste Management BMPs are provided in Appendix F.

Table 3.5 Temporary Materials Management BMPs

CASQA Fact Sheet	BMP Name	Meets a Minimum Requirement[1]	BMP Used		If not used, state reason
			Yes	No	
WM-01	Material Delivery and Storage	✓	YES		
WM-02	Material Use	✓	YES		
WM-03	Stockpile Management	✓	YES		
WM-04	Spill Prevention and Control	✓	YES		
WM-05	Solid Waste Management	✓	YES		
WM-06	Hazardous Waste Management	✓	YES		
WM-07	Contaminated Soil Management		YES		
WM-08	Concrete Waste Management	✓		NO	Not applicable to project
WM-09	Sanitary-Septic Waste Management	✓	YES		
WM-10	Liquid Waste Management		YES		

1 Applicability to this Project is determined by the QSD.

Material management BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix F. If there is a conflict between documents, Figure 4, Site Features and Proposed Layout of Best Management Practices (Appendix B) will take precedence over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in Figure 4 will take precedence over standard details included in the figure, and the narrative in the body of the SWPPP will take precedence over guidance in the BMP Fact Sheets.

Material Delivery and Storage

The laydown area will be the area designated for material delivery and storage. This area will be in the uplands, away from the SWRP, above elevation 5 feet msl, and properly maintained to be free of litter.

Material Use

Materials used on site will be used in accordance with manufacturers' directions and in a manner to prevent release of pollutants. An up-to-date inventory of materials delivered and stored on site will be kept in the onsite at the construction trailer. All hazardous materials will be stored in covered sealed containers within a bermed area, and the bermed storage area will be covered to prevent contact with storm water.

Stockpile Management

Stockpiles will be covered by soil stabilization measures (e.g., plastic sheeting, erosion control blankets) when not in use and at the end of each day throughout the term of the contract. Plastic sheeting will be used to prevent wind erosion. Stockpiles will be secured with temporary perimeter sediment barriers such as fiber rolls, which will be trenched in and staked.

Spill Prevention and Control

If a spill occurs on site, hosing off the area or burying will never be performed. Any fuel products, lubricating fluids, grease, or other products and/or waste released from the Contractor's vehicles, equipment, or operations will be collected and disposed of immediately in accordance with federal, state, and local laws. Spill cleanup materials will be stored near potential spill areas such as designated fueling areas.

Solid Waste Management

The Site will have a designated waste storage area and will be kept clean of litter and waste. Non-hazardous construction/household-type wastes will be collected from throughout the Site regularly and deposited at the designated waste storage areas. All waste materials will be removed from the storage areas by the Contractor or a licensed subcontractor on a weekly basis

and disposed of or recycled in accordance with all federal, state, and local regulations. Dumpsters will be kept closed except during active use.

Hazardous Waste Management

Hazardous wastes and containers will be placed in a designated hazardous waste storage area that is covered and has an impermeable bottom surface surrounded by secondary containment to minimize the mixing of wastes with storm water and to prevent the direct release of liquid waste to storm water. Wastes will be segregated and recycled where feasible and will not be mixed. Covered waste bins will be designated for disposal of all empty product containers. Universal waste will be handled and disposed of in accordance with applicable local, state, and federal regulations. Employees and subcontractors will be trained on proper storage practices.

Contaminated Soil Management

Contaminated soil and sediment will be transported from NASA Ames using California-licensed waste haulers. All shipments will be traced using the waste manifests signed by NASA Ames. No waste shipment will leave Moffett Field without a NASA-signed manifest. All shipments will be disposed of at waste facilities licensed to accept the waste.

Sanitary-Septic Waste Management

Portable sanitary facilities will be transported to and from the Site by a licensed contractor, placed in a convenient upland location, and maintained in good working order by a licensed service. Untreated wastewater will never be discharged to surface waters or on-site storm drains and will never be buried. Portable toilets will be properly anchored to prevent spills during high wind events and will be equipped with containment trays to capture leaks and wash water.

Liquid Waste Management

Non-sanitary wastewater, such as wastewater from decontamination procedures, will be contained and disposed of according to state, federal, and local regulations.

3.4 POST-CONSTRUCTION STORM WATER MANAGEMENT MEASURES

Post-construction BMPs are permanent measures installed either during or after construction and designed to reduce or eliminate pollutant discharges from the Site after construction is completed. Final grades will generally be sloped to minimize erosion. Storm water BMPs will remain on slopes and the existing silt fence will remain until vegetation is established (see Figure 5 in Appendix B).

The following source control post-construction BMPs to comply with General Permit Section XIII.B and local requirements have been identified for the site:

- EC-4 Hydroseeding
- SE-1 Silt Fence (to be removed upon vegetation establishment)
- SE-5 Filter Rolls (fully biodegradable, burlap-wrapped)

The General Permit requires post-development conditions to replicate the pre-project water balance (for the California General Permit [CGP], defined as the volume of rainfall that ends up as runoff) for the smallest storms up to the 85th percentile storm event (or the smallest storm event that generates runoff, whichever is larger). To provide proof of meeting this criterion, dischargers may either use the Post-Construction Water Balance Performance Standard Spreadsheet (Post-construction Calculator) provided in the CGP or a self-provided watershed process based model. However, standard does not apply to this site. No impervious surfaces will be created as part of this project; therefore, post-remediation runoff will not exceed pre-remediation runoff volume for the 85th percentile storm and no runoff retention BMPs are needed.

SECTION 4 BMP INSPECTION AND MAINTENANCE

The General Permit requires routine weekly inspections of BMPs, along with inspections before, during, and after qualifying rain events. A BMP inspection checklist must be filled out for inspections and maintained on site with the SWPPP. The inspection checklist includes the necessary information covered in Section 7.6. A blank inspection checklist is provided in Appendix G. Completed checklists will be kept in CSMP Attachment 2, Monitoring Records.

BMPs will be maintained regularly for effective functionality. If necessary, corrective actions will be implemented within 72 hours of identified deficiencies, and associated amendments to the SWPPP will be prepared by the QSD. Specific details for maintenance, inspection, and repair of construction site BMPs can be found in the BMP Fact Sheets in Appendix F.

SECTION 5 TRAINING

Appendix H identifies the QSP for the Project. To promote storm water management awareness specific for this Project, periodic training of job-site personnel will be included as part of routine Project meetings (i.e., daily/weekly tailgate safety meetings) or during task-specific training, as needed.

QSPs will be responsible for providing this training at the meetings, and subsequently completing the training logs shown in Appendix H, which identify the site-specific storm water topics covered and include the names of Site personnel who attended the meetings. Tasks may be delegated to trained employees by the QSP provided adequate supervision and oversight is provided. Training will correspond to the specific task delegated, including SWPPP implementation, BMP inspection and maintenance, and record keeping. Documentation of training activities (formal and informal) is retained in SWPPP Appendix H.

SECTION 6 RESPONSIBLE PARTIES AND OPERATORS

6.1 RESPONSIBLE PARTIES

Approved Signatories who have authority to sign permit-related documents are listed below.

The list of approved signatories will be completed by the Contractor and NASA after NASA awards the removal action contract.

Name	Title	Phone Number
To Be Determined (TBD)		
TBD		
TBD		
TBD		

QSPs identified for the project are identified in Appendix I. The QSP will have primary responsibility and significant authority for the implementation, maintenance, and inspection/monitoring of SWPPP requirements. The QSP will be available at all times throughout the duration of the Project. Duties of the QSP include but are not limited to:

- Implementing all elements of the General Permit and SWPPP, including but not limited to:
    - Ensuring that all BMPs are implemented, inspected, and properly maintained;
    - Performing non-storm water and storm water visual observations and inspections;
    - Performing non-storm water and storm water sampling and analysis, as required;
    - Performing routine inspections and observations; and
    - Implementing non-storm water management and materials and waste management activities such as monitoring discharges; general Site clean-up; vehicle and equipment cleaning, fueling, and maintenance; spill control; and ensuring that no materials other than storm water are discharged in quantities that will have an adverse effect on receiving waters or storm drain systems.
- The QSP may delegate these inspections and activities to an appropriately trained employee but will verify the adequacy and adequate deployment.

- Ensuring elimination of unauthorized discharges.

- The QSP will be assigned authority by the LRP to mobilize crews to make immediate repairs to the control measures.

- Coordinate with the Contractor(s) to ensure that all of the necessary corrections/repairs are made immediately and that the Project complies with the SWPPP, General Permit, and approved plans at all times.

- Notifying the LRP or Authorized Signatory immediately of off-site discharges or other non-compliance events.

6.2 CONTRACTOR LIST

Contractors identified for the project will be identified in Appendix J. Each contactor will provide the following contact information.

Contractor information will be completed once removal action contract is awarded.

Contractor

Name:	TBD
Title:	Construction Manager
Company:	TBD
Address:	TBD
Phone Number:	TBD
Number (24/7):	

SECTION 7 CONSTRUCTION SITE MONITORING PROGRAM

7.1 PURPOSE

This CSMP was developed to meet the following objectives:

1. To demonstrate that the Site is in compliance with the Discharge Prohibitions of the Construction General Permit;

2. To determine whether non-visible pollutants are present at the Site and are causing or contributing to exceedances of water quality objectives;

3. To determine whether immediate corrective actions, additional BMP implementation, or SWPPP revisions are necessary to reduce pollutants in storm water discharges and authorized non-storm water discharges; and

4. To determine whether BMPs included in the SWPPP are effective in preventing or reducing pollutants in storm water discharges and authorized non-storm water discharges.

7.2 APPLICABILITY OF PERMIT REQUIREMENTS

This Project has been determined to be a Risk Level 1 project. The following types of monitoring are required:

- Visual inspections of BMPs;

- Sampling and analysis of construction site runoff for non-visible pollutants when applicable;

- Visual monitoring of the Site related to qualifying storm events; and

- Visual monitoring of the Site for non-storm water discharges.

7.3 WEATHER AND RAIN EVENT TRACKING

Visual monitoring, inspections, and sampling requirements of the General Permit are triggered by a qualifying rain event. The General Permit defines a qualifying rain event as any event that produces 0.5 inch of precipitation. A minimum of 48 hours of dry weather will be used to distinguish between separate qualifying storm events.

7.3.1 WEATHER TRACKING

The QSP will consult the National Oceanographic and Atmospheric Administration (NOAA) daily for weather forecasts. These forecasts can be obtained at http://www.srh.noaa.gov/ and scrolling to the bottom of the page to find the Forecast Weather Table Interface, which provides the expected rainfall totals. Weather reports should be printed and maintained with the SWPPP in CSMP Attachment 1, Weather Reports.

7.3.2 RAIN GAUGES

The QSP will install one rain gauge near the Project trailer at the Contractor Trailer Area south of the Site. The gauge will be located in an open area away from obstructions such as trees or overhangs. Mount the gauge on a post at a height of 3 to 5 feet with the gauge extending several inches beyond the post. Make sure that the top of the gauge is level. Make sure that the post is not in an area where rainwater can indirectly splash from sheds, equipment, trailers, etc.

The rain gauge will be read daily during normal Site scheduled hours. The rain gauge will be read at approximately the same time every day, and the date and time of each reading will be recorded. Rain gauge readings will be logged in CSMP Attachment 1, Weather Reports. Follow the rain gauge instructions to obtain accurate measurements. After the rain gauge reading has been recorded, any accumulated rain will be emptied and the gauge reset. For comparison with the Site rain gauge, the nearest appropriate governmental rain gauge is located at Emily Drive and Evandale Avenue, 1.5 miles south of the site.

7.4 MONITORING LOCATIONS

Monitoring locations are shown on Figure 4 included in Appendix B, and monitoring locations are described in Sections 7.6 and 7.7. Whenever changes in the Site might affect the appropriateness of sampling locations, the sampling locations will be revised accordingly. All such revisions will be implemented as soon as feasible and the SWPPP amended. Temporary changes that result in a one-time additional sampling location do not require an SWPPP amendment.

7.5 SAFETY AND MONITORING EXEMPTIONS

Safety practices for sample collection will be in accordance with the Tetra Tech Health and Safety Plan and Contractor's Health and Safety Plan. The following safety requirements apply to sampling personnel at the Site during removal action activities:

- Heat and cold stress
- Sun exposure

- Slips, trips, and falls
- High noise
- Driving personal vehicles
- Injury and Illness Prevention Program

This Project is not required to collect samples or conduct visual observations (inspections) under the following conditions:

- During dangerous weather conditions such as flooding and electrical storms.
- Outside of scheduled Site business hours.

Scheduled Site business hours are typically Monday through Friday from 7 am to 6 pm (during daylight hours only; hours may differ depending on the season). If monitoring (visual monitoring or sample collection) of the Site is unsafe because of the dangerous conditions noted above, the QSP will document the conditions for why an exception to performing the monitoring was necessary. The exemption documentation will be filed in CSMP Attachment 2, Monitoring Records.

7.6 VISUAL MONITORING

Visual monitoring includes observations and inspections. Inspections of BMPs are required to identify and record BMPs that need maintenance to operate effectively, that have failed, or that could fail to operate as intended. Visual observations of the Site are required to observe storm water drainage areas to identify any spills, leaks, or uncontrolled pollutant sources. Table 7.1 identifies the required frequencies of visual observations and inspections. Inspections and observations will be conducted at the locations identified in Section 7.6.5.

7.6.1 ROUTINE OBSERVATIONS AND INSPECTIONS

Routine site inspections and visual monitoring are necessary to verify that the Project is in compliance with the requirements of the Construction General Permit.

Table 7.1 Summary of Visual Monitoring and Inspections

Type of Inspection	Frequency
Routine Inspections	
BMP Inspections	Weekly[(1)]
BMP Inspections – Tracking Control	Daily
Non-Storm Water Discharge Observations	Quarterly, during daylight hours
Rain Event-Triggered Inspections	
Site Inspections Prior to a Qualifying Event	Within 48 hours of a qualifying event (predicted at 50 percent or greater)[2]
BMP Inspections During an Extended Storm Event	Every 24-hour period of a qualifying rain event (produces 0.5 inch or more precipitation with a 48-hour or greater period between rain events)
Inspection of Stored or Contained Storm water	At the time of discharge from a qualifying storm event (produces 0.5 inch or more of precipitation with a 48 hour or greater period between rain events)
Site Inspections Following a Qualifying Event	Within 48 hours of a qualifying event (produces 0.5 inch or more of precipitation with a 48-hour or greater period between rain events)

1 Most BMPs must be inspected weekly; tracking control BMPs must be inspected more frequently than weekly.
2 Inspections are required during scheduled Site operating hours.

7.6.1.1 Routine BMP Inspections

Inspections of BMPs are conducted to identify and record:

- BMPs that are properly installed;
- BMPs that need maintenance to operate effectively;
- BMPs that have failed; or
- BMPs that could fail to operate as intended.

7.6.1.2 Non-Storm Water Discharge Observations

Each drainage area will be inspected for the presence or indications of prior unauthorized and authorized non-storm water discharges. Inspections will record:

- Presence or evidence of any non-storm water discharge (authorized or unauthorized);
- Pollutant characteristics (floating and suspended material, sheen, discoloration, turbidity, odor, etc.); and
- Source of discharge.

7.6.2 RAIN EVENT-TRIGGERED OBSERVATIONS AND INSPECTIONS

A qualifying rain event is any event that produces 0.5 inch or more of precipitation with a 48-hour or greater period between rain events. Visual observations of the Site and inspections of BMPs are required prior to a qualifying rain event, following a qualifying rain event, and every 24-hour period during a qualifying rain event. Pre-rain inspections will be conducted after consulting the NOAA Forecast Weather Table Interface and determining that a precipitation event with a 50-percent or greater probability of precipitation has been predicted.

7.6.2.1 Visual Observations Prior to a Forecasted Qualifying Rain Event

Within 48 hours prior to a qualifying rain event, a visual monitoring site inspection will include observations of the following:

- Storm water drainage areas, to identify any spills, leaks, or uncontrolled pollutant sources;
- BMPs, to identify if they have been properly implemented; and
- Any storm water storage and containment areas, to detect leaks and verify maintenance of adequate freeboard.

7.6.2.2 BMP Inspections during an Extended Storm Event

During an extended qualifying rain event, BMP inspections will be conducted to identify and record:

- BMPs that are properly installed;

- BMPs that need maintenance to operate effectively;
- BMPs that have failed; or
- BMPs that could fail to operate as intended.

If the Site is not accessible during the rain event, the visual inspections will be performed at all relevant outfalls, discharge points, and downstream locations. The inspections will record any projected maintenance activities.

7.6.2.3 Visual Observations Following a Qualifying Rain Event

Within 48 hours following a qualifying rain event, a visual monitoring site inspection is required to observe:

- Storm water drainage areas, to identify any spills, leaks, or uncontrolled pollutant sources;
- BMPs, to identify if they have been properly designed, implemented, and effective;
- Need for additional BMPs;
- Any storm water storage and containment areas, to detect leaks and verify maintenance of adequate freeboard; and
- Discharge of stored or contained rain water.

7.6.3 VISUAL MONITORING PROCEDURES

Visual monitoring will be conducted by the QSP or staff trained by and under the supervision of the QSP. The names and contact numbers of the Site visual monitoring personnel are listed below, and their training qualifications are provided in Appendix H.

Assigned inspector: QSP #1 Contact phone: TBD

Alternate inspector: QSP #2 Contact phone: TBD

Storm water observations will be documented on the *Visual Inspection Field Log Sheet* (see CSMP Attachment 3, Example Forms). BMP inspections will be documented on the site-specific BMP inspection checklist. Any photographs used to document observations will be referenced on storm water site inspection report and maintained with the Monitoring Records in

CSMP Attachment 2. Within 24 hours of each inspection, the QSP will submit electronic copies of the completed inspection report to NASA Ames. The completed reports will be kept in CSMP Attachment 2, Monitoring Records.

7.6.4 VISUAL MONITORING FOLLOW-UP AND REPORTING

Correction of deficiencies identified via observations or inspections, including required repairs or maintenance of BMPs, will be initiated and completed as soon as possible. If identified deficiencies require design changes, including additional BMPs, implementation of these changes will be initiated within 72 hours of identification and completed as soon as possible. When design changes to BMPs are required, the SWPPP will be amended to reflect the changes.

Deficiencies identified in site inspection reports and correction of deficiencies will be tracked on the *Inspection Field Log Sheet* or *BMP Inspection Report* and will be submitted to the QSP and kept in CSMP Attachment 2, Monitoring Records. Within 24 hours of the inspection, the QSP will submit copies of the completed *Inspection Field Log Sheet* or *BMP Inspection Report* with the corrective actions to the QSD. Results of visual monitoring must be summarized and reported in the Annual Report.

7.6.5 VISUAL MONITORING LOCATIONS

The inspections and observations identified in Sections 7.6.1 and 7.6.2 will be conducted at the locations identified in this section. BMP locations are shown on the Site Maps in Appendix B.

There are four separate locations to monitor storm water discharge from the Site. These locations reflect areas around the existing site perimeter where the majority of storm water runoff currently discharges from the FSFA into the SWRP. Storm water drainage flow arrows are shown on Figure 4 in Appendix B, and Table 7.2 that identifies each drainage area by sample location.

Table 7.2 Site Drainage Areas

Location No.	Location
1	Northeast end of site
2	Southeast end of site
3	West side of site
4	Near Gate 16C Site Entry/Exit

Each Contractor staging and laydown area has sampling points to monitor discharge (Figure 4). Site storm water discharge sample locations are shown on Figure 4 in Appendix B, and Table 7.3 identifies each storm water discharge location.

Table 7.3 Contractor Staging/Laydown Discharge Locations

Location No.	Location
4	Near Gate 16C Site Entry/Exit
5	Southeast corner of staging area, east of Gate 16A
6	Northwest corner of staging area, near Gate 16A

7.7 WATER QUALITY SAMPLING AND ANALYSIS

7.7.1 SAMPLING AND ANALYSIS PLAN FOR NON-VISIBLE POLLUTANTS IN STORM WATER RUNOFF DISCHARGES

This Sampling and Analysis Plan for Non-Visible Pollutants describes the sampling and analysis strategy and schedule for monitoring non-visible pollutants in storm water runoff discharges from the Site. Sampling for non-visible pollutants will be conducted when (1) a breach, leakage, malfunction, or spill is observed, (2) the leak or spill has not been cleaned up prior to a rain event, and (3) there is the potential for discharge of non-visible pollutants to surface waters or the drainage system.

The only construction materials, wastes, or activities, as identified in Section 2.6 and Appendix E, as a potential sources of non-visible pollutants to storm water discharges from the Project is sanitary waste. Sanitary waste areas are shown on Figure 4 in Appendix B.

Soil contaminated with PCBs, pesticides, and metal, as identified in Section 2.6 and Appendix E, are potential sources of non-visible pollutants to storm water discharges from the Project. Locations of existing Site features contaminated with non-visible pollutants are shown on the Site Maps in Appendix B.

7.7.1.1 Sampling Schedule

Samples collected for field measurements and chemical analysis of the potential non-visible pollutants and a sufficiently large unaffected background sample will be collected during the first 2 hours of discharge from rain events that result in a sufficient discharge for sample collection. Samples will be collected during the Site's scheduled working hours and will be collected regardless of the time of year and phase of the construction. Collection of discharge samples for non-visible pollutant monitoring will be triggered when any of the following conditions are observed during site inspections conducted prior to or during a rain event.

- Materials or wastes containing potential non-visible pollutants are not stored under watertight conditions. Watertight conditions are defined as (1) storage in a watertight container, (2) storage under a watertight roof or within a building, or (3) protected by

temporary cover and containment that prevents storm water contact and runoff from the storage area.

- Materials or wastes containing potential non-visible pollutants are stored under watertight conditions, but (1) a breach, malfunction, leakage, or spill is observed, (2) the leak or spill is not cleaned up prior to the rain event, and (3) there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

- A construction activity, including but not limited to those in Section 2.6 and Appendix E, with the potential to contribute non-visible pollutants (1) was occurring during or within 24 hours prior to the rain event, (2) BMPs were observed to be breached, malfunctioning, or improperly implemented, and (3) there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

- Soil amendments that have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil have been applied, and there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

- Storm water runoff from an area contaminated by historical usage of the Site has been observed to combine with storm water runoff from the Site, and there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

7.7.1.2 Sampling Locations

Sampling locations are based on proximity to planned non-visible pollutant storage, occurrence or use; accessibility for sampling, and personnel safety. They will be selected in the field based on the location of the breach/malfunction/leak. However, potential locations have been pre-selected based on locations where non-visible pollutants will be stored/handled, and these locations are listed in Tables 7.4 through 7.6 and shown on Figure 4 in Appendix B.

Three sample locations at the Contractor Staging and Laydown Areas (Table 7.4), and three sampling locations on the FSFA (Table 7.5) have been identified for the collection of samples of runoff from planned material and waste storage areas and areas where non-visible pollutant-producing construction activities are planned. Figure 4 shows the directions of existing surface water runoff from contractor staging/laydown areas and areas where constructions activities are planned, and where runoff samples will be collected.

Table 7.4 Potential Non-Visible Pollutant Sample Locations – Contractor Yard

Sample Location Number	Sample Location Description	Sample Coordinates (Decimal Degrees)
4	Near Gate 16C Site Entry/Exit	37.42793342320 -122.06346753300
5	Southeast corner of staging area, east of Gate 16A	37.42685667110 -122.05940503900
6	Northwest corner of staging area, near Gate 16A	37.42739307640 -122.06039851300

Table 7.5 Potential Non-Visible Pollutant Sample Locations – Areas of Historical Contamination

Sample Location Number	Sample Location	Sample Coordinates (Decimal Degrees)
1	Northeast end of site	37.43133874070 -122.06316129800
2	Southeast end of site	37.43021900000 -122.06300000000
3	Southwest end of Site	37.43000760890 -122.06422179100

Sample location 6 has been identified for the collection of samples of background runoff (see Table 7.6). No run-on to the project site is anticipated because the Site (FSFA) will be at the highest elevation and surrounded by the SWRP throughout construction.

Sampling location 6 also has been identified for the collection of an uncontaminated sample of runoff as a background samples for comparison with samples being analyzed for non-visible pollutants from the contractor laydown/staging areas (see Table 7.6). Run-off has the potential to combine with discharges from the site that are being sampled for non-visible pollutants. This location was selected such that the sample point will not come in contact with the operations, activities, or with disturbed soils areas.

If a storm water visual monitoring site inspection conducted prior to or during a storm event identifies the presence of a material storage, waste storage, or operations area with spills or the potential for the discharge of non-visible pollutants to surface waters or a storm drain system that is at a location not listed above and has not been identified on the Site Maps, sampling locations will be selected by the QSP using the same rationale as that used to identify planned locations. Non-visible pollutant sampling locations will be identified by the QSP on the pre-rain event inspection form prior to a forecasted qualifying rain event.

Table 7.6 Non-Visible Pollutant Sample Locations – Background (Unaffected Sample)

Sample Location Number	Sample Location	Sample Coordinates (Decimal Degrees)
6	Northeast of Gate 16A	37.42739307640 -122.06039851300

7.7.1.3 Monitoring Preparation

Non-visible pollutant samples will be collected by:

Contractor ☒ Yes ☐ No

Consultant ☐ Yes ☒ No

Laboratory ☐ Yes ☒ No

Samples on the Site will be collected by the following Contractor sampling personnel:

Name(s)/Telephone Number(s): TBD

Alternate(s)/Telephone Number: TBD

An adequate stock of monitoring supplies and equipment for monitoring non-visible pollutants will be available on the Site prior to a sampling event. Monitoring supplies and equipment will be stored in a cool temperature environment that will not come into contact with rain or direct sunlight. Sampling personnel will be available to collect samples in accordance with the sampling schedule. Supplies maintained at the Site will include, but are not limited to, clean powder-free nitrile gloves, sample collection equipment, coolers, appropriate number and volume of sample bottles, identification labels, re-sealable storage bags, paper towels, personal rain gear, ice, and *Effluent Sampling Field Log Sheets* and Chain of Custody (CoC) forms, which are provided in CSMP Attachment 3, Example Forms.

7.7.1.4 Analytical Constituents

Table 7.7 lists the specific sources and types of potential non-visible pollutants at the Site and the associated water quality indicator constituents for those pollutants.

Table 7.7 Potential Non Visible Pollutants and Water Quality Indicator Constituents

Pollutant Source[1]	Pollutant	Water Quality Indicator Constituent
On-site soil	PCBs, pesticides, and metals	PCBs, lead, and nutrients
Contaminated soil	PCBs, metals, and pesticides	PCBs, lead, nutrients
Portable toilets	Sanitary waste	Biochemical oxygen demand (BOD), total fecal coliform
Vehicle and equipment use	Batteries	Sulfuric acid, lead, and pH

1 Fuel is not listed as a non-visible pollutant because it creates a sheen and is therefore visible.

7.7.1.5 Sample Collection

Samples of discharge will be collected at the designated non-visible pollutant sampling locations shown on the Site Maps in Appendix B or in the locations determined by observed breaches, malfunctions, leakages, spills, operational areas, soil amendment application areas, and historical Site usage areas that triggered the sampling event.

Grab samples will be collected and preserved in accordance with the methods identified in Table 7.8. Only the QSP, or personnel trained in water quality sampling under the direction of the QSP will collect samples.

Sample collection and handling requirements are described in Section 7.7.5.

7.7.1.6 Sample Analysis

Samples will be analyzed for constituents listed in Table 7.8. The analytical methods and sample delivery method will be updated upon identifying a laboratory for sample analysis.

Samples will be analyzed by:

Laboratory Name: TBD

Street Address:

City, State, Zip:

Telephone Number:

Point of Contact:

Environmental Laboratory Accreditation Program (ELAP) Certification Number:

Table 7.8 Sample Collection, Preservation, and Analysis for Monitoring Non Visible Pollutants

Constituent	EPA Method Number	Minimum Sample Volume	Sample Container	Sample Preservation	Reporting Limit	Maximum Holding Time
Pesticides	8141,8081	1,000 mL	Glass	4°C	0.5 to 1 µg/L	7 days
pH	150.1	50 mL	Polypropylene	N/A	+/- 0.1	As soon as possible
BOD	5210B	1 L	Plastic	4°C	2 mg/L	48 hours
Total coliform	9221B	50 mL	Polypropylene	$Na_2S_2O_3$	1 MPN/100 mL	6 hours
PCBs	8082A	1 L	Glass (amber)	Store at 4 +/- 2°C	0.5 to 1 µg/L	7 days
Dissolved metals	200.8	250 mL	Polypropylene	HNO_3 or H_2SO_4	0.2 to 5 µg/L	48 hours

Notes:
°C – degrees Celsius
µg/L – microgram per liter
L - liter
mg/L – milligram per liter
mL – milliliter
MPN – most probable number

Samples at the Site will be delivered to the laboratory by:

Driven by Contractor	☐ Yes	☐ No
Picked up by Laboratory Courier	☐ Yes	☐ No
Shipped	☐ Yes	☐ No

7.7.1.7 Data Evaluation and Reporting

The QSP shall complete an evaluation of the water quality sample analytical results.

Runoff/downgradient results shall be compared with the associated upgradient/unaffected results and any associated run-on results. Should the runoff/downgradient sample show an increased level of the tested analyte relative to the unaffected background sample, which cannot be explained by run-on results, the BMPs, site conditions, and surrounding influences shall be assessed to determine the probable cause for the increase.

As determined by the site and data evaluation, appropriate BMPs shall be repaired or modified to mitigate discharges of non-visible pollutant concentrations. Any revisions to the BMPs shall be recorded as an amendment to the SWPPP.

The General Permit prohibits the storm water discharges that contain hazardous substances equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4. The results of any non-storm water discharge results that indicate the presence of a hazardous substance in excess of established reportable quantities shall be immediately reported to NASA.

Results of non-visible pollutant monitoring shall be reported in the Annual Report, which will be submitted to NASA Ames.

7.7.2 Sampling and Analysis Plan for Non-Storm Water Discharges

This Sampling and Analysis Plan for non-storm water discharges describes the sampling and analysis strategy and schedule for monitoring pollutants in authorized and unauthorized non-storm water discharges from the Site in accordance with the requirements of the Construction General Permit.

Sampling of non-storm water discharges will be conducted when an authorized or unauthorized non-storm water discharge is observed discharging from the Site. In the event that non-storm water discharges run-on to the Site from offsite locations, and this run-on has the potential to contribute to a violation of the General Permit, the run-on will also be sampled.

Water from dust suppression is an authorized non-storm water discharges identified in Section 2.7 that has the potential to be discharged from the Site.

In addition to the above authorized storm water discharge (water from dust suppression), some construction activities have the potential to result in an unplanned (unauthorized) non-storm water discharge if BMPs fail. These activities include:

- Fueling activities
- Leaks from vehicles and equipment
- Construction waste
- Tire wash

7.7.2.1 Sampling Schedule

Samples of authorized or unauthorized non-storm water discharges will be collected when they are observed.

7.7.2.2 Sampling Locations

Samples will be collected from the discharge points where the non-storm water discharge is running off the FSFA and contractor staging/laydown areas into the SWRP. Site discharge locations are shown on Figure 4 in Appendix B and include the sample locations identified below.

Three sampling locations on the FSFA and three samples locations on the Contractor Staging and Laydown Areas have been identified for the collection of samples of runoff from planned material and waste storage areas and areas where non-storm water-producing construction activities are planned. Table 7.9 identifies sampling locations at the Site and in the Contractor's Staging/Laydown Areas where non-storm water discharges may runoff from the Site.

Table 7.9 Non Storm Water Discharge Sample Locations

Sample Location Number	Sample Location	Sample Coordinates (Decimal Degrees)
1	Northeast end of site	37.43133874070 -122.06316129800
2	Southeast end of site	37.43021900000 -122.06300000000
3	Southwest end of Site	37.43000760890 -122.06422179100
4	Near Gate 16C Site Entry/Exit	37.42793342320 -122.06346753300
5	Southeast corner of staging area, east of Gate 16A	37.42685667110 -122.05940503900
6	Northwest corner of staging area, near Gate 16A	37.42739307640 -122.06039851300

This site does not have non-storm water run-on.

7.7.2.3 Monitoring Preparation

Non-storm water discharge samples will be collected by:

Contractor ☒ Yes ☐ No

Consultant ☐ Yes ☒ No

Laboratory ☐ Yes ☒ No

Samples at the Site will be collected by the following Contractor sampling personnel:

Name/Telephone Number: TBD

Alternate(s)/Telephone Number:

An adequate stock of monitoring supplies and equipment for monitoring non-storm water discharges will be available on the Site. Monitoring supplies and equipment will be stored in a cool temperature environment that will not come into contact with rain or direct sunlight. Personnel trained in sampling will be available to collect samples in accordance with the sampling schedule. Supplies maintained at the Site will include, but are not limited to, clean powder-free nitrile gloves, sample collection equipment, field meters, coolers, appropriate

number and volume of sample bottles, identification labels, re-sealable storage bags, paper towels, personal rain gear, ice, and *Effluent Sampling Field Log Sheets* and CoC forms provided in CSMP Attachment 3, Example Forms.

7.7.2.4 Analytical Constituents

All non-storm water discharges that flow through a disturbed area will, at minimum, be monitored for turbidity and pH. The QSP will identify additional pollutants to be monitored for each non-storm water discharge incident based on the source of the non-storm water discharge. If the source of an unauthorized non-storm water discharge is not known, monitoring for pH, turbidity, methylene blue active substances assay (MBAS), total organic carbon (TOC), and residual chlorine or chloramines is recommended to help identify the source of the discharge.

Non-storm water discharge run-on will be monitored, at minimum, for pH and turbidity. The QSP will identify additional pollutants to be monitored for each non-storm water discharge incident based on the source of the non-storm water discharge. If the source of an unauthorized non-storm water discharge is not known, monitoring for pH, turbidity, MBAS, total organic carbon TOC, and residual chlorine or chloramines is recommended to help identify the source of the discharge. Table 7.10 lists the specific sources and types of potential non-visible pollutants on the Site and the water quality indicator constituent(s) for that pollutant.

Table 7.10 Potential Non Storm Water Discharge Pollutants and Water Quality Indicator Constituents

Pollutant Source	Pollutant	Water Quality Indicator Constituent
Wheel wash	Sediment	Turbidity
Fueling activities	Fuel	Total Petroleum Hydrocarbons (TPH), oil, and grease
Water from dust suppressing activities	Runoff/sediment	Turbidity

7.7.2.5 Sample Collection

Samples will be collected at the discharge locations where the non-storm water discharge is leaving the Site and Contractors Staging/Laydown areas. Potential discharge locations are shown on the Site Maps in Appendix B and identified in Section 7.7.2.2. Grab samples will be collected and preserved in accordance with the methods identified in Table 7.11. Only personnel trained in water quality sampling under the direction of the QSP will collect samples. Sample collection and handling requirements are described in Section 7.7.5.

Table 7.11 Sample Collection, Preservation and Analysis for Monitoring Pollutants in Non-Storm Water Discharges

Constituent	EPA Method Number	Minimum Sample Volume	Sample Bottle	Sample Preservation	Reporting Limit	Maximum Holding Time
Oil and grease	1664	1 L	Glass	H_2SO_4	5 mg/L	28 days
TPH	8015b	1 L	Glass	4°C	50 g/L	14 days
Turbidity	180.1	100 mL	Glass	4°C	0.6 NTU	N/A

Notes:
°C – degrees Celsius
g/L –gram per liter
L - liter
mg/L – milligram per liter
mL – milliliter
NTU - Nephelometric Turbidity Units

7.7.2.6 Sample Analysis

Samples will be analyzed using the analytical methods identified in Table 7.11.

7.7.2.7 Data Evaluation and Reporting

The QSP will complete an evaluation of the water quality sample analytical results. Runoff results will be evaluated for the constituents suspected in the non-storm water discharge. Should the runoff sample indicate the discharge of a pollutant that cannot be explained by prior interim silt fence results, any run-on results, the BMPs, site conditions, and surrounding influences will be assessed to determine the probable cause for the increase.

As determined by the Site and data evaluation, appropriate BMPs will be repaired or modified to mitigate discharges of non-visible pollutant concentrations. Any revisions to the BMPs will be recorded as an amendment to the SWPPP. Non-storm water discharge results will be submitted to NASA with the Annual Report. The General Permit prohibits the non-storm water discharges that contain hazardous substances equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4. The results of any non-storm water discharge results that indicate the presence of a hazardous substance in excess of established reportable quantities will be immediately reported to NASA.

7.7.3 Sampling and Analysis Plan for Other Pollutants Required by the Regional Water Board

The Regional Water Board has not specified monitoring for additional pollutants.

7.7.4 Training of Sampling Personnel

Sampling personnel will be trained to collect, maintain, and ship samples in accordance with the Surface Water Ambient Monitoring program (SWAMP) 2008 Quality Assurance Program Plan (QAPrP). Training records of designated Contractor sampling personnel are provided in Appendix H. The contractor personnel information will be completed once a removal action contractor is chosen. The contractor will be conducting the sampling activities.

The storm water sampler(s) and alternate(s) have received the following storm water sampling training:

Name	Training
	INSERT LIST OF TRAINING COURSES
	INSERT LIST OF TRAINING COURSES

The storm water sampler(s) and alternates have the following storm water sampling experience:

Name	Experience
	INSERT LIST OF STORMWATER SAMPLING EXPERIENCE
	INSERT LIST OF STORMWATER SAMPLING EXPERIENCE

7.7.5 SAMPLE COLLECTION AND HANDLING

7.7.5.1 Sample Collection

Samples will be collected at the designated sampling locations shown on the Site Maps in Appendix B and listed in the preceding sections. Samples will be collected, maintained and shipped in accordance with the SWAMP 2008 QAPrP. Grab samples will be collected and preserved in accordance with the methods identified in preceding sections. To maintain sample integrity and prevent cross-contamination, sample collection personnel will follow the protocols below.

- Collect samples (for laboratory analysis) only in analytical laboratory-provided sample containers;
- Wear clean, powder-free nitrile gloves when collecting samples;
- Change gloves whenever something not known to be clean has been touched;
- Change gloves between sites;
- Decontaminate all equipment (e.g., bucket, tubing) prior to sample collection using a trisodium phosphate water wash, distilled water rinse, and final rinse with distilled water. (Dispose of wash and rinse water appropriately, i.e., do not discharge to storm drain or receiving water). Do not decontaminate laboratory provided sample containers;
- Do not smoke during sampling events;
- Never sample near a running vehicle;
- Do not park vehicles in the immediate sample collection area (even non-running vehicles);

- Do not eat or drink during sample collection; and

- Do not breathe, sneeze, or cough in the direction of an open sample container.

The most important aspect of grab sampling is to collect a sample that represents the entire runoff stream. Typically, samples are collected by dipping the collection container in the runoff flow paths and streams as noted below.

- For small streams and flow paths, simply dip the bottle facing upstream until full.

- For larger stream that can be safely accessed, collect a sample in the middle of the flow stream by directly dipping the mouth of the bottle. Once again making sure that the opening of the bottle is facing upstream as to avoid any contamination by the sampler.

- For larger streams that cannot be safely waded, pole-samplers may be needed to safely access the representative flow.

- Avoid collecting samples from ponded, sluggish or stagnant water.

- Avoid collecting samples directly downstream from a bridge as the samples can be affected by the bridge structure or runoff from the road surface.

Note that depending upon the specific analytical test, some containers may contain preservatives. These containers should **never** be dipped into the stream, but filled indirectly from the collection container.

7.7.5.2 Sample Handling

Turbidity and pH measurements must be conducted immediately. Do not store turbidity or pH samples for later measurement.

Samples for laboratory analysis must be handled as follows. Immediately following sample collection:

- Cap sample containers;

- Complete sample container labels;

- Sealed containers in a re-sealable storage bag;

- Place sample containers into an ice-chilled cooler;

- Document sample information on the *Effluent Sampling Field Log Sheet*; and

- Complete the CoC.

All samples for laboratory analysis must be maintained between 0-6 degrees Celsius during delivery to the laboratory. Samples must be kept on ice, or refrigerated, from sample collection through delivery to the laboratory. Place samples to be shipped inside coolers with ice. Make sure the sample bottles are well packaged to prevent breakage and secure cooler lids with packaging tape.

Ship samples that will be laboratory analyzed to the analytical laboratory right away. Hold times are measured from the time the sample is collected to the time the sample is analyzed. The General Permit requires that samples be received by the analytical laboratory within 48 hours of the physical sampling (unless required sooner by the analytical laboratory).

Laboratory Name:

Address:

City, State, Zip:

Telephone Number:

Point of Contact:

7.7.5.3 Sample Documentation Procedures

All original data documented on sample bottle identification labels, *Effluent Sampling Field Log Sheet*, and CoCs will be recorded using waterproof ink. These will be considered accountable documents. If an error is made on an accountable document, the individual will make corrections by lining through the error and entering the correct information. The erroneous information will not be obliterated. All corrections will be initialed and dated.

Duplicate samples will be identified consistent with the numbering system for other samples to prevent the laboratory from identifying duplicate samples. Duplicate samples will be identified in the Effluent Sampling Field Log Sheet.

Sample documentation procedures include the following:

<u>Sample Bottle Identification Labels:</u> Sampling personnel will attach an identification label to each sample bottle. Sample identification will uniquely identify each sample location.

<u>Field Log Sheets:</u> Sampling personnel will complete the *Effluent Sampling Field Log Sheet* and *Receiving Water Sampling Field Log Sheet* for each sampling event, as appropriate.

Chain of Custody: Sampling personnel will complete the CoC for each sampling event for which samples are collected for laboratory analysis. The sampler will sign the CoC when the sample(s) is turned over to the testing laboratory or courier.

7.8 QUALITY ASSURANCE AND QUALITY CONTROL

An effective Quality Assurance and Quality Control (QA/QC) plan will be implemented as part of the CSMP to verify that analytical data can be used with confidence. QA/QC procedures to be initiated include the following:

- Field logs;
- Clean sampling techniques;
- CoCs;
- QA/QC Samples; and
- Data verification.

Each of these procedures is discussed in more detail in the following sections.

7.8.1 FIELD LOGS

The purpose of field logs is to record sampling information and field observations during monitoring that may explain any uncharacteristic analytical results. Sampling information to be included in the field log include the date and time of water quality sample collection, sampling personnel, sample container identification numbers, and types of samples that were collected. Field observations should be noted in the field log for any abnormalities at the sampling location (color, odor, BMPs, etc.). Field measurements for pH and turbidity should also be recorded in the field log. A Visual Inspection Field Log, an Effluent Sampling Field Log Sheet are included in CSMP Attachment 3, Example Forms.

7.8.2 CLEAN SAMPLING TECHNIQUES

Clean sampling techniques involve the use of certified clean containers for sample collection and clean powder-free nitrile gloves during sample collection and handling. As discussed in Section 7.7.5, adoption of a clean sampling approach will minimize the chance of field contamination and questionable data results.

7.8.3 CHAIN OF CUSTODY

The sample CoC is an important documentation step that tracks samples from collection through analysis to verify the validity of the sample. Sample CoC procedures include the following:

- Proper labeling of samples;
- Use of CoC forms for all samples; and
- Prompt sample delivery to the analytical laboratory.

Analytical laboratories usually provide CoC forms to be filled out for sample containers. An example CoC is included in CSMP Attachment 3, Example Forms.

7.8.4 QA/QC SAMPLES

QA/QC samples provide an indication of the accuracy and precision of the sample collection; sample handling; field measurements; and analytical laboratory methods. The following types of QA/QC will be conducted for this project:

☒ Field duplicates at a frequency of 5 percent or one duplicate minimum per sampling event.
(Required for all sampling plans with field measurements or laboratory analysis)

☐ Equipment blanks at a frequency of [Insert frequency required by method]
(Only needed if equipment used to collect samples could add the pollutants to sample)

☐ Field blanks at a frequency of [Insert frequency required by method]
(Only required if sampling method calls for field blanks)

☐ Travel blanks at a frequency of [Insert frequency required by method]
(Required for sampling plans that include volatile organic compound [VOC] laboratory analysis)

7.8.4.1 Field Duplicates

Field duplicates provide verification of laboratory or field analysis and sample collection. Duplicate samples will be collected, handled, and analyzed using the same protocols as primary samples. The sample location where field duplicates are collected will be randomly selected from the discharge locations. Duplicate samples will be collected immediately after the primary sample has been collected. Duplicate samples must be collected in the same manner and as close in time as possible to the original sample. Duplicate samples will not influence any evaluations or conclusion.

7.8.4.2 Equipment Blanks

Equipment blanks provide verification that equipment has not introduced a pollutant into the sample. Equipment blanks are typically collected when:

- New equipment is used;
- Equipment that has been cleaned after use at a contaminated site;
- Equipment that is not dedicated for surface water sampling is used; or
- Whenever a new lot of filters is used when sampling metals.

Equipment blanks will not be collected for this project because sample collection does not require equipment use. All samples will be grab samples.

7.8.4.3 Field Blanks

Field blanks assess potential sample contamination levels that occur during field sampling activities. De-ionized water field blanks are taken to the field, transferred to the appropriate container, and treated the same as the corresponding sample type during the course of a sampling event.

Use of field blanks is recommended in areas where VOCs contamination is present; therefore, field blanks will not be used during sampling events for this project.

7.8.4.4 Travel Blanks

Travel blanks assess the potential for cross-contamination of volatile constituents between sample containers during shipment from the field to the laboratory. De-ionized water blanks are taken along for the trip and held unopened in the same cooler with the VOC samples.

Travel blanks will be not be used during sampling events for this project because VOCs are not included in the analytical constituents.

7.8.5 DATA VERIFICATION

After results are received from the analytical laboratory, the QSP will verify the data to verify that it is complete, accurate, and the appropriate QA/QC requirements were met. Data must be verified as soon as the data reports are received. Data verification will include:

- Check the CoC and laboratory reports.
  Make sure all requested analyses were performed and all samples are accounted for in the reports.

- Check laboratory reports to make sure hold times were met and that the reporting levels meet or are lower than the reporting levels agreed to in the contract.

- Check data for outlier values and follow up with the laboratory.
  Occasionally typographical errors, unit reporting errors, or incomplete results are reported and should be easily detected. These errors need to be identified, clarified, and corrected quickly by the laboratory. The QSP should especially note data that is an order of magnitude or more different than similar locations, or is inconsistent with previous data from the same location.

- Check laboratory QA/QC results.
  EPA establishes QA/QC checks and acceptable criteria for laboratory analyses. These data are typically reported along with the sample results. The QSP will evaluate the reported QA/QC data to check for contamination (method, field, and equipment blanks), precision (laboratory matrix spike duplicates), and accuracy (matrix spikes and laboratory control samples). When QA/QC checks are outside acceptable ranges, the laboratory must flag the data, and usually provides an explanation of the potential impact to the sample results.

- Check the data set for outlier values and, accordingly, confirm results and re-analyze samples where appropriate.
  Sample re-analysis should only be undertaken when it appears that some part of the QA/QC resulted in a value out of the accepted range. Sample results may not be discounted unless the analytical laboratory identifies the required QA/QC criteria were not met and confirms this in writing.

Field data including inspections and observations must be verified as soon as the field logs are received, typically at the end of the sampling event. Field data verification will include:

- Check field logs to make sure all required measurements were completed and appropriately documented;

- Check reported values that appear out of the typical range or inconsistent; follow-up immediately to identify potential reporting or equipment problems, if appropriate, recalibrate equipment after sampling;

- Verify equipment calibrations;

- Review observations noted on the field logs; and

- Review notations of any errors and actions taken to correct the equipment or recording errors.

7.9 RECORDS RETENTION

All records of storm water monitoring information and copies of reports (including Annual Reports) must be retained for a period of at least three years from date of submittal or longer if required by the Regional Water Board.

Results of visual monitoring, field measurements, and laboratory analyses must be kept in the SWPPP along with CoCs, and other documentation related to the monitoring.

Records are to be kept onsite while construction is ongoing. Records to be retained include:

- The date, place, and time of inspections, sampling, visual observations, and/or measurements, including precipitation;

- The individual(s) who performed the inspections, sampling, visual observation, and/or field measurements;

- The date and approximate time of field measurements and laboratory analyses;

- The individual(s) who performed the laboratory analyses;

- A summary of all analytical results, the method detection limits and reporting limits, and the analytical techniques or methods used;

- Rain gauge readings from site inspections;

- QA/QC records and results;

- Calibration records;

- Visual observation and sample collection exemption records;

- The records of any corrective actions and follow-up activities that resulted from analytical results, visual observations, or inspections.

SECTION 8 REFERENCES

CASQA 2009, *Stormwater BMP Handbook Portal: Construction*, November 2009, www.casqa.org.

Design, Community and Environment (DCE). 2002. NASA Ames Development Plan Final Programmatic Environmental Impact Statement. July.

Earth Resources Technology, Inc. (ERT). 2015. Environmental Resources Document, NASA Ames Research Center, Moffett Field, California. March.

San Francisco Bay Basin Region 2 (Basin Plan). 2017. Water Quality Control Plan. California Regional Water Quality Control Board San Francisco Bay Region. Available on-line at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/docs/BP_all_chapters.pdf

State Water Resources Control Board 2009. Order 2009-0009-DWQ, NPDES General Permit No. CAS000002: National Pollutant Discharges Elimination System (NPDES) California General Permit for Storm Water Discharge Associated with Construction and Land Disturbing Activities. Available on-line at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.shtml.

State Water Resources Control Board 2010. Order 2010-0014-DWQ, NPDES General Permit No. CAS000002: National Pollutant Discharges Elimination System (NPDES) California General Permit for Storm Water Discharge Associated with Construction and Land Disturbing Activities. Available on-line at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.shtml.

State Water Resources Control Board (2012). Order 2012-0006-DWQ, NPDES General Permit No. CAS000002: National Pollutant Discharges Elimination System (NPDES) California General Permit for Storm Water Discharge Associated with Construction and Land Disturbing Activities. Available on-line at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.shtml.

Tetra Tech 2017a. Action Memorandum for AOI 14, January.

Tetra Tech 2017b. Removal Action Work Plan, February.

CSMP ATTACHMENTS

CSMP ATTACHMENT 1: WEATHER REPORTS

BMP INSPECTION REPORT

Date and Time of Inspection:			Date Report Written:	
Inspection Type: (Circle one)	Weekly *Complete Parts I,II,III and VII*	Pre-Storm *Complete Parts I,II,III,IV and VII*	During Rain Event *Complete Parts I, II, III, V, and VII*	Post-Storm *Complete Parts I,II,III,VI and VII*

Part I. General Information

Site Information			
Construction Site Name:			
Construction stage and completed activities:			Approximate area of site that is exposed:
Photos Taken: (Circle one)	Yes	No	Photo Reference IDs:
Weather			
Estimate storm beginning: (date and time)			Estimate storm duration: (hours)
Estimate time since last storm: (days or hours)			Rain gauge reading and location: (in)
Is a "Qualifying Event" predicted or did one occur (i.e., 0.5" rain with 48-hrs or greater between events)? (Y/N) If yes, summarize forecast:			
Exemption Documentation (explanation required if inspection could not be conducted). Visual inspections are not required outside of business hours or during dangerous weather conditions such as flooding or electrical storms.			
Inspector Information			
Inspector Name and Title:		Company Name:	
Signature:			Date:

Part II. BMP Observations. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level ___1__ Sites	Failures or other short comings (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Good Housekeeping for Construction Materials			
Inventory of products (excluding materials designed to be outdoors)			
Stockpiled construction materials not actively in use are covered and bermed			
All chemicals are stored in watertight containers with appropriate secondary containment, or in a completely enclosed storage shed			
Construction materials are minimally exposed to precipitation			
BMPs preventing the offsite tracking of materials are implemented and properly effective			
Good Housekeeping for Waste Management			
Wash/rinse water and materials are prevented from being disposed into the storm drain system			
Portable toilets are contained to prevent discharges of waste			
Sanitation facilities are clean and with no apparent for leaks and spills			
Equipment is in place to cover waste disposal containers at the end of business day and during rain events			
Discharges from waste disposal containers are prevented from discharging to the storm drain system / receiving water			
Stockpiled waste material is securely protected from wind and rain if not actively in use			
Procedures are in place for addressing hazardous and non-hazardous spills			
Appropriate spill response personnel are assigned and trained			
Equipment and materials for cleanup of spills is available onsite			
Washout areas (e.g., concrete) are contained appropriately to prevent discharge or infiltration into the underlying soil			
Good Housekeeping for Vehicle Storage and Maintenance			
Measures are in place to prevent oil, grease, or fuel from leaking into the ground, storm drains, or surface waters			
All equipment or vehicles are fueled, maintained, and stored in a designated area with appropriate BMPs			
Vehicle and equipment leaks are cleaned immediately and disposed of properly			
Good Housekeeping for Landscape Materials			
Stockpiled landscape materials such as mulches and topsoil are contained and covered when not actively in use			

Part II. BMP Observations. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level ___1__ Sites	Failures or other short comings (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Good Housekeeping for Landscape Materials			
Erodible landscape material has not been applied 2 days before a forecasted rain event or during an event			
Erodible landscape materials are applied at quantities and rates in accordance with manufacturer recommendations			
Bagged erodible landscape materials are stored on pallets and covered			
Good Housekeeping for Air Deposition of Site Materials			
Good housekeeping measures are implemented onsite to control the air deposition of site materials and from site operations			
Non-Storm Water Management			
Non-storm water discharges are properly controlled			
Vehicles are washed in a manner to prevent non-storm water discharges to surface waters or drainage systems			
Streets are cleaned in a manner to prevent unauthorized non-storm water discharges to surface waters or drainage systems.			
Erosion Controls			
Wind erosion controls are effectively implemented			
Effective soil cover is provided for disturbed areas inactive (i.e., not scheduled to be disturbed for 14 days) as well as finished slopes, open space, utility backfill, and completed lots			
The use of plastic materials is limited in cases when a more sustainable, environmentally friendly alternative exists.			
Sediment Controls			
Perimeter controls are established and effective at controlling erosion and sediment discharges from the site			
Entrances and exits are stabilized to control erosion and sediment discharges from the site			
Sediment basins are properly maintained			
Linear sediment control along toe of slope, face of slope an at grade breaks (Risk Level 2 Only)			
Limit construction activity to and from site to entrances and exits that employ effective controls to prevent offsite tracking (Risk Level 2 Only)			
Ensure all storm, drain inlets and perimeter controls, runoff control BMPs and pollutants controls at entrances and exits are maintained and protected from activities the reduce their effectiveness (Risk Level 2 Only)			
Inspect all immediate access roads daily (Risk Level 2 Only)			

Part II. BMP Observations. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level ___1__ Sites	Failures or other short comings (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Run-On and Run-Off Controls			
Run-on to the site is effectively managed and directed away from all disturbed areas.			
Other			
Are the project SWPPP and BMP plan up to date, available on-site and being properly implemented?			

Part III. Descriptions of BMP Deficiencies		
Deficiency	**Repairs Implemented: Note - Repairs must begin within 72 hours of identification and, complete repairs as soon as possible.**	
	Start Date	**Action**
1.		
2.		
3.		

Part IV. Additional Pre-Storm Observations. Note the presence or absence of floating and suspended materials, sheen, discoloration, turbidity, odors, and source(s) of pollutants(s).	
	Yes, No, N/A
Do storm water storage and containment areas have adequate freeboard? If no, complete Part III.	
Are drainage areas free of spills, leaks, or uncontrolled pollutant sources? If no, complete Part VII and describe below.	
Notes:	
Are storm water storage and containment areas free of leaks? If no, complete Parts III and/or VII and describe below.	
Notes:	

Part V. Additional During Storm Observations. If BMPs cannot be inspected during inclement weather, list the results of visual inspections at all relevant outfalls, discharge points, and downstream locations. Note odors or visible sheen on the surface of discharges. Complete Part VII (Corrective Actions) as needed.	
Outfall, Discharge Point, or Other Downstream Location	
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description

Part VI. Additional Post-Storm Observations. Visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event, and observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Complete Part VII (Corrective Actions) as needed.	
Discharge Location, Storage or Containment Area	**Visual Observation**

Part VII. Additional Corrective Actions Required. **Identify additional corrective actions not included with BMP Deficiencies (Part III) above. Note if SWPPP change is required.**	
Required Actions	**Implementation Date**

Quarterly Visual Observations of Non-Storm Water Discharges (NSWD)

[] January – March [] April – June [] July-September [] October- December

Project Name_____ Drainage Area (as identified on SWPPP Map) _____

All projects must

- conduct one visual observation (inspection) quarterly
- visually inspect each drainage area for the presence of (or indication of prior) unauthorized and authorized non-storm water discharges and their sources.
- maintain on-site records indicating the personnel performing the visual observation (inspections), the dates and approximate time each drainage area and non-storm water discharge was observed, and the response taken

DATE/TIME OF OBSERVATION **OBSERVER NAME AND TITLE**	**TYPE OF DISCHARGE[1]**	**SOURCE/ LOCATION** Example Condensate from Air Conditioning units at Building C	**DESCRIBE POLLUTANT CHARACTERISTICS** (Odors, Floating or Suspended Martial, Sheen, Discoloration, Turbidity)	**ACTIONS** To eliminate unauthorized NSWD and to reduce/ prevent pollutants from contacting NSWD	**DESCRIBE ANY NEW OR REVISED BMPS AND THEIR IMPLEMENTATION DATE**
Date: Time: Name: Title:	[] Authorized [] Unauthorized				
Date: Time: Name: Title:	[] Authorized [] Unauthorized				
Date: Time: Name: Title:	[] Authorized [] Unauthorized				
Date: Time: Name: Title:	[] Authorized [] Unauthorized				
Date: Time: Name: Title:	[] Authorized [] Unauthorized				

CSMP ATTACHMENT 3: EXAMPLE FORMS

Rain Gauge Log Sheet				
Construction Site Name:				
WDID #:				
Date (mm/dd/yy)	Time (24-hr)	Initials	Rainfall Depth (Inches)	Notes:

Risk Level 1 ***Visual Inspection Field Log Sheet***						
Date and Time of Inspection:				Report Date:		
Inspection Type:	☐ Weekly	☐ Before predicted rain	☐ During rain event	☐ Following qualifying rain event	☐ Contained storm water release	☐ Quarterly non-storm water
Site Information						
Construction Site Name:						
Construction stage and completed activities:					Approximate area of exposed site:	
Weather and Observations						
Date Rain Predicted to Occur:				Predicted % chance of rain:		
Estimate storm beginning: _____ (date and time)		Estimate storm duration: _____ (hours)		Estimate time since last storm: _____ (days or hours)	Rain gauge reading: _____ (inches)	
Observations: If yes identify location						
Odors	Yes ☐	No ☐				
Floating material	Yes ☐	No ☐				
Suspended Material	Yes ☐	No ☐				
Sheen	Yes ☐	No ☐				
Discolorations	Yes ☐	No ☐				
Turbidity	Yes ☐	No ☐				
Site Inspections						
Outfalls or BMPs Evaluated			**Deficiencies Noted**			
(add additional sheets or attached detailed BMP Inspection Checklists)						
Photos Taken:	Yes ☐	No ☐		Photo Reference IDs:		
Corrective Actions Identified (note if SWPPP change is needed)						
Inspector Information						
Inspector Name:				Inspector Title:		
Signature:						Date:

CHAIN-OF-CUSTODY **DATE:** **Lab ID:**

DESTINATION LAB:

ATTN:

ADDRESS:

Office Phone:

Cell Phone:

SAMPLED BY:

Contact:

Project Name

REQUESTED ANALYSIS

Notes:

Client Sample ID	Sample Date	Sample Time	Sample Matrix	Container #	Container Type	Container Pres.				

SENDER COMMENTS:

RELINQUISHED BY

Signature:

Print:

Company:

Date: TIME:

LABORATORY COMMENTS:

RECEIVED BY

Signature:

Print:

Company:

Date: TIME:

CSMP ATTACHMENT 4: FIELD METER INSTRUCTIONS

CSMP ATTACHMENT 5: SUPPLEMENTAL INFORMATION

APPENDIX A
CONSTRUCTION GENERAL PERMIT

State Water Resources Control Board
Division of Water Quality
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
Fax (916) 341-5463 • http://www.waterboards.ca.gov

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

CONSTRUCTION GENERAL PERMIT FACT SHEET TABLE OF CONTENTS

I. BACKGROUND 1

A. History 1

B. Legal Challenges and Court Decisions 1

C. Blue Ribbon Panel of Experts and Feasibility of Numeric Effluent Limitations 4

D. Summary of Panel Findings on Construction Activities 4

E. How the Panel's Findings are Used in this General Permit 5

F. Summary of Significant Changes in This General Permit 5

II. RATIONALE 7

A. General Permit Approach 7

B. Construction Activities Covered 7

C. Construction Activities Not Covered 9

D. Obtaining and Terminating Permit Coverage 12

E. Discharge Prohibitions 12

F. Effluent Standards for All Types of Discharges 13

G. Receiving Water Limitations 20

H. Training Qualifications and Requirements 20

I. Sampling, Monitoring, Reporting and Record Keeping 21

J. Risk Determination 27

K. ATS Requirements 35

L. Post-Construction Requirements 37

M. Storm Water Pollution Prevention Plans 46

N. Regional Water Board Authorities 48

LIST OF TABLES

Table 1 - Regional Water Board Basin Plans, Water Quality Objectives for Turbidity 16
Table 2 - Results of Ecoregion Analysis 16
Table 3 – ACL Sampling Data taken by Regional Water Board Staff 17
Table 4 - Required Monitoring Elements for Risk Levels 21
Table 5 - Storm Water Effluent Monitoring Requirements by Risk Level 23
Table 6 - Receiving Water Monitoring Requirements 26
Table 7 - Combined Risk Level Matrix 29
Table 8 -National Oceanic and Atmospheric Administration (NOAA) Definition of Probability of Precipitation (PoP) 31
Table 9 - Qualified SWPPP Developer/ Qualified SWPPP Practitioner Certification Criteria 47

LIST OF FIGURES

Figure 1 -Statewide Map of K * LS 28
Figure 2 - Suite of Storm Events 37
Figure 3 - Northern CA (2009) Counties / Cities With SUSMP-Plus Coverage 39
Figure 4 - Southern CA (2009) Counties / Cities With SUSMP-Plus Coverage 40
Figure 5 - Schematic of the Lane Relationship 42
Figure 6 - Channel Changes Associated with Urbanization 43

I. BACKGROUND

A. History

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The 1987 amendments to the CWA added Section 402(p), which establishes a framework for regulating municipal and industrial storm water discharges under the NPDES Program. On November 16, 1990, the U.S. Environmental Protection Agency (USEPA) published final regulations that established storm water permit application requirements for specified categories of industries. The regulations provide that discharges of storm water to waters of the United States from construction projects that encompass five or more acres of soil disturbance are effectively prohibited unless the discharge is in compliance with an NPDES Permit. Regulations (Phase II Rule) that became final on December 8, 1999 lowered the permitting threshold from five acres to one acre.

While federal regulations allow two permitting options for storm water discharges (Individual Permits and General Permits), the State Water Board has elected to adopt only one statewide General Permit at this time that will apply to most storm water discharges associated with construction activity.

On August 19, 1999, the State Water Board reissued the General Construction Storm Water Permit (Water Quality Order 99-08-DWQ). On December 8, 1999 the State Water Board amended Order 99-08-DWQ to apply to sites as small as one acre.

The General Permit accompanying this fact sheet regulates storm water runoff from construction sites. Regulating many storm water discharges under one permit will greatly reduce the administrative burden associated with permitting individual storm water discharges. To obtain coverage under this General Permit, dischargers shall electronically file the Permit Registration Documents (PRDs), which includes a Notice of Intent (NOI), Storm Water Pollution Prevention Plan (SWPPP), and other compliance related documents required by this General Permit and mail the appropriate permit fee to the State Water Board. It is expected that as the storm water program develops, the Regional Water Quality Control Boards (Regional Water Boards) may issue General Permits or Individual Permits containing more specific permit provisions. When this occurs, this General Permit will no longer regulate those dischargers.

B. Legal Challenges and Court Decisions

1. Early Court Decisions

Shortly after the passage of the CWA, the USEPA promulgated regulations exempting most storm water discharges from the NPDES permit requirements. (See 40 C.F.R. § 125.4 (1975); see also *Natural Resources Defense Council v. Costle* (D.C. Cir. 1977) 568 F.2d 1369, 1372 (*Costle*); *Defenders of Wildlife v. Browner* (9th Cir. 1999) 191 F.3d 1159, 1163 (*Defenders of Wildlife*).) When environmental groups challenged this exemption in federal court, the District of Columbia Court of Appeals invalidated the regulation, holding that the USEPA "does not have authority to exempt categories of point sources from the permit requirements of [CWA] § 402." (*Costle*, 568 F.2d at 1377.) The *Costle* court rejected the USEPA's argument that effluent-based storm sewer regulation was administratively infeasible because of the variable nature of storm water pollution and the number of affected storm sewers throughout the country. (*Id.* at 1377-82.) Although the court acknowledged the practical problems relating to storm sewer regulation, the court found the USEPA had the flexibility under the CWA to design regulations that would overcome these problems. (*Id.* at 1379-83.) In particular, the court pointed to general permits and permits based on requiring best management practices (BMPs).

During the next 15 years, the USEPA made numerous attempts to reconcile the statutory requirement of point source regulation with the practical problem of regulating possibly millions of diverse point source discharges of storm water. (See *Defenders of Wildlife*, 191 F.3d at 1163; see also Gallagher, Clean Water Act in Environmental Law Handbook (Sullivan, edit., 2003)
p. 300 (Environmental Law Handbook); Eisen, *Toward a Sustainable Urbanism: Lessons from Federal Regulation of Urban Storm Water Runoff* (1995) 48 Wash. U.J. Urb. & Contemp. L.1, 40-41 [Regulation of Urban Storm Water Runoff].)

In 1987, Congress amended the CWA to require NPDES permits for storm water discharges. (See CWA § 402(p), 33 U.S.C. § 1342(p); *Defenders of Wildlife,* 191 F.3d at 1163; *Natural Resources Defense Council v. USEPA* (9th Cir. 1992) 966 F.2d 1292, 1296.) In these amendments, enacted as part of the Water Quality Act of 1987, Congress distinguished between industrial and municipal storm water discharges. With respect to industrial storm water discharges, Congress provided that NPDES permits "shall meet all applicable provisions of this section and section 1311 [requiring the USEPA to establish effluent limitations under specific timetables]." (CWA § 402(p)(3)(A), 33 U.S.C. § 1342(p)(3)(A); see also *Defenders of Wildlife,* 191 F.3d at 1163-64.)

In 1990, USEPA adopted regulations specifying what activities were considered "industrial" and thus required discharges of storm water associated with those activities to obtain coverage under NPDES permits. (55 Fed. Reg. 47,990 (1990); 40 C.F.R. § 122.26(b)(14).) Construction activities, deemed a subset of the industrial activities category, must also be regulated by an NPDES permit. (40 C.F.R. § 122.26(b)(14)(x)). In 1999, USEPA issued regulations for "Phase II" of storm water regulation, which required most small construction sites (1-5 acres) to be regulated under the NPDES program. (64 Fed. Reg. 68,722; 40 C.F.R. § 122.26(b)(15)(i).)

2. Court Decisions on Public Participation

Two recent federal court opinions have vacated USEPA rules that denied meaningful public review of NPDES permit conditions. On January 14, 2003, the Ninth Circuit Court of Appeals held that certain aspects of USEPA's Phase II regulations governing MS4s were invalid primarily because the general permit did not contain express requirements for public participation. (*Environmental Defense Center v. USEPA* (9th Cir. 2003) 344 F.3d 832.) Specifically, the court determined that applications for general permit coverage (including the Notice of Intent (NOI) and Storm Water Management Program (SWMP)) must be made available to the public, the applications must be reviewed and determined to meet the applicable standard by the permitting authority before coverage commences, and there must be a process to accommodate public hearings. (*Id.* at 852-54.) Similarly, on February 28, 2005, the Second Circuit Court of Appeals held that the USEPA's confined animal feeding operation (CAFO) rule violated the CWA because it allowed dischargers to write their own nutrient management plans without public review. (*Waterkeeper Alliance v. USEPA* (2d Cir. 2005) 399 F.3d 486.) Although neither decision involved the issuance of construction storm water permits, the State Water Board's Office of Chief Counsel has recommended that the new General Permit address the courts' rulings where feasible[1].

---

[1] In *Texas Independent Producers and Royalty Owners Assn. v. USEPA* (7th Cir. 2005) 410 F.3d 964, the Seventh Circuit Court of Appeals held that the USEPA's construction general permit was not required to provide the public with the opportunity for a public hearing on the Notice of Intent or Storm Water Pollution Prevention Plan. The Seventh Circuit briefly discussed why it agreed with the Ninth Circuit's dissent in *Environmental Defense Center*, but

The CWA and the USEPA's regulations provide states with the discretion to formulate permit terms, including specifying best management practices (BMPs), to achieve strict compliance with federal technology-based and water quality-based standards. (*Natural Resources Defense Council v. USEPA* (9th Cir. 1992) 966 F.2d 1292, 1308.) Accordingly, this General Permit has developed specific BMPs as well as numeric action levels (NALs) in order to achieve these minimum federal standards. In addition, the General Permit requires a SWPPP and REAP (another dynamic, site-specific plan) to be developed but has removed all language requiring the discharger to implement these plans – instead, the discharger is required to comply with specific requirements. By requiring the dischargers to implement these specific BMPs and NALs, this General Permit ensures that the dischargers do not "write their own permits." As a result this General Permit does not require each discharger's SWPPP and REAP to be reviewed and approved by the Regional Water Boards.

This General Permit also requires dischargers to electronically file all permit-related compliance documents. These documents include, but are not limited to, NOIs, SWPPPs, annual reports, Notice of Terminations (NOTs), and numeric action level (NAL) exceedance reports. Electronically submitted compliance information is immediately available to the public, as well as the Regional Water Quality Control Board (Regional Water Board) offices, via the Internet. In addition, this General Permit enables public review and hearings on permit applications when appropriate. Under this General Permit, the public clearly has a meaningful opportunity to participate in the permitting process.

---

generally did not discuss the substantive holdings in *Environmental Defense Center* and *Waterkeeper Alliance*, because neither court addressed the initial question of whether the plaintiffs had standing to challenge the permits at issue. However, notwithstanding the Seventh Circuit's decision, it is not binding or controlling on the State Water Board because California is located within the Ninth Circuit.

C. Blue Ribbon Panel of Experts and Feasibility of Numeric Effluent Limitations

In 2005 and 2006, the State Water Board convened an expert panel (panel) to address the feasibility of numeric effluent limitations (NELs) in California's storm water permits. Specifically, the panel was asked to address:

"Is it technically feasible to establish numeric effluent limitations, or some other quantifiable limit, for inclusion in storm water permits? How would such limitations or criteria be established, and what information and data would be required?"

"The answers should address industrial general permits, construction general permits, and area-wide municipal permits. The answers should also address both technology-based limitations or criteria and water quality-based limitations or criteria. In evaluating establishment of any objective criteria, the panel should address all of the following:

The ability of the State Water Board to establish appropriate objective limitations or criteria;

How compliance determinations would be made;

The ability of dischargers and inspectors to monitor for compliance; and

The technical and financial ability of dischargers to comply with the limitations or criteria."

Through a series of public participation processes (State Water Board meetings, State Water Board workshops, and the solicitation of written comments), a number of water quality, public process and overall program effectiveness problems were identified. Some of these problems are addressed through this General Permit.

D. Summary of Panel Findings on Construction Activities

The panel's final report can be downloaded and viewed through links at www.waterboards.ca.gov or by clicking here[2].

The panel made the following observations:

"Limited field studies indicate that traditional erosion and sediment controls are highly variable in performance, resulting in highly variable turbidity levels in the site discharge."

"Site-to-site variability in runoff turbidity from undeveloped sites can also be quite large in many areas of California, particularly in more arid regions with less natural vegetative cover and steep slopes."

[2] http://www.waterboards.ca.gov/stormwtr/docs/numeric/swpanel_final_report.pdf

“Active treatment technologies involving the use of polymers with relatively large storage systems now exist that can provide much more consistent and very low discharge turbidity. However, these technologies have as yet only been applied to larger construction sites, generally five acres or greater. Furthermore, toxicity has been observed at some locations, although at the vast majority of sites, toxicity has not occurred. There is also the potential for an accidental large release of such chemicals with their use.”

“To date most of the construction permits have focused on TSS and turbidity, but have not addressed other, potentially significant pollutants such as phosphorus and an assortment of chemicals used at construction sites.”

“Currently, there is no required training or certification program for contractors, preparers of soil erosion and sediment control Storm Water Pollution Prevention Plans, or field inspectors.”

“The quality of storm water discharges from construction sites that effectively employ BMPs likely varies due to site conditions such as climate, soil, and topography.”

“The States of Oregon and Washington have recently adopted similar concepts to the Action Levels described earlier.”

In addition, the panel made the following conclusions:

“It is the consensus of the Panel that active treatment technologies make Numeric Limits technically feasible for pollutants commonly associated with storm water discharges from construction sites (e.g. TSS and turbidity) for larger construction sites. Technical practicalities and cost-effectiveness may make these technologies less feasible for smaller sites, including small drainages within a larger site, as these technologies have seen limited use at small construction sites. If chemical addition is not permitted, then Numeric Limits are not likely feasible.”

“The Board should consider Numeric Limits or Action Levels for other pollutants of relevance to construction sites, but in particular pH. It is of particular concern where fresh concrete or wash water from cement mixers/equipment is exposed to storm water.”

“The Board should consider the phased implementation of Numeric Limits and Action Levels, commensurate with the capacity of the dischargers and support industry to respond.”

E. How the Panel’s Findings are Used in this General Permit

The State Water Board carefully considered the findings of the panel and related public comments. The State Water Board also reviewed and considered the comments regarding statewide storm water policy and the reissuance of the Industrial General Permit. From the input received the State Water Board identified some permit and program performance gaps that are addressed in this General Permit. The Summary of Significant Changes (below) in this General Permit are a direct result of this process.

F. Summary of Significant Changes in This General Permit

The State Water Board has significant changes to Order 99-08-DWQ. This General Permit differs from Order 99-08-DWQ in the following significant ways:

Rainfall Erosivity Waiver: this General Permit includes the option allowing a small construction site (>1 and <5 acres) to self-certify if the rainfall erosivity value (R value) for their site's given location and time frame compute to be less than or equal to 5.

Technology-Based Numeric Action Levels: this General Permit includes NALs for pH and turbidity.

Risk-Based Permitting Approach: this General Permit establishes three levels of risk possible for a construction site. Risk is calculated in two parts: 1) Project Sediment Risk, and 2) Receiving Water Risk.

Minimum Requirements Specified: this General Permit imposes more minimum BMPs and requirements that were previously only required as elements of the SWPPP or were suggested by guidance.

Project Site Soil Characteristics Monitoring and Reporting: this General Permit provides the option for dischargers to monitor and report the soil characteristics at their project location. The primary purpose of this requirement is to provide better risk determination and eventually better program evaluation.

Effluent Monitoring and Reporting: this General Permit requires effluent monitoring and reporting for pH and turbidity in storm water discharges. The purpose of this monitoring is to evaluate whether NALs and NELs for Active Treatment Systems included in this General Permit are exceeded.

Receiving Water Monitoring and Reporting: this General Permit requires some Risk Level 3 and LUP Type 3 dischargers to monitor receiving waters and conduct bioassessments.

Post-Construction Storm Water Performance Standards: this General Permit specifies runoff reduction requirements for all sites not covered by a Phase I or Phase II MS4 NPDES permit, to avoid, minimize and/or mitigate post-construction storm water runoff impacts.

Rain Event Action Plan: this General Permit requires certain sites to develop and implement a Rain Event Action Plan (REAP) that must be designed to protect all exposed portions of the site within 48 hours prior to any likely precipitation event.

Annual Reporting: this General Permit requires all projects that are enrolled for more than one continuous three-month period to submit information and annually certify that their site is in compliance with these requirements. The primary purpose of this requirement is to provide information needed for overall program evaluation and pubic information.

Certification/Training Requirements for Key Project Personnel: this General Permit requires that key personnel (e.g., SWPPP preparers, inspectors, etc.) have specific training or certifications to ensure their level of knowledge and skills are adequate to ensure their ability to design and evaluate project specifications that will comply with General Permit requirements.

Linear Underground/Overhead Projects: this General Permit includes requirements for all Linear Underground/Overhead Projects (LUPs).

II. RATIONALE

A. General Permit Approach

A general permit for construction activities is an appropriate permitting approach for the following reasons:

1. A general permit is an efficient method to establish the essential regulatory requirements for a broad range of construction activities under differing site conditions;

2. A general permit is the most efficient method to handle the large number of construction storm water permit applications;

3. The application process for coverage under a general permit is far less onerous than that for individual permit and hence more cost effective;

4. A general permit is consistent with USEPA's four-tier permitting strategy, the purpose of which is to use the flexibility provided by the CWA in designing a workable and efficient permitting system; and

5. A general permit is designed to provide coverage for a group of related facilities or operations of a specific industry type or group of industries. It is appropriate when the discharge characteristics are sufficiently similar, and a standard set of permit requirements can effectively provide environmental protection and comply with water quality standards for discharges. In most cases, the general permit will provide sufficient and appropriate management requirements to protect the quality of receiving waters from discharges of storm water from construction sites.

There may be instances where a general permit is not appropriate for a specific construction project. A Regional Water Board may require any discharger otherwise covered under the General Permit to apply for and obtain an Individual Permit or apply for coverage under a more specific General Permit. The Regional Water Board must determine that this General Permit does not provide adequate assurance that water quality will be protected, or that there is a site-specific reason why an individual permit should be required.

B. Construction Activities Covered

1. **Construction activity subject to this General Permit:**

Any construction or demolition activity, including, but not limited to, clearing, grading, grubbing, or excavation, or any other activity that results in a land disturbance of equal to or greater than one acre.

Construction activity that results in land surface disturbances of less than one acre if the construction activity is part of a larger common plan of development or sale of one or more acres of disturbed land surface.

Construction activity related to residential, commercial, or industrial development on lands currently used for agriculture including, but not limited to, the construction of buildings related to agriculture that are considered industrial pursuant to USEPA regulations, such as dairy barns or food processing facilities.

Construction activity associated with LUPs including, but not limited to, those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment and associated ancillary facilities) and include, but are not limited to, underground utility mark-out, potholing, concrete

and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

Discharges of sediment from construction activities associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities.[3]

Storm water discharges from dredge spoil placement that occur outside of U.S. Army Corps of Engineers jurisdiction[4] (upland sites) and that disturb one or more acres of land surface from construction activity are covered by this General Permit. Construction projects that intend to disturb one or more acres of land within the jurisdictional boundaries of a CWA § 404 permit should contact the appropriate Regional Water Board to determine whether this permit applies to the project.

2. Linear Underground/Overhead Projects (LUPs) subject to this General Permit:

Underground/overhead facilities typically constructed as LUPs include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water, wastewater for domestic municipal services), liquescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g., telephone, telegraph, radio or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment and associated ancillary facilities) and include, but are not limited to, underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

Water Quality Order 2003-0007-DWQ regulated construction activities associated with small LUPs that resulted in land disturbances greater than one acre, but less than five acres. These projects were considered non-traditional construction projects. Attachment A of this Order now regulates all construction activities from LUPs resulting in land disturbances greater than one acre.

3. Common Plan of Development or Sale

USEPA regulations include the term “common plan of development or sale” to ensure that acreage within a common project does not artificially escape the permit requirements because construction activities are phased, split among smaller parcels, or completed by different owners/developers. In the absence of an

---

[3] Pursuant to the Ninth Circuit Court of Appeals’ decision in *NRDC v. EPA* (9th Cir. 2008) 526 F.3d 591, and subsequent denial of the USEPA’s petition for reconsideration in November 2008, oil and gas construction activities discharging storm water contaminated only with sediment are no longer exempt from the NPDES program.

[4] A construction site that includes a dredge and/or fill discharge to any water of the United States (e.g., wetland, channel, pond, or marine water) requires a CWA Section 404 permit from the U.S. Army Corps of Engineers and a CWA Section 401 Water Quality Certification from the Regional Water Board or State Water Board.

exact definition of “common plan of development or sale,” the State Water Board is required to exercise its regulatory discretion in providing a common sense interpretation of the term as it applies to construction projects and permit coverage. An overbroad interpretation of the term would render meaningless the clear “one acre” federal permitting threshold and would potentially trigger permitting of almost any construction activity that occurs within an area that had previously received area-wide utility or road improvements.

Construction projects generally receive grading and/or building permits (Local Permits) from local authorities prior to initiating construction activity. These Local Permits spell out the scope of the project, the parcels involved, the type of construction approved, etc. Referring to the Local Permit helps define “common plan of development or sale.” In cases such as tract home development, a Local Permit will include all phases of the construction project including rough grading, utility and road installation, and vertical construction. All construction activities approved in the Local Permit are part of the common plan and must remain under the General Permit until construction is completed. For custom home construction, Local Permits typically only approve vertical construction as the rough grading, utilities, and road improvements were already independently completed under the a previous Local Permit. In the case of a custom home site, the homeowner must submit plans and obtain a distinct and separate Local Permit from the local authority in order to proceed. It is not the intent of the State Water Board to require permitting for an individual homeowner building a custom home on a private lot of less than one acre if it is subject to a separate Local Permit. Similarly, the installation of a swimming pool, deck, or landscaping that disturbs less than one acre that was not part of any previous Local Permit are not required to be permitted.

The following are several examples of construction activity of less than one acre that would require permit coverage:

a. A landowner receives a building permit(s) to build tract homes on a 100-acre site split into 200 one-third acre parcels, (the remaining acreage consists of streets and parkways) which are sold to individual homeowners as they are completed. The landowner completes and sells all the parcels except for two. Although the remaining two parcels combined are less than one acre, the landowner must continue permit coverage for the two parcels.

b. One of the parcels discussed above is sold to another owner who intends to complete the construction as already approved in the Local Permit. The new landowner must file Permit Registration Documents (PRDs) to complete the construction even if the new landowner is required to obtain a separate Local Permit.

c. Landowner in (1) above purchases 50 additional one half-acre parcels adjacent to the original 200-acre project. The landowner seeks a Local Permit (or amendment to existing Local permit) to build on 20 parcels while leaving the remaining 30 parcels for future development. The landowner must amend PRDs to include the 20 parcels 14 days prior to commencement of construction activity on those parcels.

C. Construction Activities Not Covered

1. Traditional Construction Projects Not Covered

This General Permit does not apply to the following construction activity:

a. Routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

b. Disturbances to land surfaces solely related to agricultural operations such as disking, harrowing, terracing and leveling, and soil preparation.

c. Discharges of storm water from areas on tribal lands; construction on tribal lands is regulated by a federal permit.

d. Discharges of storm water within the Lake Tahoe Hydrologic Unit. The Lahontan Regional Water Board has adopted its own permit to regulate storm water discharges from construction activity in the Lake Tahoe Hydrologic Unit (Regional Water Board 6SLT). Owners of construction projects in this watershed must apply for the Lahontan Regional Water Board permit rather than the statewide Construction General Permit. Construction projects within the Lahontan region must also comply with the Lahontan Region Project Guideline for Erosion Control (R6T-2005-0007 Section), which can be found at **http://www.waterboards.ca.gov/lahontan/Adopted_Orders/2005/r6t_2005_0007.pdf**

e. Construction activity that disturbs less than one acre of land surface, unless part of a larger common plan of development or the sale of one or more acres of disturbed land surface.

f. Construction activity covered by an individual NPDES Permit for storm water discharges.

g. Landfill construction activity that is subject to the Industrial General Permit.

h. Construction activity that discharges to Combined Sewer Systems.

i. Conveyances that discharge storm water runoff combined with municipal sewage.

j. Discharges of storm water identified in CWA § 402(*l*)(2), 33 U.S.C. § 1342(*l*)(2).

2. **Linear Projects Not Covered**

a. LUP construction activity does not include linear routine maintenance projects. Routine maintenance projects are projects associated with operations and maintenance activities that are conducted on existing lines and facilities and within existing right-of-way, easements, franchise agreements, or other legally binding agreements of the discharger. Routine maintenance projects include, but are not limited to projects that are conducted to:

i. Maintain the original purpose of the facility or hydraulic capacity.

ii. Update existing lines[5] and facilities to comply with applicable codes, standards, and regulations regardless if such projects result in increased capacity.

iii. Repairing leaks.

[5]Update existing lines includes replacing existing lines with new materials or pipes.

Routine maintenance does not include construction of new[6] lines or facilities resulting from compliance with applicable codes, standards, and regulations.

Routine maintenance projects do not include those areas of maintenance projects that are outside of an existing right-of-way, franchise, easements, or agreements. When a project must secure new areas, those areas may be subject to this General Permit based on the area of disturbed land outside the original right-of-way, easement, or agreement.

b. LUP construction activity does not include field activities associated with the planning and design of a project (e.g., activities associated with route selection).

c. Tie-ins conducted immediately adjacent to "energized" or "pressurized" facilities by the discharger are not considered construction activities where all other LUP construction activities associated with the tie-in are covered by an NOI and SWPPP of a third party or municipal agency.

3. **EPA's Small Construction Rainfall Erosivity Waiver**

EPA's Storm Water Phase II Final Rule provides the option for a Small Construction Rainfall Erosivity Waiver. This waiver applies to small construction sites between 1 and 5 acres, and allows permitting authorities to waive those sites that do not have adverse water quality impacts.

Dischargers eligible for this waiver are exempt from Construction General Permit Coverage. In order to obtain the waiver, the discharger must certify to the State Water Board that small construction activity will occur only when the rainfall erosivity factor is less than 5 ("R" in the Revised Universal Soil Loss Equation). The period of construction activity begins at initial earth disturbance and ends with final stabilization. Where vegetation will be used for final stabilization, the date of installation of a practice that provides interim non-vegetative stabilization can be used for the end of the construction period. The operator must agree (as a condition waiver eligibility) to periodically inspect and properly maintain the area until the criteria for final stabilization as defined in the General Permit have been met. If use of this interim stabilization eligibility condition was relied on to qualify for the waiver, signature on the waiver with a certification statement constitutes acceptance of and commitment to complete the final stabilization process. The discharger must submit a waiver certification to the State Board prior to commencing construction activities.

USEPA funded a cooperative agreement with Texas A&M University to develop an online rainfall erosivity calculator. Dischargers can access the calculator from EPA's website at: www.epa.gov/npdes/stormwater/cgp. Use of the calculator allows the discharger to determine potential eligibility for the rainfall erosivity waiver. It may also be useful in determining the time periods during which construction activity could be waived from permit coverage.

[6]New lines are those that are not associated with existing facilities and are not part of a project to update or replace existing lines.

D. Obtaining and Terminating Permit Coverage

The appropriate Legally Responsible Person (LRP) must obtain coverage under this General Permit. To obtain coverage, the LRP or the LRP's Approved Signatory must file Permit Registration Documents (PRDs) prior to the commencement of construction activity. Failure to obtain coverage under this General Permit for storm water discharges to waters of the United States is a violation of the CWA and the California Water Code.

To obtain coverage under this General Permit, LRPs must electronically file the PRDs, which include a Notice of Intent (NOI), Storm Water Pollution Prevention Plan (SWPPP), and other documents required by this General Permit, and mail the appropriate permit fee to the State Water Board. It is expected that as the storm water program develops, the Regional Water Boards may issue General Permits or Individual Permits that contain more specific permit provisions. When this occurs, this General Permit will no longer regulate those dischargers that obtain coverage under Individual Permits.

Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted.

The application requirements of the General Permit establish a mechanism to clearly identify the responsible parties, locations, and scope of operations of dischargers covered by the General Permit and to document the discharger's knowledge of the General Permit's requirements.

This General Permit provides a grandfathering exception to existing dischargers subject to Water Quality Order No. 99-08-DWQ. Construction projects covered under Water Quality Order No. 99-08-DWQ shall obtain permit coverage at Risk Level 1. LUP projects covered under Water Quality Order No. 2003-0007-DWQ shall obtain permit coverage at LUP Type 1. The Regional Water Boards have the authority to require Risk Determination to be performed on projects currently covered under Water Quality Order No. 99-08-DWQ and 2003-0007-DWQ where they deem necessary.

LRPs must file a Notice of Termination (NOT) with the Regional Water Board when construction is complete and final stabilization has been reached or ownership has been transferred. The discharger must certify that all State and local requirements have been met in accordance with this General Permit. In order for construction to be found complete, the discharger must install post-construction storm water management measures and establish a long-term maintenance plan. This requirement is intended to ensure that the post-construction conditions at the project site do not cause or contribute to direct or indirect water quality impacts (i.e., pollution and/or hydromodification) upstream and downstream. Specifically, the discharger must demonstrate compliance with the post-construction standards set forth in this General Permit (Section XIII). The discharger is responsible for all compliance issues including all annual fees until the NOT has been filed and approved by the local Regional Water Board.

E. Discharge Prohibitions

This General Permit authorizes the discharge of storm water to surface waters from construction activities that result in the disturbance of one or more acres of land, provided that the discharger satisfies all permit conditions set forth in the Order. This General Permit prohibits the discharge of pollutants other than storm water and non-storm water discharges authorized by this General Permit or another NPDES permit. This General Permit also prohibits all discharges which contain a hazardous substance in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges. In addition, this General Permit incorporates discharge prohibitions contained in water quality control plans, as implemented by the nine Regional Water Boards. Discharges to Areas of Special Biological Significance (ASBS) are prohibited unless covered by an exception that the State Water Board has approved.

Non-storm water discharges include a wide variety of sources, including improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges may contribute significant pollutant loads to receiving waters. Measures to control spills, leakage, and dumping, and to prevent illicit connections during construction must be addressed through structural as well as non-structural BMPs. The State Water Board recognizes, however, that certain non-storm water discharges may be necessary for the completion of construction projects. Authorized non-storm water discharges may include those from de-chlorinated potable water sources such as: fire hydrant flushing, irrigation of vegetative erosion control measures, pipe flushing and testing, water to control dust, uncontaminated ground water dewatering, and other discharges not subject to a separate general NPDES permit adopted by a region. Therefore this General Permit authorizes such discharges provided they meet the following conditions.

These authorized non-storm water discharges must:

1. be infeasible to eliminate;
2. comply with BMPs as described in the SWPPP;
3. filter or treat, using appropriate technology, all dewatering discharges from sedimentation basins;
4. meet the NALs for pH and turbidity; and
5. not cause or contribute to a violation of water quality standards.

Additionally, authorized non-storm water discharges must not be used to clean up failed or inadequate construction or post-construction BMPs designed to keep materials onsite. Authorized non-storm water dewatering discharges may require a permit because some Regional Water Boards have adopted General Permits for dewatering discharges.

This General Permit prohibits the discharge of storm water that causes or threatens to cause pollution, contamination, or nuisance.

F. Effluent Standards for All Types of Discharges

1. Technology-Based Effluent Limitations

Permits for storm water discharges associated with construction activity must meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require controls of pollutant discharges that utilize best available technology economically achievable (BAT) for toxic pollutants and non conventional pollutants and best conventional pollutant control technology (BCT) for conventional pollutants. Additionally, these provisions require controls of pollutant discharges to reduce pollutants and any more stringent controls necessary to meet water quality standards. The USEPA has already established such limitations, known as effluent limitation guidelines (ELGs), for some industrial categories. This is not the case with construction discharges. In instances where there are no ELGs the permit writer is to use best professional judgment (BPJ) to establish requirements that the discharger must meet using BAT/BCT technology. This General Permit contains only narrative effluent limitations and does not contain numeric effluent limitations, except for Active Treatment Systems (ATS).

Order No. 2009-0009-DWQ, as originally adopted by the State Water Board on September 2, 2009, contained numeric effluent limitations for pH (within the range of 6.0 and 9.0 pH units) and turbidity (500 NTU) that applied only to Risk Level 3 and LUP Type 3 construction sites. The State Water Board adopted the numeric effluent limitations as technology-based effluent limitations based upon its best professional judgment. The California Building Industry Association, the Building Industry Legal Defense

Foundation, and the California Business Properties Association (petitioners) challenged Order No. 2009-0009-DWQ in *California Building Industry Association et al. v. State Water Resources Control Board*. On December 27, 2011, the Superior Court issued a judgment and writ of mandamus. The Superior Court ruled in favor of the State Water Board on almost all of the issues the petitioners raised, but the Superior Court invalidated the numeric effluent limitations for pH and turbidity for Risk Level 3 and LUP Type 3 sites because it determined that the State Water Board did not have sufficient BMP performance data to support those numeric effluent limitations. Therefore, the Superior Court concluded that the State Water Board did not comply with the federal regulations that apply to the use of best professional judgment. In invalidating the numeric effluent limitations, the Superior Court also suspended two ancillary requirements (a compliance storm event provision and receiving water monitoring at Risk Level 3 and LUP Type 3 sites that violated the numeric effluent limitations) that related solely to the invalidated numeric effluent limitations.

As a result of the Superior Court's writ of mandamus, this Order no longer contains numeric effluent limitations for pH and turbidity, except for ATS. In addition, as a result of the Superior Court's writ of mandamus, the receiving water monitoring requirements for Risk Level 3 and LUP Type 3 sites were suspended until the State Water Board amended this Order to restore the receiving water monitoring requirements. As amended, this Order now requires Risk Level 3 and LUP Type 3 Dischargers with direct discharges to surface waters to conduct receiving water monitoring whenever their effluent exceeds specified receiving water monitoring triggers. The receiving water monitoring triggers were established at the same levels as the previous numeric effluent limitations (effluent pH outside the range of 6.0 and 9.0 pH units or turbidity exceeding 500 NTU). In restoring the receiving water monitoring requirements, the State Water Board determined that it was appropriate to require receiving water monitoring for these types of sites with direct discharges to surface waters that exceeded the receiving water monitoring triggers under any storm event scenarios, because these sites represent the highest threat to receiving water quality. An exceedance of a receiving water monitoring trigger does not constitute a violation of this General Permit. These receiving water monitoring requirements take effect on the effective date of the amendment to this Order.

BAT/BCT technologies not only include passive systems such as conventional runoff and sediment control, but-also treatment systems such as coagulation/flocculation using sand filtration, when appropriate. Such technologies allow for effective treatment of soil particles less 0.02 mm (medium silt) in diameter. The discharger must install structural-controls, as necessary, such as erosion and sediment controls that meet BAT and BCT to achieve compliance with water quality standards. The narrative effluent limitations constitute compliance with the requirements of the CWA.

Because the permit is an NPDES permit, there is no legal requirement to address the factors set forth in Water Code sections 13241 and 13263, unless the permit is more stringent than what federal law requires. (See *City of Burbank v. State Water Resources Control Bd.* (2005) 35 Cal.4th 613, 618, 627.) None of the requirements in this permit are more stringent than the minimum federal requirements, which include technology-based requirements achieving BAT/BCT and strict compliance with water quality standards. The inclusion of numeric effluent limitations (NELs) in the permit for Active Treatment Systems does not cause the permit to be more stringent than current federal law. NELs and best management practices are simply two different-methods of achieving the same federal requirement: strict compliance with state water quality standards. Federal law authorizes both narrative and numeric effluent limitations to meet state water quality standards. The use of NELs to achieve compliance with water quality standards is not a more stringent requirement than the use of BMPs. (State Water Board Order No. WQ 2006-0012 (*Boeing*).) Accordingly, the State Water Board does not need to take into account the factors in Water Code sections 13241 and 13263.

The State Water Board has concluded that the establishment of BAT/BCT will not create or aggravate other environmental problems through increases in air pollution, solid waste generation, or energy consumption.–While there may be a slight increase in non-water quality impacts due to the implementation of additional monitoring or the construction of additional BMPs, these impacts will be negligible in comparison with the construction activities taking place on site and would be justified by the water quality benefits associated with compliance.

pH Receiving Water Monitoring Trigger

Given the potential contaminants, the minimum standard method for control of pH in runoff requires the use of preventive measures such as avoiding concrete pours during rainy weather, covering concrete and directing flow away from fresh concrete if a pour occurs during rain, covering scrap drywall and stucco materials when stored outside and potentially exposed to rain, and other housekeeping measures. If necessary, pH-impaired storm water from construction sites can be treated in a filter or settling pond or basin, with additional natural or chemical treatment required to meet pH limits set forth in this permit. The basin or pond acts as a collection point and holds storm water for a sufficient period for the contaminants to be settled out, either naturally or artificially, and allows any additional treatment to take place. The State Water Board considers these techniques to be equivalent to BCT. In determining the pH concentration trigger for discharges, the State Water Board used BPJ to set these limitations.

The chosen trigger was established by calculating three standard deviations above and below the mean pH of runoff from highway construction sites[7] in California. Proper implementation of BMPs should result in discharges that are within the range of 6.0 to 9.0 pH Units.

Turbidity Receiving Water Monitoring Trigger

The Turbidity receiving water monitoring trigger of 500 NTU is a technology-based trigger and was developed using three different analyses aimed at finding the appropriate threshold to set the technology-based limit to ensure environmental protection, effluent quality and cost-effectiveness. The analyses fell into three, main types: (1) an ecoregion-specific dataset developed by Simon et. al. (2004) [8]; (2) Statewide Regional Water Quality Control Board enforcement data; and (3) published, peer-reviewed studies and reports on in-situ performance of best management practices in terms of erosion and sediment control on active construction sites.

A 1:3 relationship between turbidity (expressed as NTU) and suspended sediment concentration (expressed as mg/L) is assumed based on a review of suspended sediment and turbidity data from three gages used in the USGS National Water Quality Assessment Program:

USGS 11074000 SANTA ANA R BL PRADO DAM CA
USGS 11447650 SACRAMENTO R A FREEPORT CA
USGS 11303500 SAN JOAQUIN R NR VERNALIS CA

The receiving water monitoring trigger represents staff determination that the trigger value is the most practicable based on available data. The turbidity receiving water monitoring trigger represents a bridge between the narrative effluent limitations and receiving water limitations. To support this receiving water monitoring trigger, State Water Board staff analyzed construction site discharge information (monitoring data, estimates) and receiving water monitoring information.

Since the turbidity receiving water monitoring trigger represents an appropriate threshold level expected at a site, compliance with this value does not necessarily represent compliance with either the narrative effluent limitations (as enforced through the BAT/BCT standard) or the receiving water limitations. In the San Diego region, some inland surface waters have a receiving water objective for turbidity equal to 20 NTU. Obviously a discharge up to, but not exceeding, the turbidity receiving water monitoring trigger of

[7] Caltrans Construction Sites Runoff Characterization Study, 2002. Available at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-02-055.pdf.

500 NTU may still cause or contribute to the exceedance of the 20 NTU standard. Most of the waters of the State are protected by turbidity objectives based on background conditions**.**

Table 1 - Regional Water Board Basin Plans, Water Quality Objectives for Turbidity

REGIONAL WATER BOARD	WQ Objective	Background/Natural Turbidity	Maximum Increase
1	Based on background	All levels	20%
2	Based on background	> 50 NTU	10%
3	Based on background	0-50 JTU 50-100 JTU > 100 JTU	20% 10 NTU 10%
4	Based on background	0-50 NTU > 50 NTU	20% 10%
5	Based on background	0-5 NTU 5-50 NTU 50-100 NTU >100 NTU	1 NTU 20% 10 NTU 10%
6	Based on background	All levels	10%
7	Based on background	N/A	N/A
8	Based on background	0-50 NTU 50-100 NTU >100 NTU	20% 10 NTU 10%
9	Inland Surface Waters, 20 NTU All others, based on background	0-50 NTU 50-100 NTU >100 NTU	20% 10 NTU 10%

Table 2 shows the suspended sediment concentrations at the 1.5 year flow recurrence interval for the 12 ecoregions in California from Simon et. al (2004).

Table 2 - Results of Ecoregion Analysis

Ecoregion	Percent of California Land Area	Median Suspended Sediment Concentration (mg/L)
1	9.1	874
4	0.2	120
5	8.8	35.6
6	20.7	1530
7	7.7	122
8	3.0	47.4
9	9.4	284
13	5.2	143
14	21.7	5150
78	8.1	581
80	2.4	199
81	3.7	503
Area-weighted average		1633

If a 1:3 relationship between turbidity and suspended sediment is assumed, the median turbidity is 544 NTU.

The following table is composed of turbidity readings measured in NTUs from administrative civil liability (ACL) actions for construction sites from 2003 - 2009. This data was derived from the complete listing of construction-related ACLs for the six year period. All ACLs were reviewed and those that included turbidimeter readings at the point of storm water discharge were selected for this dataset.

Table 3 – ACL Sampling Data taken by Regional Water Board Staff

WDID#	Region	Discharger	Turbidity (NTU)
5S34C331884	5S	Bradshaw Interceptor Section 6B	1800
5S05C325110	5S	Bridalwood Subdivision	1670
5S48C336297	5S	Cheyenne at Browns Valley	1629
5R32C314271	5R	Grizzly Ranch Construction	1400
6A090406008	6T	El Dorado County Department of Transportation, Angora Creek	97.4
5S03C346861	5S	TML Development, LLC	1600
6A31C325917	6T	Northstar Village	See Subdata Set

Subdata Set - Turbidity for point of storm water runoff discharge at Northstar Village

Date	Turbidity (NTU)	Location
10/5/2006	900	Middle Martis Creek
11/2/2006	190	Middle Martis Creek
01/04/2007	36	West Fork, West Martis Creek
02/08/2007	180	Middle Martis Creek
02/09/2007	130	Middle Martis Creek
02/09/2007	290	Middle Martis Creek
02/09/2007	100	West Fork, West Martis Creek
02/10/2007	28	Middle Martis Creek
02/10/2007	23	Middle Martis Creek
02/10/2007	32	Middle Martis Creek
02/10/2007	12	Middle Martis Creek
02/10/2007	60	West Fork, West Martis Creek
02/10/2007	34	West Fork, West Martis Creek

A 95% confidence interval for mean turbidity in an ACL order was constructed. The data set used was a small sample size, so the 500 NTU (the value derived as the receiving water monitoring trigger for this General Permit) needed to be verified as a possible population mean. In this case, the population refers to a hypothetical population of turbidity measurements of which our sample of 20 represents. A t-distribution was assumed due to the small sample size:

Mean: 512.23 NTU Standard Deviation: 686.85 **Margin of** Error: 321.45 Confidence Interval: 190.78 NTU (Low) 833.68 NTU (High)

Based on a constructed 95% confidence interval, an ACL order turbidity measurement will be between 190.78 – 833.68 NTU. 500 NTU falls within this range. Using the same data set, a small-sample hypothesis test was also performed to test if the ACL turbidity data set contains enough information to cast doubt on choosing a 500 NTU as a mean. 500 NTU was again chosen due to its proposed use as an acceptable value. The test was carried out using a 95% confidence interval. Results indicated that the ACL turbidity data set *does not* contain significant sample evidence to reject the claim of 500 NTU as an acceptable mean for the ACL turbidity population.

There are not many published, peer-reviewed studies and reports on in-situ performance of best management practices in terms of erosion and sediment control on active construction sites. The most often cited study is a report titled, "Improving the Cost Effectiveness of Highway Construction Site Erosion and Pollution Control" (Horner, Guedry, and Kortenhof 1990, http://www.wsdot.wa.gov/Research/Reports/200/200.1.htm). In a comment letter summarizing this report sent to the State Water Board, the primary author, Dr. Horner, states:

"The most effective erosion control product was wood fiber mulch applied at two different rates along with a bonding agent and grass seed in sufficient time before the tests to achieve germination. Plots treated in this way reduced influent turbidity by more than 97 percent and discharged effluent exhibiting mean and maximum turbidity values of 21 and 73 NTU, respectively. Some other mulch and blanket materials performed nearly as well. These tests demonstrated the control ability of widely available BMPs over a very broad range of erosion potential."

Other technologies studied in this report produced effluent quality at or near 100 NTU. It is the BPJ of the State Water Board staff that erosion control, while preferred, is not always an option on construction sites and that technology performance in a controlled study showing effluent quality directly leaving a BMP is always easier and cheaper to control than effluent being discharged from the project (edge of property, etc.). As a result, it is the BPJ of the State Water Board staff that it is not cost effective or feasible, at this time, for all risk level and type 3 sites in California to achieve effluent discharges with turbidity values that are less than 100 NTU.

To summarize, the analysis showed that: (1) results of the Simon et. al dataset reveals turbidity values in background receiving water in California's ecoregions range from 16 NTU to 1716 NTU (with a mean of 544 NTU); (2) based on a constructed 95% confidence interval, construction sites will be subject to administrative civil liability (ACL) when their turbidity measurement falls between 190.78 – 833.68 NTU; and (3) sites with highly controlled discharges employing and maintaining good erosion control practices can discharge effluent from the BMP with turbidity values less than 100 NTU. State Water Board staff has determined, using its BPJ, that it is most cost effective to set the receiving water monitoring trigger for turbidity at 500 NTU.

i. *Compliance Storm Event*

While this General Permit no longer contains "compliance storm event" exceptions from technology-based NELs, the "compliance storm event" exception from the ATS NELs remain in effect. See Section K of this Fact Sheet, and Attachment F of this General Permit for more information.

a. TMDLs and Waste Load Allocations

Dischargers located within the watershed of a CWA § 303(d) impaired water body, for which a TMDL for sediment has been adopted by the Regional Water Board or USEPA, must comply with the approved TMDL if it identifies "construction activity" or land disturbance as a source of sediment. If it does, the

TMDL should include a specific waste load allocation for this activity/source. The discharger, in this case, may be required by a separate Regional Water Board order to implement additional BMPs, conduct additional monitoring activities, and/or comply with an applicable waste load allocation and implementation schedule. If a specific waste load allocation has been established that would apply to a specific discharge, the Regional Water Board may adopt an order requiring specific implementation actions necessary to meet that allocation. In the instance where an approved TMDL has specified a general waste load allocation to construction storm water discharges, but no specific requirements for construction sites have been identified in the TMDL, dischargers must consult with the state TMDL authority[9] to confirm that adherence to a SWPPP that meets the requirements of the General Permit will be consistent with the approved TMDL.

2. Determining Compliance with Effluent Standards

a. Technology-Based Numeric Action Levels (NALs)

This General Permit contains technology-based NALs for pH and turbidity, and requirements for effluent monitoring at all Risk level 2 & 3, and LUP Type 2 & 3 sites. Numeric action levels are essentially numeric benchmark values for certain parameters that, if exceeded in effluent sampling, trigger the discharger to take actions. Exceedance of an NAL does not itself constitute a violation of the General Permit. If the discharger fails to take the corrective action required by the General Permit, though, that may consititute a violation.

The primary purpose of NALs is to assist dischargers in evaluating the effectiveness of their on-site measures. Construction sites need to employ many different systems that must work together to achieve compliance with the permit's requirements. The NALs chosen should indicate whether the systems are working as intended.

Another purpose of NALs is to provide information regarding construction activities and water quality impacts. This data will provide the State and Regional Water Boards and the rest of the storm water community with more information about levels and types of pollutants present in runoff and how effective the dischargers BMPs are at reducing pollutants in effluent. The State Water Board also hopes to learn more about the linkage between effluent and receiving water quality. In addition, these requirements will provide information on the mechanics needed to establish compliance monitoring programs at construction sites in future permit deliberations.

i. *pH*

The chosen limits were established by calculating one standard deviation above and below the mean pH of runoff from highway construction sites[10] in California. Proper implementation of BMPs should result in discharges that are within the range of 6.5 to 8.5 pH Units.

---

[9] http://www.waterboards.ca.gov/tmdl/tmdl.html.
[10] Caltrans Construction Sites Runoff Characterization Study, 2002. Available at: http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-02-055.pdf.

The Caltrans study included 33 highway construction sites throughout California over a period of four years, which included 120 storm events. All of these sites had BMPs in place that would be generally implemented at all types of construction sites in California.

ii. ***Turbidity***

BPJ was used to develop an NAL that can be used as a learning tool to help dischargers improve their site controls, and to provide meaningful information on the effectiveness of storm water controls. A statewide turbidity NAL has been set at 250 NTU.

G. Receiving Water Limitations

Construction-related activities that cause or contribute to an exceedance of water quality standards must be addressed. The dynamic nature of construction activity gives the discharger the ability to quickly identify and monitor the source of the exceedances. This is because when storm water mobilizes sediment, it provides visual cues as to where corrective actions should take place and how effective they are once implemented.

This General Permit requires that storm water discharges and authorized non-storm water discharges must not contain pollutants that cause or contribute to an exceedance of any applicable water quality objective or water quality standards. The monitoring requirements in this General Permit for sampling and analysis procedures will help determine whether BMPs installed and maintained are preventing pollutants in discharges from the construction site that may cause or contribute to an exceedance of water quality standards.

Water quality standards consist of designated beneficial uses of surface waters and the adoption of ambient criteria necessary to protect those uses. When adopted by the State Water Board or a Regional Water Board, the ambient criteria are termed “water quality objectives.” If storm water runoff from construction sites contains pollutants, there is a risk that those pollutants could enter surface waters and cause or contribute to an exceedance of water quality standards. For that reason, dischargers should be aware of the applicable water quality standards in their receiving waters. (The best method to ensure compliance with receiving water limitations is to implement BMPs that prevent pollutants from contact with storm water or from leaving the construction site in runoff.)

In California, water quality standards are published in the Basin Plans adopted by each Regional Water Board, the California Toxics Rule (CTR), the National Toxics Rule (NTR), and the Ocean Plan.

Dischargers can determine the applicable water quality standards by contacting Regional Water Board staff or by consulting one of the following sources. The actual Basin Plans that contain the water quality standards can be viewed at the website of the appropriate Regional Water Board. (http://www.waterboards.ca.gov/regions.html), the State Water Board site for statewide plans (http://www.waterboards.ca.gov/plnspols/index.html), or the USEPA regulations for the NTR and CTR (40 C.F.R. §§ 131.36-38). Basin Plans and statewide plans are also available by mail from the appropriate Regional Water Board or the State Water Board. The USEPA regulations are available at http://www.epa.gov/. Additional information concerning water quality standards can be accessed through http://www.waterboards.ca.gov/stormwtr/gen_const.html.

H. Training Qualifications and Requirements

The Blue Ribbon Panel (BRP) made the following observation about the lack of industry-specific training requirements:

“Currently, there is no required training or certification program for contractors, preparers of soil erosion and sediment control Storm Water Pollution Prevention Plans, or field inspectors.”

Order 99-08-DWQ required that all dischargers train their employees on how to comply with the permit, but it did not specificy a curriculum or certification program. This has resulted in inconsistent implementation by all affected parties - the dischargers, the local governments where the construction activity occurs, and the regulators required to enforce 99-08-DWQ. This General Permit requires Qualified SWPPP Developers and practitioners to obtain appropriate training, and makes this curriculum mandatory two years after adoption, to allow time for course completion. The State and Regional Water Board are working with many stakeholders to develop the curriculum and mechanisms needed to develop and deliver the courses.

To ensure that the preparation, implementation, and oversight of the SWPPP is sufficient for effective pollution prevention, the Qualified SWPPP Developer and Qualified SWPPP Practitioners responsible for creating, revising, overseeing, and implementing the SWPPP must attend a State Water Board-sponsored or approved Qualified SWPPP Developer and Qualified SWPPP Practitioner training course.

I. Sampling, Monitoring, Reporting and Record Keeping

1. Traditional Construction Monitoring Requirements

This General Permit requires visual monitoring at all sites, and effluent water quality at all Risk Level 2 & 3 sites. It requires receiving water monitoring at some Risk Level 3 sites. All sites are required to submit annual reports, which contain various types of information, depending on the site characteristics and events. A summary of the monitoring and reporting requirements is found in Table 4.

Table 4 - Required Monitoring Elements for Risk Levels

	Visual	Non-visible Pollutant	Effluent	Receiving Water
Risk Level 1	three types required for all Risk Levels: non-storm water, pre-rain and post-rain	As needed for all Risk Levels (see below)	where applicable	not required
Risk Level 2			pH, turbidity	not required
Risk Level 3			pH, turbidity	(if Receiving Water Monitoring Trigger exceeded) pH, turbidity and SSC. Bioassessment for sites 30 acres or larger.

a. Visual

All dischargers are required to conduct quarterly, non-storm water visual inspections. For these inspections, the discharger must visually observe each drainage area for the presence of (or indications of prior) unauthorized and authorized non-storm water discharges and their sources. For storm-related inspections, dischargers must visually observe storm water discharges at all discharge locations within two business days after a qualifying event. For this requirement, a qualifying rain event is one producing precipitation of ½ inch or more of discharge. Dischargers must conduct a post-storm event inspection to (1) identify whether BMPs were adequately designed, implemented, and effective, and (2) identify any additional BMPs necessary and revise the SWPPP accordingly. Dischargers must maintain on-site records of all visual observations, personnel performing the observations, observation dates, weather conditions, locations observed, and corrective actions taken in response to the observations.

b. Non-Visible Pollutant Monitoring

This General Permit requires that all dischargers develop a sampling and analysis strategy for monitoring pollutants that are not visually detectable in storm water. Monitoring for non-visible pollutants must be required at any construction site when the exposure of construction materials occurs and where a discharge can cause or contribute to an exceedance of a water quality objective.

Of significant concern for construction discharges are the pollutants found in materials used in large quantities at construction sites throughout California and exposed throughout the rainy season, such as cement, flyash, and other recycled materials or by-products of combustion. The water quality standards that apply to these materials will depend on their composition. Some of the more common storm water pollutants from construction activity are not CTR pollutants. Examples of non-visible pollutants include glyphosate (herbicides), diazinon and chlorpyrifos (pesticides), nutrients (fertilizers), and molybdenum (lubricants). The use of diazinon and chlorpyrifos is a common practice among landscaping professionals and may trigger sampling and analysis requirements if these materials come into contact with storm water. High pH values from cement and gypsum, high pH and SSC from wash waters, and chemical/fecal contamination from portable toilets, also are not CTR pollutants. Although some of these constituents do have numeric water quality objectives in individual Basin Plans, many do not and are subject only to narrative water quality standards (i.e. not causing toxicity). Dischargers are encouraged to discuss these issues with Regional Water Board staff and other storm water quality professionals.

The most effective way to avoid the sampling and analysis requirements, and to ensure permit compliance, is to avoid the exposure of construction materials to precipitation and storm water runoff. Materials that are not exposed do not have the potential to enter storm water runoff, and therefore receiving waters sampling is not required. Preventing contact between storm water and construction materials is one of the most important BMPs at any construction site.

Preventing or eliminating the exposure of pollutants at construction sites is not always possible. Some materials, such as soil amendments, are designed to be used in a manner that will result in exposure to storm water. In these cases, it is important to make sure that these materials are applied according to the manufacturer's instructions and at a time when they are unlikely to be washed away. Other construction materials can be exposed when storage, waste disposal or the application of the material is done in a manner not protective of water quality. For these situations, sampling is required unless there is capture and containment of all storm water that has been exposed. In cases where construction materials may be exposed to storm water, but the storm water is contained and is not allowed to run off the site, sampling will only be required when inspections show that the containment failed or is breached, resulting in potential exposure or discharge to receiving waters.

The discharger must develop a list of potential pollutants based on a review of potential sources, which will include construction materials soil amendments, soil treatments, and historic contamination at the site. The discharger must review existing environmental and real estate documentation to determine the potential for pollutants that could be present on the construction site as a result of past land use activities.

Good sources of information on previously existing pollution and past land uses include:

i. Environmental Assessments;

ii. Initial Studies;

iii. Phase 1 Assessments prepared for property transfers; and

iv. Environmental Impact Reports or Environmental Impact Statements prepared under the requirements of the National Environmental Policy Act or the California Environmental Quality Act.

In some instances, the results of soil chemical analyses may be available and can provide additional information on potential contamination.

The potential pollutant list must include all non-visible pollutants that are known or should be known to occur on the construction site including, but not limited to, materials that:

i. are being used in construction activities;

ii. are stored on the construction site;

iii. were spilled during construction operations and not cleaned up;

iv. were stored (or used) in a manner that created the potential for a release of the materials during past land use activities;

v. were spilled during previous land use activities and not cleaned up; or

vi. were applied to the soil as part of past land use activities.

C. Effluent Monitoring

Federal regulations[11] require effluent monitoring for discharges subject to NALs. Subsequently, all Risk Level 2 and 3 dischargers must perform sampling and analysis of effluent discharges to characterize discharges associated with construction activity from the entire area disturbed by the project. Dischargers must collect samples of stored or contained storm water that is discharged subsequent to a storm event producing precipitation of ½ inch or more at the time of discharge.

Table 5 - Storm Water Effluent Monitoring Requirements by Risk Level

	Frequency	Effluent Monitoring (Section E, below)
Risk Level 1	when applicable	non-visible pollutant parameters (if applicable)
Risk Level 2	Minimum of 3 samples per day during qualifying rain event characterizing discharges associated with construction activity from the entire project disturbed area.	pH, turbidity, and non-visible pollutant parameters (if applicable)
Risk Level 3	Minimum of 3 samples per day during qualifying rain event characterizing discharges associated with construction activity from the entire project disturbed area.	pH, turbidity, and non-visible pollutant parameters if applicable

Risk Level 1 dischargers must analyze samples for:

i. any parameters indicating the presence of pollutants identified in the pollutant source assessment required in Attachment C contained in the General Permit.

[11] 40 C.F.R. § 122.44.

Risk Level 2 dischargers must analyze samples for:

i. pH and turbidity;

ii. any parameters indicating the presence of pollutants identified in the pollutant source assessment required in Attachment D contained in the General Permit, and

iii. any additional parameters for which monitoring is required by the Regional Water Board.

Risk Level 3 dischargers must analyze samples for:

i. pH, turbidity;

ii. any parameters indicating the presence of pollutants identified in the pollutant source assessment required in Attachment E contained in the General Permit, and

iii. any additional parameters for which monitoring is required by the Regional Water Board.

2. Linear Monitoring and Sampling Requirements

Attachment A, establishes minimum monitoring and reporting requirements for all LUPs. It establishes different monitoring requirements depending on project complexity and risk to water quality. The monitoring requirements for Type 1 LUPs are less than Type 2 & 3 projects because Type 1 projects have a lower potential to impact water quality.

A discharger shall prepare a monitoring program prior to the start of construction and immediately implement the program at the start of construction for LUPs. The monitoring program must be implemented at the appropriate level to protect water quality at all times throughout the life of the project.

a. Type 1 LUP Monitoring Requirements

A discharger must conduct daily visual inspections of Type 1 LUPs during working hours while construction activities are occurring. Inspections are to be conducted by qualified personnel and can be conducted in conjunction with other daily activities. Inspections will be conducted to ensure the BMPs are adequate, maintained, and in place at the end of the construction day. The discharger will revise the SWPPP, as appropriate, based on the results of the daily inspections. Inspections can be discontinued in non-active construction areas where soil disturbing activities have been completed and final stabilization has been achieved (e.g., trench has been paved, substructures have been installed, and successful final vegetative cover or other stabilization criteria have been met).

A discharger shall implement the monitoring program for inspecting Type 1 LUPs. This program requires temporary and permanent stabilization BMPs after active construction is completed. Inspection activities will continue until adequate permanent stabilization has been established and will continue in areas where re-vegetation is chosen until minimum vegetative coverage has been established. Photographs shall be taken during site inspections and submitted to the State Water Board.

b. Type 2 & 3 LUP Monitoring Requirements

A discharger must conduct daily visual inspections of Type 2 & 3 LUPs during working hours while construction activities are occurring. Inspections are to be conducted by qualified personnel and can be in conjunction with other daily activities.

All dischargers of Type 2 & 3 LUPs are required to conduct inspections by qualified personnel of the construction site during normal working hours prior to all anticipated storm events and after actual storm events. During extended storm events, the discharger shall conduct inspections during normal working hours for each 24-hour period. Inspections can be discontinued in non-active construction areas where soil disturbing activities have been completed and final stabilization has been achieved (e.g., trench has been paved, substructures installed, and successful vegetative cover or other stabilization criteria have been met).

The goals of these inspections are (1) to identify areas contributing to a storm water discharge; (2) to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly installed and functioning in accordance with the terms of the General Permit; and (3) to determine whether additional control practices or corrective maintenance activities are needed. Equipment, materials, and workers must be available for rapid response to failures and emergencies. All corrective maintenance to BMPs shall be performed as soon as possible, depending upon worker safety.

All dischargers shall develop and implement a monitoring program for inspecting Type 2 & 3 LUPs that require temporary and permanent stabilization BMPs after active construction is completed. Inspections will be conducted to ensure the BMPs are adequate and maintained. Inspection activities will continue until adequate permanent stabilization has been established and will continue in areas where revegetation is chosen until minimum vegetative coverage has been established.

A log of inspections conducted before, during, and after the storm events must be maintained in the SWPPP. The log will provide the date and time of the inspection and who conducted the inspection. Photographs must be taken during site inspections and submitted to the State Water Board.

C. Sampling Requirements for all LUP Project Types

LUPs are also subject to sampling and analysis requirements for visible pollutants (i.e., sedimentation/siltation, turbidity) and for non-visible pollutants.

Sampling for visible pollutants is required for Type 2 & 3 LUPs.

Non-visible pollutant monitoring is required for pollutants associated with construction sites and activities that (1) are not visually detectable in storm water discharges, and (2) are known or should be known to occur on the construction site, and (3) could cause or contribute to an exceedance of water quality objectives in the receiving waters. Sample collection for non-visible pollutants must only be required (1) during a storm event when pollutants associated with construction activities may be discharged with storm water runoff due to a spill, or in the event there was a breach, malfunction, failure, and/or leak of any BMP, and (2) when the discharger has failed to adequately clean the area of material and pollutants. Failure to implement appropriate BMPs will trigger the same sampling requirements as those required for a breach, malfunction and/or leak, or when the discharger has failed to implement appropriate BMPs prior to the next storm event.

Additional monitoring parameters may be required by the Regional Water Boards.

It is not anticipated that many LUPs will be required to collect samples for pollutants not visually detected in runoff due to the nature and character of the construction site and activities as previously described in this fact sheet. Most LUPs are constructed in urban areas with public access (e.g., existing roadways, road shoulders, parking areas, etc.). This raises a concern regarding the potential contribution of pollutants from vehicle use and/or from normal activities of the public (e.g., vehicle washing, landscape fertilization, pest spraying, etc.) in runoff from the project site. Since the dischargers are not the land owners of the project area and are not able to control the presence of these pollutants in the storm water that runs through their projects, it is not the intent of this General Permit to require dischargers to sample for these pollutants. This General Permit does not require the discharger to sample for these types of pollutants except where the discharger has brought materials onsite that contain these pollutants and when a condition (e.g., breach, failure, etc.) described above occurs.

3. Receiving Water Monitoring

In order to ensure that receiving water limitations are met, discharges subject to receiving water monitoring triggers (i.e., Risk Level 3 and LUP Type 3 sites) or numeric effluent limitations (i.e., Risk Level 3 and LUP Type 3 sites utilizing ATS with direct discharges into receiving waters) must also monitor the downstream receiving water(s) for turbidity, SSC, and pH (if applicable) when a receiving water monitoring trigger or NEL is exceeded.

a. Bioassessment Monitoring

This General Permit requires a bioassessment of receiving waters for dischargers of Risk Level 3 or LUP Type 3 construction projects equal to or larger than 30 acres with direct discharges into receiving waters. Benthic macroinvertebrate samples will be taken upstream and downstream of the site's discharge point in the receiving water. Bioassessments measure the quality of the stream by analyzing the aquatic life present. Higher levels of appropriate aquatic species tend to indicate a healthy stream; whereas low levels of organisms can indicate stream degradation. Active construction sites have the potential to discharge large amounts of sediment and pollutants into receiving waters. Requiring a bioassessment for large project sites, with the most potential to impact water quality, provides a snapshot of the health of the receiving water prior to initiation of construction activities. This snapshot can be used in comparison to the health of the receiving water after construction has commenced.

Each ecoregion (biologically and geographically related area) in the State has a specific yearly peak time where stream biota is in a stable and abundant state. This time of year is called an Index Period. The bioassessment requirements in this General Permit, requires benthic macroinvertebrate sampling within a sites index period. The State Water Board has developed a map designating index periods for the ecoregions in the State (see State Water Board Website).

This General Permit requires the bioassessment methods to be in accordance with the Surface Water Ambient Monitoring Program (SWAMP) in order to provide data consistency within the state as well as generate useable biological stream data.

Table 6 - Receiving Water Monitoring Requirements

	Receiving Water Monitoring Parameters
Risk Level 1 /LUP Type 1	not required
Risk Level 2 / LUP Type 2	not required
Risk Level 3 / LUP Type 3	If Receiving Water Monitoring Trigger exceeded: pH (if applicable), turbidity, and SSC. Bioassessment for sites 30 acres or larger.

4. Reporting Requirements

a. NAL Exceedance Report

All Risk Level 3 and LUP Type 3 dischargers must electronically submit all storm event sampling results to the State And Regional Boards, via the electronic data system, no later than 10 days after the conclusion of the storm event.

b. Annual Report

All dischargers must prepare and electronically submit an annual report no later than September 1 of each year using the Storm water Multi-Application Reporting and Tracking System (SMARTS). The

Annual Report must include a summary and evaluation of all sampling and analysis results, original laboratory reports, chain of custody forms, a summary of all corrective actions taken during the compliance year, and identification of any compliance activities or corrective actions that were not implemented.

5. Record Keeping

According to 40 C.F.R. Parts 122.21(p) and 122.41(j), the discharger is required to retain paper or electronic copies of all records required by this General Permit for a period of at least three years from the date generated or the date submitted to the State Water Board or Regional Water Boards. A discharger must retain records for a period beyond three years as directed by Regional Water Board.

J. Risk Determination

1. Traditional Projects

a. Overall Risk Determination

There are two major requirements related to site planning and risk determination in this General Permit. The project's overall risk is broken up into two elements – (1) project sediment risk (the relative amount of sediment that can be discharged, given the project and location details) and (2) receiving water risk (the risk sediment discharges pose to the receiving waters).

Project Sediment Risk:
Project Sediment Risk is determined by multiplying the R, K, and LS factors from the Revised Universal Soil Loss Equation (RUSLE) to obtain an estimate of project-related bare ground soil loss expressed in tons/acre. The RUSLE equation is as follows:

$$A = (R)(K)(LS)(C)(P)$$

Where: A = the rate of sheet and rill erosion
R = rainfall-runoff erosivity factor
K = soil erodibility factor
LS = length-slope factor
C = cover factor (erosion controls)
P = management operations and support practices (sediment controls)

The C and P factors are given values of 1.0 to simulate bare ground conditions.

There is a map option and a manual calculation option for determining soil loss. For the map option, the R factor for the project is calculated using the online calculator at http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm. The product of K and LS are shown on Figure 1. To determine soil loss in tons per acre, the discharger multiplies the R factor times the value for K times LS from the map.

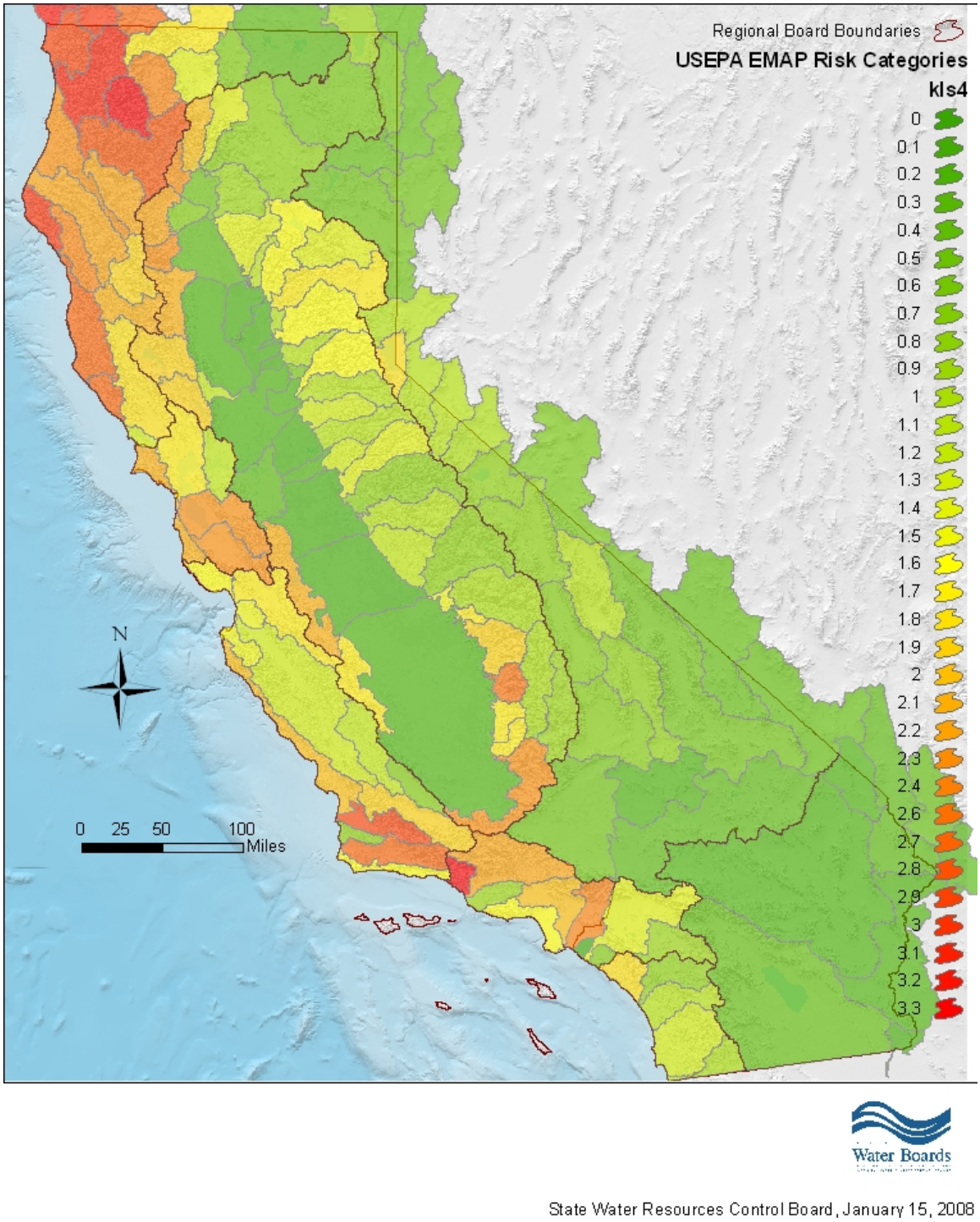


Figure 1 -Statewide Map of K * LS

For the manual calculation option, the R factor for the project is calculated using the online calculator at http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm. The K and LS factors are determined using Appendix 1.

Soil loss of less than 15 tons/acre is considered **low** sediment risk.
Soil loss between 15 and 75 tons/acre is **medium** sediment risk.
Soil loss over 75 tons/acre is considered **high** sediment risk.

The soil loss values and risk categories were obtained from mean and standard deviation RKLS values from the USEPA EMAP program. High risk is the mean RKLS value plus two standard deviations. Low risk is the mean RKLS value minus two standard deviations.

Receiving Water Risk:
Receiving water risk is based on whether a project drains to a sediment-sensitive waterbody. A sediment-sensitive waterbody is either

on the most recent 303d list for waterbodies impaired for sediment;
has a USEPA-approved Total Maximum Daily Load implementation plan for sediment; **or**
has the beneficial uses of COLD, SPAWN, and MIGRATORY.

A project that meets at least one of the three criteria has a high receiving water risk. A list of sediment-sensitive waterbodies will be posted on the State Water Board's website. It is anticipated that an interactive map of sediment sensitive water bodies in California will be available in the future.

The Risk Levels have been altered by eliminating the possibility of a Risk Level 4, and expanding the constraints for Risk Levels 1, 2, and 3. Therefore, projects with high receiving water risk and high sediment risk will be considered a Risk Level 3 risk to water quality.

In response to public comments, the Risk Level requirements have also been changed such that Risk Level 1 projects will be subject to minimum BMP and visual monitoring requirements, Risk Level 2 projects will be subject to NALs and some additional monitoring requirements, and Risk Level 3 projects will be subject to NALs, and more rigorous monitoring requirements such as receiving water monitoring and in some cases bioassessment.

Table 7 - Combined Risk Level Matrix

Combined Risk Level Matrix				
Receiving Water Risk		Sediment Risk		
		Low	Medium	High
	Low	Level 1	Level 2	
	High	Level 2		Level 3

b. Effluent Standards

All dischargers are subject to the narrative effluent limitations specified in the General Permit. The narrative effluent limitations require storm water discharges associated with construction activity to meet all applicable provisions of Sections 301 and 402 of the CWA. These provisions require controls of pollutant discharges that utilize BAT and BCT to reduce pollutants and any more stringent controls necessary to meet water quality standards.

Risk Level 2 dischargers that pose a medium risk to water quality are subject to technology-based NALs for pH and turbidity. Risk Level 3 dischargers that pose a high risk to water quality are also subject to technology-based NALs for pH and turbidity.

c. **Good Housekeeping**

Proper handling and managing of construction materials can help minimize threats to water quality. The discharger must consider good housekeeping measures for: construction materials, waste management, vehicle storage & maintenance, landscape materials, and potential pollutant sources. Examples include; conducting an inventory of products used, implementing proper storage & containment, and properly cleaning all leaks from equipment and vehicles.

d. **Non-Storm Water Management**

Non-storm water discharges directly connected to receiving waters or the storm drain system have the potential to negatively impact water quality. The discharger must implement measures to control all non-storm water discharges during construction, and from dewatering activities associated with construction. Examples include; properly washing vehicles in contained areas, cleaning streets, and minimizing irrigation runoff.

e. **Erosion Control**

The best way to minimize the risk of creating erosion and sedimentation problems during construction is to disturb as little of the land surface as possible by fitting the development to the terrain. When development is tailored to the natural contours of the land, little grading is necessary and, consequently, erosion potential is lower.[14] Other effective erosion control measures include: preserving existing vegetation where feasible, limiting disturbance, and stabilizing and re-vegetating disturbed areas as soon as possible after grading or construction activities. Particular attention must be paid to large, mass-graded sites where the potential for soil exposure to the erosive effects of rainfall and wind is great and where there is potential for significant sediment discharge from the site to surface waters. Until permanent vegetation is established, soil cover is the most cost-effective and expeditious method to protect soil particles from detachment and transport by rainfall. Temporary soil stabilization can be the single most important factor in reducing erosion at construction sites. The discharger is required to consider measures such as: covering disturbed areas with mulch, temporary seeding, soil stabilizers, binders, fiber rolls or blankets, temporary vegetation, and permanent seeding. These erosion control measures are only examples of what should be considered and should not preclude new or innovative approaches currently available or being developed. Erosion control BMPs should be the primary means of preventing storm water contamination, and sediment control techniques should be used to capture any soil that becomes eroded.[12]

Risk Level 3 dischargers pose a higher risk to water quality and are therefore additionally required to ensure that post-construction soil loss is equivalent to or less than the pre-construction levels.

f. **Sediment Control**

Sediment control BMPs should be the secondary means of preventing storm water contamination. When erosion control techniques are ineffective, sediment control techniques should be used to capture any soil that becomes eroded. The discharger is required to consider perimeter control measures such as: installing silt fences or placing straw wattles below slopes. These sediment control measures are only

---

[12] U.S. Environmental Protection Agency. 2007. Developing Your Storm Water Pollution Prevention Plan: A Guide for Construction Sites.

examples of what should be considered and should not preclude new or innovative approaches currently available or being developed.

Because Risk Level 2 and 3 dischargers pose a higher risk to water quality, additional requirements for the application of sediment controls are imposed on these projects. This General Permit also authorizes the Regional Water Boards to require Risk Level 3 dischargers to implement additional site-specific sediment control requirements if the implementation of other erosion or sediment controls are not adequately protecting the receiving waters.

g. Run-on and Runoff Control

Inappropriate management of run-on and runoff can result in excessive physical impacts to receiving waters from sediment and increased flows. The discharger is required to manage all run-on and runoff from a project site. Examples include: installing berms and other temporary run-on and runoff diversions.

Risk Level 1 dischargers with lower risks to impact water quality are not subject to the run-on and runoff control requirements unless an evaluation deems them necessary or visual inspections show that such controls are required.

h. Inspection, Maintenance and Repair

All measures must be periodically inspected, maintained and repaired to ensure that receiving water quality is protected. Frequent inspections coupled with thorough documentation and timely repair is necessary to ensure that all measures are functioning as intended.

i. Rain Event Action Plan (REAP)

A Rain Event Action Plan (REAP) is a written document, specific for each rain event. A REAP should be designed that when implemented it protects all exposed portions of the site within 48 hours of any likely precipitation event forecast of 50% or greater probability.

This General Permit requires Risk Level 2 and 3 dischargers to develop and implement a REAP designed to protect all exposed portions of their sites within 48 hours prior to any likely precipitation event. The REAP requirement is designed to ensure that the discharger has adequate materials, staff, and time to implement erosion and sediment control measures that are intended to reduce the amount of sediment and other pollutants generated from the active site. A REAP must be developed when there is likely a forecast of 50% or greater probability of precipitation in the project area. (The National Oceanic and Atmospheric Administration (NOAA) defines a chance of precipitation as a probability of precipitation of 30% to 50% chance of producing precipitation in the project area.[13] NOAA defines the probability of precipitation (PoP) as the likelihood of occurrence (expressed as a percent) of a measurable amount (0.01 inch or more) of liquid precipitation (or the water equivalent of frozen precipitation) during a specified period of time at any given point in the forecast area.) Forecasts are normally issued for 12-hour time periods. Descriptive terms for uncertainty and aerial coverage are used as follows:

Table 8 -National Oceanic and Atmospheric Administration (NOAA) Definition of Probability of Precipitation (PoP)

[13] http://www.crh.noaa.gov/lot/severe/wxterms.php.

PoP	Expressions of Uncertainty	Aerial Coverage
0%	none used	none used
10%	none used	isolated
20%	slight chance	isolated
30-50%	chance	scattered
60-70%	likely	numerous
80-100%	none used	none used

The discharger must obtain the precipitation forecast information from the National Weather Service Forecast Office (http://www.srh.noaa.gov/).

2. Linear Projects

a. Linear Risk Determination

LUPs vary in complexity and water quality concerns based on the type of project. This General Permit has varying application requirements based on the project's risk to water quality. Factors that lead to the characterization of the project include location, sediment risk, and receiving water risk.

Based on the location and complexity of a project area or project section area, LUPs are separated into project types. As described below, LUPs have been categorized into three project types.

i. *Type 1 LUPs*

Type 1 LUPs are those construction projects where:

(1) 70 percent or more of the construction activity occurs on a paved surface and where areas disturbed during construction will be returned to preconstruction conditions or equivalent protection established at the end of the construction activities for the day, or

(2) greater than 30 percent of construction activities occur within the non-paved shoulders or land immediately adjacent to paved surfaces, or where construction occurs on unpaved improved roads, including their shoulders or land immediately adjacent to them where:

Areas disturbed during construction will be returned to pre-construction conditions or equivalent protection established at the end of the construction activities for the day to minimize the potential for erosion and sediment deposition, and

Areas where established vegetation was disturbed during construction will be stabilized and re-vegetated by the end of project. When required, adequate temporary stabilization Best Management Practices (BMPs) will be installed and maintained until vegetation is established to meet minimum cover requirements established in this General Permit for final stabilization.

Type 1 LUPs typically do not have a high potential to impact storm water quality because (1) these construction activities are not typically conducted during a rain event, (2) these projects are normally constructed over a short period of time[14], minimizing the duration that pollutants could potentially be exposed to rainfall; and (3) disturbed soils such as those from trench excavation are required to be hauled away, backfilled into the trench, and/or covered (e.g., metal plates, pavement, plastic covers over spoil piles) at the end of the construction day.

Type 1 LUPs are determined during the risk assessment found in Attachment A.1 to be 1) low sediment risk and low receiving water risk; 2) low sediment risk and medium receiving water risk; and 3) medium sediment risk and low receiving water risk.

This General Permit requires the discharger to ensure a SWPPP is developed for these construction activities that is specific to project type, location and characteristics.

ii. ***Type 2 LUPs:***

Type 2 projects are determined to have a combination of High, Medium, and Low project sediment risk along with High, Medium, and Low receiving water risk. Like Type 1 projects, Type 2 projects are typically constructed over a short period of time. However, these projects have a higher potential to impact water quality because they:

(1) typically occur outside the more urban/developed areas;

(2) have larger areas of soil disturbance that are not closed or restored at the end of the day;

(3) may have onsite stockpiles of soil, spoil and other materials;

(4) cross or occur in close proximity to a wide variety of sensitive resources that may include, but are not limited to, steep topography and/or water bodies; and

(5) have larger areas of disturbed soils that may be exposed for a longer time interval before final stabilization, cleanup and/or reclamation occurs.

This General Permit requires the discharger to develop and implement a SWPPP for these construction activities that are specific for project type, location and characteristics.

iii. ***Type 3 LUPs:***

[14] Short period of time refers to a project duration of weeks to months, but typically less than one year in duration.

Type 3 projects are determined to have a combination of High and Medium project sediment risk along with High and Medium receiving water risk. Similar to Type 2 projects, Type 3 projects have a higher potential to impact water quality because they:

(1) typically occur outside of the more urban/developed areas;

(2) have larger areas of soil disturbance that are not closed or restored at the end of the day;

(3) may have onsite stockpiles of soil, spoil and other materials;

(4) cross or occur in close proximity to a wide variety of sensitive resources that may include, but are not limited to, steep topography and/or water bodies; and

(5) have larger areas of disturbed soils that may be exposed for a longer time interval before final stabilization, cleanup and/or reclamation occurs.

This General Permit requires the discharger to develop and implement a SWPPP for these construction activities that are specific for project type, location, and characteristics.

b. Linear Effluent Standards

All LUPs are subject to the narrative effluent limitations specified in the General Permit.

Type 2 and Type 3 projects are subject to technology-based NALs for pH and turbidity.

c. Linear Good Housekeeping

Improper use and handling of construction materials could potentially cause a threat to water quality. In order to ensure proper site management of these construction materials, all LUP dischargers must comply with a minimum set of Good Housekeeping measures specified in Attachment A of this General Permit.

d. Linear Non-Storm Water Management

In order to ensure control of all non-storm water discharges during construction, all LUP dischargers must comply with the Non-Storm Water Management measures specified in Attachment A of this General Permit.

e. Linear Erosion Control

This General Permit requires all LUP dischargers to implement effective wind erosion control measures, and soil cover for inactive areas. Type 3 LUPs posing a higher risk to water quality are additionally required to ensure the post-construction soil loss is equivalent to or less than the pre-construction levels.

f. Linear Sediment Control

In order to ensure control and containment of all sediment discharges, all LUP dischargers must comply with the general Sediment Control measures specified in Attachment A or this General Permit. Additional requirements for sediment controls are imposed on Type 2 & 3 LUPs due to their higher risk to water quality.

g. Linear Run-on and Runoff Control

Discharges originating outside of a project's perimeter and flowing onto the property can adversely affect the quantity and quality of discharges originating from a project site. In order to ensure proper management of run-on and runoff, all LUPs must comply with the run-on and runoff control measures specified in Attachment A of this General Permit. Due to the lower risk of impacting water quality, Type 1 LUPs are not required to implement run-on and runoff controls unless deemed necessary by the discharger.

h. Linear Inspection, Maintenance and Repair

Proper inspection, maintenance, and repair activities are important to ensure the effectiveness of on-site measures to control water quality. In order to ensure that inspection, maintenance, and repair activities are adequately performed, the all LUP dischargers a re required to comply with the Inspection, Maintenance, and Repair requirements specified in Attachment A of this General Permit.

K. ATS[15] Requirements

There are instances on construction sites where traditional erosion and sediment controls do not effectively control accelerated erosion. Under such circumstances, or under circumstances where storm water discharges leaving the site may cause or contribute to an exceedance of a water quality standard, the use of an Active Treatment System (ATS) may be necessary. Additionally, it may be appropriate to use an ATS when site constraints inhibit the ability to construct a correctly sized sediment basin, when clay and/or highly erosive soils are present, or when the site has very steep or long slope lengths.[16]

Although treatment systems have been in use in some form since the mid-1990s, the ATS industry in California is relatively young, and detailed regulatory standards have not yet been developed. Many developers are using these systems to treat storm water discharges from their construction sites. The new ATS requirements set forth in this General Permit are based on those in place for small wastewater treatment systems, ATS regulations from the Central Valley Regional Water Quality Control Board (September 2005 memorandum "2005/2006 Rainy Season – Monitoring Requirements for Storm Water Treatment Systems that Utilize Chemical Additives to Enhance Sedimentation"), the Construction Storm Water Program at the State of Washington's Department of Ecology, as well as recent advances in technology and knowledge of coagulant performance and aquatic safety.

The effective design of an ATS requires a detailed survey and analysis of site conditions. With proper planning, ATS performance can provide exceptional water quality discharge and prevent significant impacts to surface water quality, even under extreme environmental conditions.

These systems can be very effective in reducing the sediment in storm water runoff, but the systems that use additives/polymers to enhance sedimentation also pose a potential risk to water quality (e.g., operational failure, equipment failure, additive/polymer release, etc.). The State Water Board is concerned about the potential acute and chronic impacts that the polymers and other chemical additives may have on fish and aquatic organisms if released in sufficient quantities or concentrations. In addition

---

[15] An ATS is a treatment system that employs chemical coagulation, chemical flocculation, or electrocoagulation in order to reduce turbidity caused by fine suspended sediment.
[16] Pitt, R., S. Clark, and D. Lake. 2006. Construction Site Erosion and Sediment Controls: Planning, Design, and Performance. DEStech Publications. Lancaster, PA. 370pp.

to anecdotal evidence of polymer releases causing aquatic toxicity in California, the literature supports this concern.[17] For example, cationic polymers have been shown to bind with the negatively charged gills of fish, resulting in mechanical suffocation.[18] Due to the potential toxicity impacts, which may be caused by the release of additives/polymers into receiving waters, this General Permit establishes residual polymer monitoring and toxicity testing requirements have been established in this General Permit for discharges from construction sites that utilize an ATS in order to protect receiving water quality and beneficial uses.

The primary treatment process in an ATS is coagulation/flocculation. ATS's operate on the principle that the added coagulant is bound to suspended sediment, forming floc, which is gravitationally settled in tanks or a basin, or removed by sand filters. A typical installation utilizes an injection pump upstream from the clarifier tank, basin, or sand filters, which is electronically metered to both flow rate and suspended solids level of the influent, assuring a constant dose. The coagulant mixes and reacts with the influent, forming a dense floc. The floc may be removed by gravitational setting in a clarifier tank or basin, or by filtration. Water from the clarifier tank, basin, or sand filters may be routed through cartridge(s) and/or bag filters for final polishing. Vendor-specific systems use various methods of dose control, sediment/floc removal, filtration, etc., that are detailed in project-specific documentation. The particular coagulant/flocculant to be used for a given project is determined based on the water chemistry of the site because the coagulants are specific in their reactions with various types of sediments. Appropriate selection of dosage must be carefully matched to the characteristics of each site.

ATS's are operated in two differing modes, either Batch or Flow-Through. Batch treatment can be defined as Pump-Treat-Hold-Test-Release. In Batch treatment, water is held in a basin or tank, and is not discharged until treatment is complete. Batch treatment involves holding or recirculating the treated water in a holding basin or tank(s) until treatment is complete or the basin or storage tank(s) is full. In Flow-Through treatment, water is pumped into the ATS directly from the runoff collection system or storm water holding pond, where it is treated and filtered as it flows through the system, and is then directly discharged. "Flow-Through Treatment" is also referred to as "Continuous Treatment."

1. Effluent Standards

This General Permit establishes NELs for discharges from construction sites that utilize an ATS. These systems lend themselves to NELs for turbidity and pH because of their known reliable treatment. Advanced systems have been in use in some form since the mid-1990s. An ATS is considered reliable, can consistently produce a discharge of less than 10 NTU, and has been used successfully at many sites in several states since 1995 to reduce turbidity to very low levels.[19]

This General Permit contains "compliance storm event" exceptions from the technology-based NELs for ATS discharges. The rationale is that technology-based requirements are developed assuming a certain design storm. In the case of ATS the industry-standard design storm is 10-year, 24-hour (as stated in

---

[17] RomØen, K., B. Thu, and Ø. Evensen. 2002. Immersion delivery of plasmid DNA II. A study of the potentials of a chitosan based delivery system in rainbow trout (*Oncorhynchus mykiss*) fry. *Journal of Controlled Release* **85**: 215-225.

[18] Bullock, G., V. Blazer, S. Tsukuda, and S. Summerfelt. 2000. Toxicity of acidified chitosan for cultured rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* **185**:273-280.

[19] Currier, B., G. Minton, R. Pitt, L. Roesner, K. Schiff, M. Stenstrom, E. Strassler, and E. Strecker. 2006. The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities.

Attachment F of this General Permit), so the compliance storm event has been established as the 10-year 24-hour event as well to provide consistency.

2. **Training**

Operator training is critical to the safe and efficient operation and maintenance of the ATS, and to ensure that all State Water Board monitoring and sampling requirements are met. The General Permit requires that all ATS operators have training specific to using ATS's liquid coagulants.

L. Post-Construction Requirements

Under past practices, new and redevelopment construction activities have resulted in modified natural watershed and stream processes. This is caused by altering the terrain, modifying the vegetation and soil characteristics, introducing impervious surfaces such as pavement and buildings, increasing drainage density through pipes and channels, and altering the condition of stream channels through straightening, deepening, and armoring. These changes result in a drainage system where sediment transport capacity is increased and sediment supply is decreased. A receiving channel's response is dependent on dominant channel materials and its stage of adjustment.

Construction activity can lead to impairment of beneficial uses in two main ways. First, during the actual construction process, storm water discharges can negatively affect the chemical, biological, and physical properties of downstream receiving waters. Due to the disturbance of the landscape, the most likely pollutant is sediment, however pH and other non-visible pollutants are also of great concern. Second, after most construction activities are completed at a construction site, the finished project may result in significant modification of the site's response to precipitation. New development and redevelopment projects have almost always resulted in permanent post-construction water quality impacts because more precipitation ends up as runoff and less precipitation is intercepted, evapotranspired, and infiltrated.

General Permit 99-08-DWQ required the SWPPP to include a description of all post-construction BMPs on a site and a maintenance schedule. An effective storm water management strategy must address the full suite of storm events (water quality, channel protection, overbank flood protection, extreme flood protection) (Figure 2).

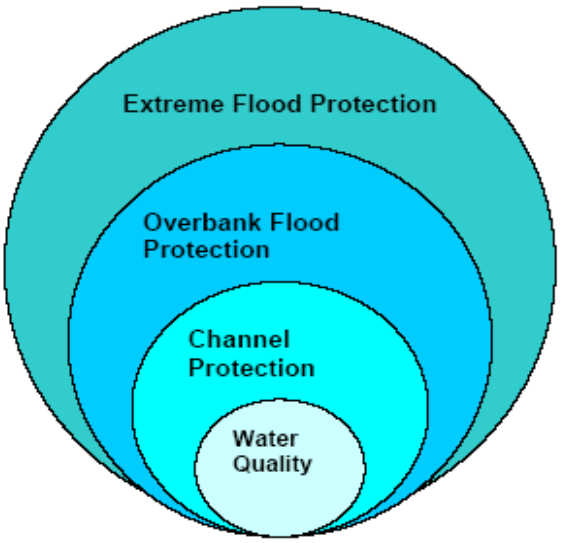


Figure 2 - Suite of Storm Events

The post-construction storm water performance standards in this General Permit specifically address water quality and channel protection events. Overbank flood protection and extreme flood protection events are traditionally dealt with in local drainage and flood protection ordinances. However, measures in this General Permit to address water quality and channel protection also reduce overbank and extreme flooding impacts. This General Permit aims to match post-construction runoff to pre-construction runoff for the 85th percentile storm event, which not only reduces the risk of impact to the receiving water's channel morphology but also provides some protection of water quality.

This General Permit clarifies that its runoff reduction requirements only apply to projects that lie outside of jurisdictions covered by a Standard Urban Storm water Management Plan (SUSMP) (or other more protective) post-construction requirements in either Phase I or Phase II permits.

Figures 3 and 4, below, show the General Permit enrollees (to Order 99-08-DWQ, as of March 10, 2008) overlaid upon a map with SUSMP (or more protective) areas in blue and purple. Areas without blue or purple indicate where the General Permit's runoff reduction requirements would actually apply.

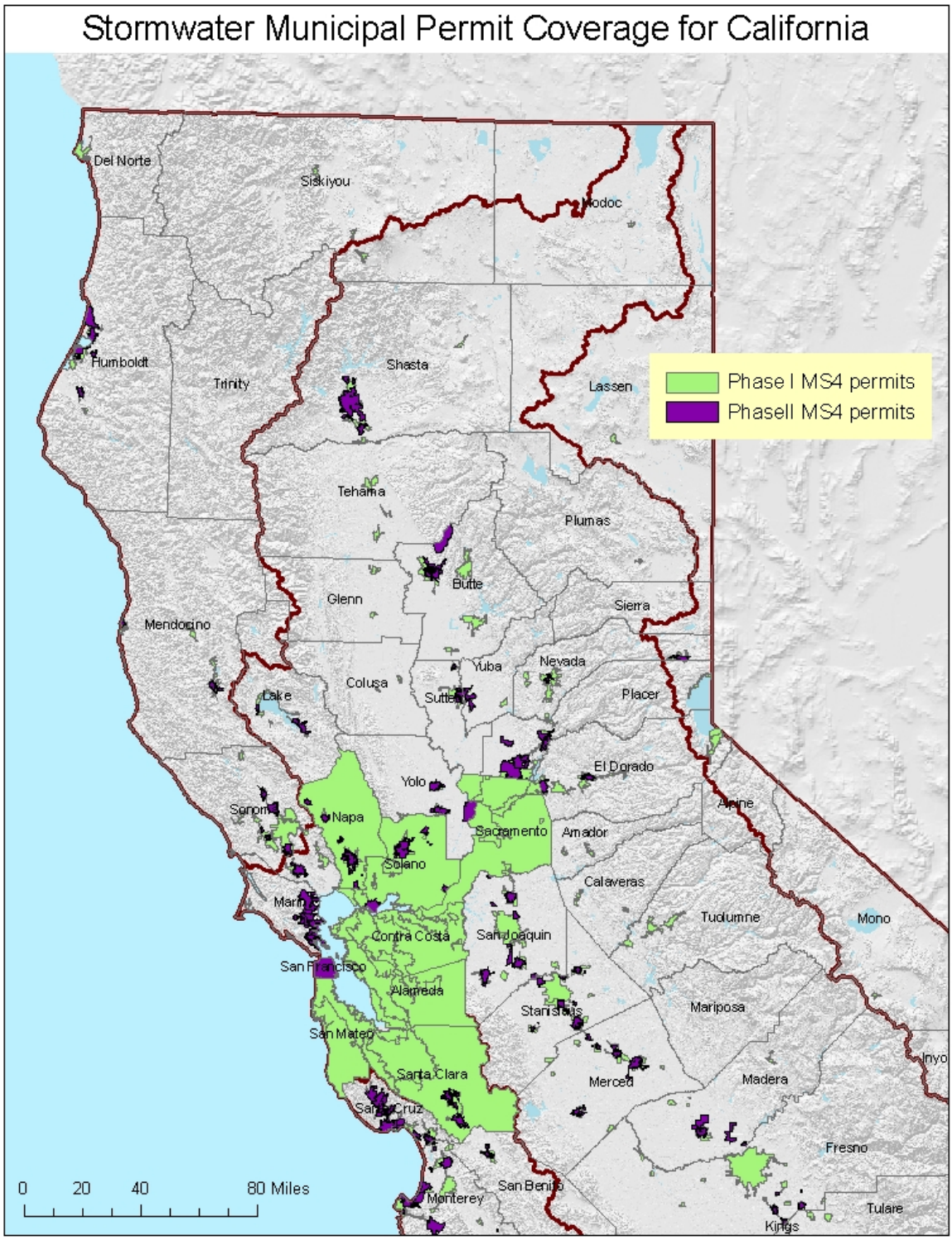


Figure 3 - Northern CA (2009) Counties / Cities With SUSMP-Plus Coverage

Figure 4 - Southern CA (2009) Counties / Cities With SUSMP-Plus Coverage

Water Quality:
This General Permit requires dischargers to replicate the pre-project runoff water balance (defined as the amount of rainfall that ends up as runoff) for the smallest storms up to the 85th percentile storm event, or the smallest storm event that generates runoff, whichever is larger. Contemporary storm water management generally routes these flows directly to the drainage system, increasing pollutant loads and potentially causing adverse effects on receiving waters. These smaller water quality events happen much more frequently than larger events and generate much higher pollutant loads on an annual basis. There are other adverse hydrological impacts that result from not designing according to the site's pre-construction water balance. In Maryland, Klein[20] noted that baseflow decreases as the extent of urbanization increases. Ferguson and Suckling[21] noted a similar relation in watersheds in Georgia. On Long Island, Spinello and Simmons[22] noted substantial decreases in base flow in intensely urbanized watersheds.

The permit emphasizes runoff reduction through on-site storm water reuse, interception, evapo-transpiration and infiltration through non-structural controls and conservation design measures (e.g., downspout disconnection, soil quality preservation/enhancement, interceptor trees). Employing these measures close to the source of runoff generation is the easiest and most cost-effective way to comply with the pre-construction water balance standard. Using low-tech runoff reduction techniques close to the source is consistent with a number of recommendations in the literature.[23] In many cases, BMPs implemented close to the source of runoff generation cost less than end-of the pipe measures.[24] Dischargers are given the option of using Appendix 2 to calculate the required runoff volume or a watershed process-based, continuous simulation model such as the EPA's Storm Water Management Model (SWMMM) or Hydrologic Simulation Program Fortran (HSPF). Such methods used by the discharger will be reviewed by the Regional Water Board upon NOT application.

Channel Protection:
In order to address channel protection, a basic understanding of fluvial geomorphic concepts is necessary. A dominant paradigm in fluvial geomorphology holds that streams adjust their channel dimensions (width and depth) in response to long-term changes in sediment supply and bankfull discharge (1.5 to 2 year recurrence interval). The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which the moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels.[25] Lane (1955 as cited in Rosgen 1996[26]) showed the generalized relationship between sediment load, sediment size, stream discharge and stream slope in

---

[20] Klein 1979 as cited in Delaware Department of Natural Resources (DDNR). 2004. Green Technology: The Delaware Urban Runoff Management Approach. Dover, DE. 117 pp.
[21] Ferguson and Suckling 1990 as cited Delaware Department of Natural Resources (DDNR). 2004. Green Technology: The Delaware Urban Runoff Management Approach. Dover, DE. 117 pp.
[22] Center for Watershed Protection (CWP). 2000. The Practice of Watershed Protection: Techniques for protecting our nation's streams, lakes, rivers, and estuaries. Ellicott City, MD. 741 pp.
[23] Bay Area Storm Water Management Agencies Association (BASMAA). 1997. Start at the Source: Residential Site Planning and Design Guidance Manual for Storm Water Quality Protection. Palo Alto, CA;
McCuen, R.H. 2003 Smart Growth: hydrologic perspective. Journal of Professional Issues in Engineering Education and Practice. Vol (129), pp.151-154;
Moglen, G.E. and S. Kim. 2007. Impervious imperviousness-are threshold based policies a good idea? Journal of the American Planning Association, Vol 73 No. 2. pp 161-171.
[24] Delaware Department of natural Resources (DDNR). 2004. Green technology: The Delaware urban Runoff Management Approcah. Dover, DE. 117 pp.
[25] Dunne, T and L.B. Leopold. 1978. Water in Environmental Planning. San Francisco W.H. Freeman and Company
[26] Rosgen. D.L. 1996. Applied River Morphology. Pagosa Springs. Wildland Hydrology

Figure 5. A change in any one of these variables sets up a series of mutual adjustments in the companion variables with a resulting direct change in the physical characteristics of the stream channel.

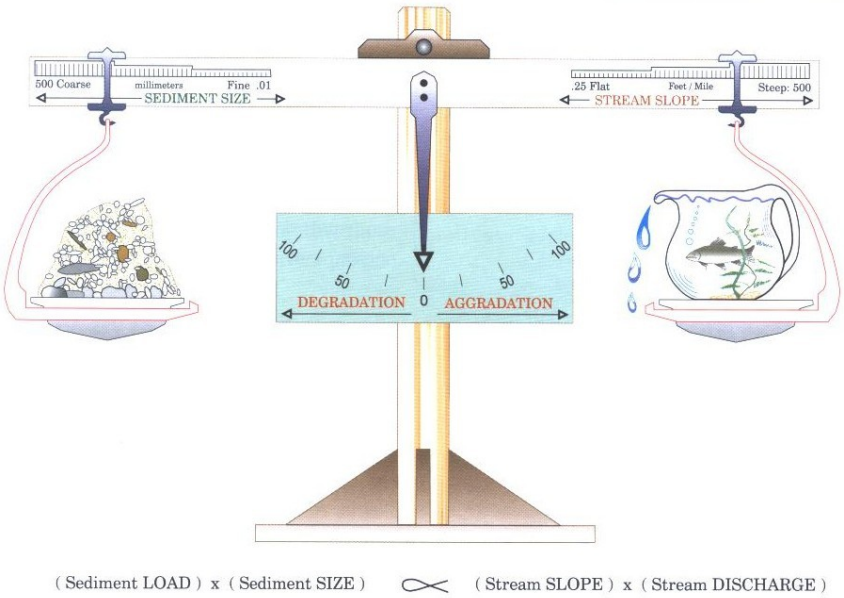


Figure 5 - Schematic of the Lane Relationship

After Lane (1955) as cited in Rosgen (1996)

Stream slope multiplied by stream discharge (the right side of the scale) is essentially an approximation of stream power, a unifying concept in fluvial geomorphology (Bledsoe 1999). Urbanization generally increases stream power and affects the resisting forces in a channel (sediment load and sediment size represented on the left side of the scale).

During construction, sediment loads can increase from 2 to 40,000 times over pre-construction levels.[27] Most of this sediment is delivered to stream channels during large, episodic rain events.[28] This increased sediment load leads to an initial aggradation phase where stream depths may decrease as sediment fills the channel, leading to a decrease in channel capacity and increase in flooding and overbank deposition. A degradation phase initiates after construction is completed.

Schumm et. al (1984) developed a channel evolution model that describes the series of adjustments from initial downcutting, to widening, to establishing new floodplains at lower elevations (Figure 6).

---

[27] Goldman S.J., K. Jackson, and T.A. Bursztynsky. 1986. Erosion and Sediment Control Handbook. McGraw Hill. San Francisco.

[28] Wolman 1967 as cited in Paul, M.P. and J.L. Meyer. 2001. Streams in the Urban Landscape. *Annu. Rev.Ecol. Syst.* 32: 333-365.

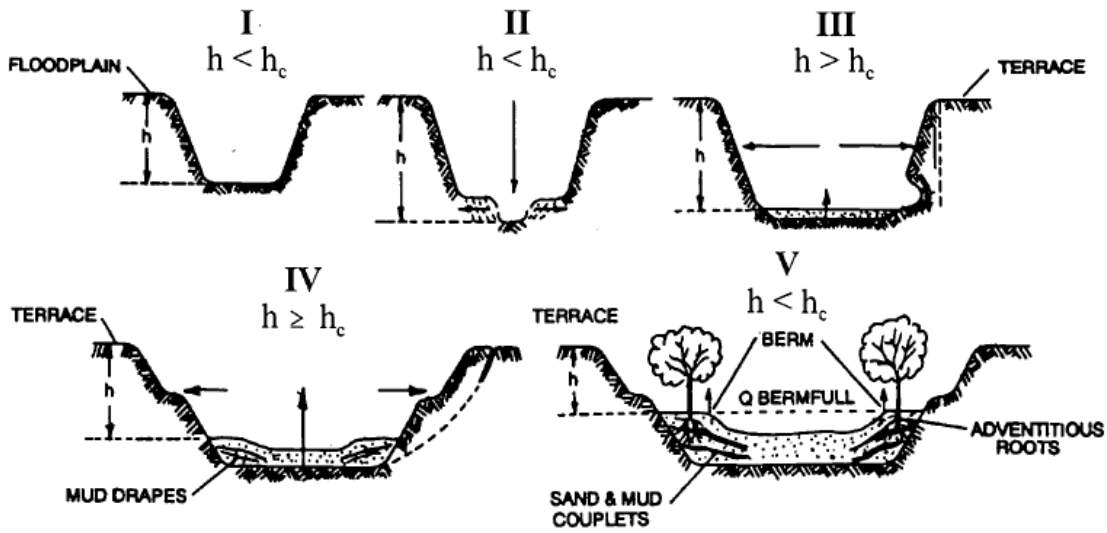


Figure 6 - Channel Changes Associated with Urbanization

After Incised Channel Evolution Sequence in Schumm et. al 1984

Channel incision (Stage II) and widening (Stages III and to a lesser degree, Stage IV) are due to a number of fundamental changes on the landscape. Connected impervious area and compaction of pervious surfaces increase the frequency and volume of bankfull discharges.[29] Increased drainage density (miles of stream length per square mile of watershed) also negatively impacts receiving stream channels.[30] Increased drainage density and hydraulic efficiency leads to an increase in the frequency and volume of bankfull discharges because the time of concentration is shortened. Flows from engineered pipes and channels are also often "sediment starved" and seek to replenish their sediment supply from the channel.

Encroachment of stream channels can also lead to an increase in stream slope, which leads to an increase in stream power. In addition, watershed sediment loads and sediment size (with size generally represented as the median bed and bank particle size, or d_{50}) decrease during urbanization.[31] This means

[29] Booth, D. B. and C. R. Jackson. 1997. Urbanization of Aquatic Systems: Degradation Thresholds, Storm Water Detection, and the Limits of Mitigation. Journal of the American Water Resources Association Vol. 33, No.5, pp. 1077-1089.

[30] May, C.W. 1998. Cumulative effects of urbanization on small streams in the Puget Sound Lowland ecoregion. Conference proceedings from Puget Sound Research '98 held March 12, 13 1998 in Seattle, WA;
Santa Clara Valley Urban Runoff Pollution Prevention Program. 2002. Hydromodification Management Plan Literature Review. 80 pp.

[31] Finkenbine, J.K., D.S. Atwater, and D.S. Mavinic. 2000. Stream health after urbanization. *J. Am. Water Resour. Assoc.* 36:1149-60;

that even if pre- and post-development stream power are the same, more erosion will occur in the post-development stage because the smaller particles are less resistant (provided they are non-cohesive).

As shown in Stages II and III, the channel deepens and widens to accommodate the increased stream power [32]and decrease in sediment load and sediment size. Channels may actually narrow as entrained sediment from incision is deposited laterally in the channel. After incised channels begin to migrate laterally (Stage III), bank erosion begins, which leads to general channel widening.[33] At this point, a majority of the sediment that leaves a drainage area comes from within the channel, as opposed to the background and construction related hillslope contribution. Stage IV is characterized by more aggradation and localized bank instability. Stage V represents a new quasi-equilibrium channel morphology in balance with the new flow and sediment supply regime. In other words, stream power is in balance with sediment load and sediment size.

The magnitude of the channel morphology changes discussed above varies along a stream network as well as with the age of development, slope, geology (sand-bedded channels may cycle through the evolution sequence in a matter of decades whereas clay-dominated channels may take much longer), watershed sediment load and size, type of urbanization, and land use history. It is also dependent on a channel's stage in the channel evolution sequence when urbanization occurs. Management strategies

---

Pizzuto, J.E. W.S. Hession, and M. McBride. 2000. Comparing gravel-bed rivers in paired urban and rural catchments of southeastern Pennsylvania. *Geology* 28:79-82.

[32] Hammer 1973 as cited in Delaware Department of Natural Resources (DDNR). 2004. Green Technology: The Delaware Urban Runoff Management Approach. Dover, DE. 117 pp;
Booth, D.B. 1990. Stream Channel Incision Following Drainage Basin Urbanization. *Water Resour. Bull.* 26:407-417.

[33] Trimble, S.W. 1997. Contribution of Stream Channel Erosion to Sediment Yield from an Urbanizing Watershed. *Science*: Vol. 278 (21), pp. 1442-1444.

must take into account a channel's stage of adjustment and account for future changes in the evolution of channel form (Stein and Zaleski 2005).[34]

Traditional structural water quality BMPs (e.g. detention basins and other devices used to store volumes of runoff) unless they are highly engineered to provide adequate flow duration control, do not adequately protect receiving waters from accelerated channel bed and bank erosion, do not address post-development increases in runoff volume, and do not mitigate the decline in benthic macroinvertebrate communities in the receiving waters[35] suggest that structural BMPs are not as effective in protecting aquatic communities as a continuous riparian buffer of native vegetation. This is supported by the findings of Zucker and White[36], where instream biological metrics were correlated with the extent of forested buffers.

This General Permit requires dischargers to maintain pre-development drainage densities and times of concentration in order to protect channels and encourages dischargers to implement setbacks to reduce channel slope and velocity changes that can lead to aquatic habitat degradation.

There are a number of other approaches for modeling fluvial systems, including statistical and physical models and simpler stream power models.[37] The use of these models in California is described in Stein and Zaleski (2005).[38] Rather than prescribe a specific one-size-fits-all modeling method in this permit, the State Water Board intends to develop a stream power and channel evolution model-based framework to assess channels and develop a hierarchy of suitable analysis methods and management strategies. In time, this framework may become a State Water Board water quality control policy.

Permit Linkage to Overbank and Extreme Flood Protection
Site design BMPs (e.g. rooftop and impervious disconnection, vegetated swales, setbacks and buffers) filter and settle out pollutants and provide for more infiltration than is possible for traditional centralized structural BMPs placed at the lowest point in a site. They provide source control for runoff and lead to a reduction in pollutant loads. When implemented, they also help reduce the magnitude and volume of larger, less frequent storm events (e.g., 10-yr, 24-hour storm and larger), thereby reducing the need for expensive flood control infrastructure. Nonstructural BMPs can also be a landscape amenity, instead of a large isolated structure requiring substantial area for ancillary access, buffering, screening and maintenance facilities.[25] The multiple benefits of using non-structural benefits will be critically important as the state's population increases and imposes strains upon our existing water resources.

Maintaining predevelopment drainage densities and times of concentration will help reduce post-development peak flows and volumes in areas not covered under a municipal permit. The most effective way to preserve drainage areas and maximize time of concentration is to implement landform grading,

---

[34] Stein, E.S. and S. Zaleski. 2005.Managing runoff to protect natural stream: the latest developments on investigation and management of hydromodification in California. Southern California Coastal Water Research Project Technical Report 475. 26 pp.
[35] Horner, R.R. 2006. Investigation of the Feasibility and Benefits of Low-Impact Site Design Practices (LID) for the San Diego Region. Available at: http://www.projectcleanwater.org/pdf/permit/case-study_lid.pdf.
[36] Delaware Department of Natural Resources (DDNR). 2004. Green Technology: The Delaware Urban Runoff Management Approach. Dover, DE. 117 pp.
[37] Finlayson, D.P. and D.R. Montgomery. 2003. Modeling large-scale fluvial erosion in geographic information systems. Geomorphology (53), pp. 147-164).
[38] Stein, E.S. and S. Zaleski. 2005.Managing runoff to protect natural stream: the latest developments on investigation and management of hydromodification in California. Southern California Coastal Water Research Project Technical Report 475. 26 pp.

incorporate site design BMPs and implement distributed structural BMPs (e.g., bioretention cells, rain gardens, rain cisterns).

M. Storm Water Pollution Prevention Plans

USEPA's Construction General Permit requires that qualified personnel conduct inspections. USEPA defines qualified personnel as "a person knowledgeable in the principles and practice of erosion and sediment controls who possesses the skills to assess conditions at the construction site that could impact storm water quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of storm water discharges from the construction activity."[39] USEPA also suggests that qualified personnel prepare SWPPPs and points to numerous states that require certified professionals to be on construction sites at all times. States that currently have certification programs are Washington, Georgia, Florida, Delaware, Maryland, and New Jersey. The Permit 99-08-DWQ did not require that qualified personnel prepare SWPPPs or conduct inspections. However, to ensure that water quality is being protected, this General Permit requires that all SWPPPs be written, amended, and certified by a Qualified SWPPP Developer. A Qualified SWPPP Developer must possess one of the eight certifications and or registrations specified in this General Permit and effective two years after the adoption date of this General Permit, must have attended a State Water Board-sponsored or approved Qualified SWPPP Developer training course. Table 9 provides an overview of the criteria used in determining qualified certification titles for a QSD and QSP.

39 US Environmental Protection Agency. Stormwater Pollution Prevention Plans for Construction Activities. <http://cfpub.epa.gov/npdes/stormwater/swppp.cfm> and <http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf>.

Table 9 - Qualified SWPPP Developer/ Qualified SWPPP Practitioner Certification Criteria

Certification/ Title	Registered By	QSD/QSP	Certification Criteria
Professional Civil Engineer	California	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites
Professional Geologist or Engineering Geologist	California	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites
Landscape Architect	California	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites
Professional Hydrologist	American Institute of Hydrology	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites
Certified Professional in Erosion and Sediment Control™ (CPESC)	Enviro Cert International Inc.	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites 5. Continuing Education
Certified Inspector of Sediment and Erosion Control™ (CISEC)	Certified Inspector of Sediment and Erosion Control, Inc.	QSP	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites 5. Continuing Education
Certified Erosion, Sediment and Storm Water Inspector™ (CESSWI)	Enviro Cert International Inc.	QSP	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites 5. Continuing Education
Certified Professional in Storm Water Quality™ (CPSWQ)	Enviro Cert International Inc.	Both	1. Approval Process 2. Code of Ethics 3. Accountability 4. Pre-requisites 5. Continuing Education

The previous versions of the General Permit required development and implementation of a SWPPP as the primary compliance mechanism. The SWPPP has two major objectives: (1) to help identify the sources of sediment and other pollutants that affect the quality of storm water discharges; and (2) to describe and ensure the implementation of BMPs to reduce or eliminate sediment and other pollutants in storm water and non-storm water discharges. The SWPPP must include BMPs that address source control, BMPs that address pollutant control, and BMPs that address treatment control.

This General Permit shifts some of the measures that were covered by this general requirement to specific permit requirements, each individually enforceable as a permit term. This General Permit emphasizes the use of appropriately selected, correctly installed and maintained pollution reduction BMPs. This approach provides the flexibility necessary to establish BMPs that can effectively address source control of pollutants during changing construction activities. These specific requirements also improve both the clarity and the enforceability of the General Permit so that the dischargers understand, and the public can determine whether the discharges are in compliance with, permit requirements.

The SWPPP must be implemented at the appropriate level to protect water quality at all times throughout the life of the project. The SWPPP must remain on the site during construction activities, commencing with the initial mobilization and ending with the termination of coverage under the General Permit. For LUPs the discharger shall make the SWPPP available at the construction site during working hours while construction is occurring and shall be made available upon request by a State or Municipal inspector. When the original SWPPP is retained by a crewmember in a construction vehicle and is not currently at the construction site, current copies of the BMPs and map/drawing will be left with the field crew and the original SWPPP shall be made available via a request by radio or telephone. Once construction activities are complete, until stabilization is achieved, the SWPPP shall be available from the SWPPP contact listed in the PRDs

A SWPPP must be appropriate for the type and complexity of a project and will be developed and implemented to address project specific conditions. Some projects may have similarities or complexities, yet each project is unique in its progressive state that requires specific description and selection of BMPs needed to address all possible generated pollutants

N. Regional Water Board Authorities

Because this General Permit will be issued to thousands of construction sites across the State, the Regional Water Boards retain discretionary authority over certain issues that may arise from the discharges in their respective regions. This General Permit does not grant the Regional Water Boards any authority they do not otherwise have; rather, it merely emphasizes that the Regional Water Boards can take specific actions related to this General Permit. For example, the Regional Water Boards will be enforcing this General Permit and may need to adjust some requirements for a discharger based on the discharger's compliance history.

Linda S. Adams
Secretary for Environmental Protection

State Water Resources Control Board

Division of Water Quality
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
Fax (916) 341-5463 • http://www.waterboards.ca.gov

Arnold Schwarzenegger
Governor

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT FOR
STORM WATER DISCHARGES
ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE
ACTIVITIES

ORDER NO. 2009-0009-DWQ
NPDES NO**. CAS000002**

This Order was adopted by the State Water Resources Control Board on:	**September 2, 2009**
This Order shall become effective on:	**July 1, 2010**
This Order shall expire on:	**September 2, 2014**

IT IS HEREBY ORDERED, that this Order supersedes Order No. 99-08-DWQ [as amended by Order No. 2010-0014-DWQ] except for enforcement purposes. The Discharger shall comply with the requirements in this Order to meet the provisions contained in Division 7 of the California Water Code (commencing with section 13000) and regulations adopted thereunder, and the provisions of the federal Clean Water Act and regulations and guidelines adopted thereunder.

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the State Water Resources Control Board, on September 2, 2009.

AYE: Vice Chair Frances Spivy-Weber
Board Member Arthur G. Baggett, Jr.
Board Member Tam M. Doduc

NAY: Chairman Charles R. Hoppin

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

Linda S. Adams
Secretary for Environmental Protection

State Water Resources Control Board

Division of Water Quality
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
Fax (916) 341-5463 • http://www.waterboards.ca.gov

Arnold Schwarzenegger
Governor

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) GENERAL PERMIT FOR STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE ACTIVITIES

ORDER NO. 2010-0014-DWQ
NPDES NO. CAS000002

Order No. 2009-0009-DWQ was adopted by the State Water Resources Control Board on:	**September 2, 2009**
Order No. 2009-0009-DWQ became effective on:	**July 1, 2010**
Order No. 2009-0009-DWQ shall expire on:	**September 2, 2014**
This Order, which amends Order No. 2009-0009-DWQ, was adopted by the State Water Resources Control Board on:	**November 16, 2010**
This Order shall become effective on:	**February 14, 2011**

IT IS HEREBY ORDERED that this Order amends Order No. 2009-0009-DWQ. Additions to Order No. 2009-0009-DWQ are reflected in blue-underline text and deletions are reflected in red-strikeout text.

IT IS FURTHER ORDERED that staff are directed to prepare and post a conformed copy of Order No. 2009-0009-DWQ incorporating the revisions made by this Order.

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the State Water Resources Control Board, on **November 16, 2010.**

AYE: Chairman Charles R. Hoppin
Vice Chair Frances Spivy-Weber
Board Member Arthur G. Baggett, Jr.
Board Member Tam M. Doduc

NAY: None

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT FOR
STORM WATER DISCHARGES
ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE ACTIVITIES

ORDER NO. 2012-0006-DWQ
NPDES NO**. CAS000002**

Order No. 2009-0009-DWQ was adopted by the State Water Resources Control Board on:	**September 2, 2009**
Order No. 2009-0009-DWQ became effective on:	**July 1, 2010**
Order No. 2010-0014-DWQ became effective on:	**February 14, 2011**
Order No. 2009-0009-DWQ as amended by 2010-0014-DWQ shall expire on:	**September 2, 2014**
This Order, which amends Order No. 2009-0009-DWQ as amended by 2010-0014-DWQ, was adopted by the State Water Resources Control Board on:	**July 17, 2012**
This Order No. 2012-0006-DWQ shall become effective on:	**July 17, 2012**

IT IS HEREBY ORDERED that this Order amends Order No. 2009-0009-DWQ. Additions to Order No. 2009-0009-DWQ are reflected in blue-underline text and deletions are reflected in red-strikeout text.

IT IS FURTHER ORDERED that staff are directed to prepare and post a conformed copy of Order No. 2009-000-DWQ incorporating the revisions made by this Order.

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the State Water Resources Control Board, on July 17, 2012.

AYE: Chairman Charles R. Hoppin
Vice Chair Frances Spivy-Weber
Board Member Tam M. Doduc
Board Member Steven Moore
Board Member Felicia Marcus

NAY: None

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

TABLE OF CONTENTS

I. FINDINGS 1
II. CONDITIONS FOR PERMIT COVERAGE 14
III. DISCHARGE PROHIBITIONS 20
IV. SPECIAL PROVISIONS 22
V. EFFLUENT STANDARDS & RECEIVING WATER MONITORING 28
VI. RECEIVING WATER LIMITATIONS 31
VII. TRAINING QUALIFICATIONS AND CERTIFICATION REQUIREMENTS 32
VIII. RISK DETERMINATION 33
IX. RISK LEVEL 1 REQUIREMENTS 34
X. RISK LEVEL 2 REQUIREMENTS 34
XI. RISK LEVEL 3 REQUIREMENTS 34
XII. ACTIVE TREATMENT SYSTEMS (ATS) 34
XIII. POST-CONSTRUCTION STANDARDS 35
XIV. SWPPP REQUIREMENTS 37
XV. REGIONAL WATER BOARD AUTHORITIES 38
XVI. ANNUAL REPORTING REQUIREMENTS 39

LIST OF ATTACHMENTS

Attachment A – Linear Underground/Overhead Requirements
Attachment A.1 – LUP Type Determination
Attachment A.2 – LUP Permit Registration Documents
Attachment B – Permit Registration Documents
Attachment C – Risk Level 1 Requirements
Attachment D – Risk Level 2 Requirements
Attachment E – Risk Level 3 Requirements
Attachment F – Active Treatment System (ATS) Requirements

LIST OF APPENDICES

Appendix 1 – Risk Determination Worksheet
Appendix 2 – Post-Construction Water Balance Performance Standard
Appendix 2.1 – Post-Construction Water Balance Performance Standard Spreadsheet
Appendix 3 – Bioassessment Monitoring Guidelines
Appendix 4 – Adopted/Implemented Sediment TMDLs
Appendix 5 – Glossary
Appendix 6 – Acronyms
Appendix 7 – State and Regional Water Resources Control Board Contacts

STATE WATER RESOURCES CONTROL BOARD
ORDER NO. 2009-0009-DWQ
[AS AMENDED BY ORDER NO. 2010-0014-DWQ]
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
GENERAL PERMIT NO. CAS000002

WASTE DISCHARGE REQUIREMENTS
FOR
DISCHARGES OF STORM WATER RUNOFF ASSOCIATED WITH
CONSTRUCTION AND LAND DISTURBANCE ACTIVITIES

I. FINDINGS

A. General Findings

The State Water Resources Control Board (State Water Board) finds that:

1. The federal Clean Water Act (CWA) prohibits certain discharges of storm water containing pollutants except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit (Title 33 United States Code (U.S.C.) §§ 1311 and 1342(p); also referred to as Clean Water Act (CWA) §§ 301 and 402(p)). The U.S. Environmental Protection Agency (U.S. EPA) promulgates federal regulations to implement the CWA's mandate to control pollutants in storm water runoff discharges. (Title 40 Code of Federal Regulations (C.F.R.) Parts 122, 123, and 124). The federal statutes and regulations require discharges to surface waters comprised of storm water associated with construction activity, including demolition, clearing, grading, and excavation, and other land disturbance activities (except operations that result in disturbance of less than one acre of total land area and which are not part of a larger common plan of development or sale), to obtain coverage under an NPDES permit. The NPDES permit must require implementation of Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate pollutants in storm water runoff. The NPDES permit must also include additional requirements necessary to implement applicable water quality standards.

2. This General Permit authorizes discharges of storm water associated with construction activity so long as the dischargers comply with all requirements, provisions, limitations and prohibitions in the permit. In addition, this General Permit regulates the discharges of storm water associated with construction activities from all Linear

Underground/Overhead Projects resulting in the disturbance of greater than or equal to one acre (Attachment A).

3. This General Permit regulates discharges of pollutants in storm water associated with construction activity (storm water discharges) to waters of the United States from construction sites that disturb one or more acres of land surface, or that are part of a common plan of development or sale that disturbs more than one acre of land surface.

4. This General Permit does not preempt or supersede the authority of local storm water management agencies to prohibit, restrict, or control storm water discharges to municipal separate storm sewer systems or other watercourses within their jurisdictions.

5. This action to adopt a general NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code Section 21100, et seq.), pursuant to Section 13389 of the California Water Code.

6. Pursuant to 40 C.F.R. § 131.12 and State Water Board Resolution No. 68-16,[1] which incorporates the requirements of § 131.12 where applicable, the State Water Board finds that discharges in compliance with this General Permit will not result in the lowering of water quality standards, and are therefore consistent with those provisions. Compliance with this General Permit will result in improvements in water quality.

7. This General Permit serves as an NPDES permit in compliance with CWA § 402 and will take effect on July 1, 2010 by the State Water Board provided the Regional Administrator of the U.S. EPA has no objection. If the U.S. EPA Regional Administrator objects to its issuance, the General Permit will not become effective until such objection is withdrawn.

8. Following adoption and upon the effective date of this General Permit, the Regional Water Quality Control Boards (Regional Water Boards) shall enforce the provisions herein.

9. Regional Water Boards establish water quality standards in Basin Plans. The State Water Board establishes water quality standards in various statewide plans, including the California Ocean Plan. U.S. EPA establishes water quality standards in the National Toxic Rule (NTR) and the California Toxic Rule (CTR).

[1] Resolution No. 68-16 generally requires that existing water quality be maintained unless degradation is justified based on specific findings.

10. This General Permit does not authorize discharges of fill or dredged material regulated by the U.S. Army Corps of Engineers under CWA § 404 and does not constitute a waiver of water quality certification under CWA § 401.

11. The primary storm water pollutant at construction sites is excess sediment. Excess sediment can cloud the water, which reduces the amount of sunlight reaching aquatic plants, clog fish gills, smother aquatic habitat and spawning areas, and impede navigation in our waterways. Sediment also transports other pollutants such as nutrients, metals, and oils and greases.

12. Construction activities can impact a construction site's runoff sediment supply and transport characteristics. These modifications, which can occur both during and after the construction phase, are a significant cause of degradation of the beneficial uses established for water bodies in California. Dischargers can avoid these effects through better construction site design and activity practices.

13. This General Permit recognizes four distinct phases of construction activities. The phases are Grading and Land Development Phase, Streets and Utilities Phase, Vertical Construction Phase, and Final Landscaping and Site Stabilization Phase. Each phase has activities that can result in different water quality effects from different water quality pollutants. This General Permit also recognizes inactive construction as a category of construction site type.

14. Compliance with any specific limits or requirements contained in this General Permit does not constitute compliance with any other applicable requirements.

15. Following public notice in accordance with State and Federal laws and regulations, the State Water Board heard and considered all comments and testimony in a public hearing on 06/03/2009. The State Water Board has prepared written responses to all significant comments.

16. Construction activities obtaining coverage under the General Permit may have multiple discharges subject to requirements that are specific to general, linear, and/or active treatment system discharge types.

17. The State Water Board may reopen the permit if the U.S. EPA adopts a final effluent limitation guideline for construction activities.

B. Activities Covered Under the General Permit

18. Any construction or demolition activity, including, but not limited to, clearing, grading, grubbing, or excavation, or any other activity that results in a land disturbance of equal to or greater than one acre.

19. Construction activity that results in land surface disturbances of less than one acre if the construction activity is part of a larger common plan of development or the sale of one or more acres of disturbed land surface.

20. Construction activity related to residential, commercial, or industrial development on lands currently used for agriculture including, but not limited to, the construction of buildings related to agriculture that are considered industrial pursuant to U.S. EPA regulations, such as dairy barns or food processing facilities.

21. Construction activity associated with Linear Underground/Overhead Utility Projects (LUPs) including, but not limited to, those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment and associated ancillary facilities) and include, but are not limited to, underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

22. Discharges of sediment from construction activities associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities.[2]

23. Storm water discharges from dredge spoil placement that occur outside of U.S. Army Corps of Engineers jurisdiction (upland sites) and that disturb one or more acres of land surface from construction activity are covered by this General Permit. Construction sites that intend to disturb one or more acres of land within the jurisdictional boundaries of

[2] Pursuant to the Ninth Circuit Court of Appeals' decision in *NRDC v. EPA* (9th Cir. 2008) 526 F.3d 591, and subsequent denial of the U.S. EPA's petition for reconsideration in November 2008, oil and gas construction activities discharging storm water contaminated only with sediment are no longer exempt from the NPDES program.

a CWA § 404 permit should contact the appropriate Regional Water Board to determine whether this permit applies to the site.

C. Activities Not Covered Under the General Permit

24. Routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

25. Disturbances to land surfaces solely related to agricultural operations such as disking, harrowing, terracing and leveling, and soil preparation.

26. Discharges of storm water from areas on tribal lands; construction on tribal lands is regulated by a federal permit.

27. Construction activity and land disturbance involving discharges of storm water within the Lake Tahoe Hydrologic Unit. The Lahontan Regional Water Board has adopted its own permit to regulate storm water discharges from construction activity in the Lake Tahoe Hydrologic Unit (Regional Water Board 6SLT). Owners of construction sites in this watershed must apply for the Lahontan Regional Water Board permit rather than the statewide Construction General Permit.

28. Construction activity that disturbs less than one acre of land surface, and that is not part of a larger common plan of development or the sale of one or more acres of disturbed land surface.

29. Construction activity covered by an individual NPDES Permit for storm water discharges.

30. Discharges from small (1 to 5 acre) construction activities with an approved Rainfall Erosivity Waiver authorized by U.S. EPA Phase II regulations certifying to the State Board that small construction activity will occur only when the Rainfall Erosivity Factor is less than 5 (“R” in the Revised Universal Soil Loss Equation).

31. Landfill construction activity that is subject to the Industrial General Permit.

32. Construction activity that discharges to Combined Sewer Systems.

33. Conveyances that discharge storm water runoff combined with municipal sewage.

34. Discharges of storm water identified in CWA § 402(*l*)(2), 33 U.S.C. § 1342(*l*)(2).

35. Discharges occurring in basins that are not tributary or hydrologically connected to waters of the United States (for more information contact your Regional Water Board).

D. Obtaining and Modifying General Permit Coverage

36. This General Permit requires all dischargers to electronically file all Permit Registration Documents (PRDs), Notices of Termination (NOT), changes of information, annual reporting, and other compliance documents required by this General Permit through the State Water Board's Storm water Multi-Application and Report Tracking System (SMARTS) website.

37. Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted.

38. This General Permit grants an exception from the Risk Determination requirements for existing sites covered under Water Quality Orders No. 99-08-DWQ, and No. 2003-0007-DWQ. For certain sites, adding additional requirements may not be cost effective. Construction sites covered under Water Quality Order No. 99-08-DWQ shall obtain permit coverage at the Risk Level 1. LUPs covered under Water Quality Order No. 2003-0007-DWQ shall obtain permit coverage as a Type 1 LUP. The Regional Water Boards have the authority to require Risk Determination to be performed on sites currently covered under Water Quality Orders No. 99-08-DWQ and No. 2003-0007-DWQ where they deem it necessary. The State Water Board finds that there are two circumstances when it may be appropriate for the Regional Water Boards to require a discharger that had filed an NOI under State Water Board Order No. 99-08-DWQ to recalculate the site's risk level. These circumstances are: (1) when the discharger has a demonstrated history of noncompliance with State Water Board Order No. 99-08-DWQ or; (2) when the discharger's site poses a significant risk of causing or contributing to an exceedance of a water quality standard without the implementation of the additional Risk Level 2 or 3 requirements.

E. Prohibitions

39. All discharges are prohibited except for the storm water and non-storm water discharges specifically authorized by this General Permit or another NPDES permit. Non-storm water discharges include a wide variety of sources, including improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges may

contribute significant pollutant loads to receiving waters. Measures to control spills, leakage, and dumping, and to prevent illicit connections during construction must be addressed through structural as well as non-structural Best Management Practices (BMPs)[3]. The State Water Board recognizes, however, that certain non-storm water discharges may be necessary for the completion of construction.

40. This General Permit prohibits all discharges which contain a hazardous substance in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

41. This General Permit incorporates discharge prohibitions contained in water quality control plans, as implemented by the State Water Board and the nine Regional Water Boards.

42. Pursuant to the Ocean Plan, discharges to Areas of Special Biological Significance (ASBS) are prohibited unless covered by an exception that the State Water Board has approved.

43. This General Permit prohibits the discharge of any debris[4] from construction sites. Plastic and other trash materials can cause negative impacts to receiving water beneficial uses. The State Water Board encourages the use of more environmentally safe, biodegradable materials on construction sites to minimize the potential risk to water quality.

F. Training

44. In order to improve compliance with and to maintain consistent enforcement of this General Permit, all dischargers are required to appoint two positions - the Qualified SWPPP Developer (QSD) and the Qualified SWPPP Practitioner (QSP) - who must obtain appropriate training. Together with the key stakeholders, the State and Regional Water Boards are leading the development of this curriculum through a collaborative organization called The Construction General Permit (CGP) Training Team.

45. The Professional Engineers Act (Bus. & Prof. Code section 6700, et seq.) requires that all engineering work must be performed by a California licensed engineer.

---

[3] BMPs are scheduling of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the United States. BMPs also include treatment requirements, operating procedures, and practice to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

[4] Litter, rubble, discarded refuse, and remains of destroyed inorganic anthropogenic waste.

G. Determining and Reducing Risk

46. The risk of accelerated erosion and sedimentation from wind and water depends on a number of factors, including proximity to receiving water bodies, climate, topography, and soil type.

47. This General Permit requires dischargers to assess the risk level of a site based on both sediment transport and receiving water risk. This General Permit contains requirements for Risk Levels 1, 2 and 3, and LUP Risk Type 1, 2, and 3 (Attachment A). Risk levels are established by determining two factors: first, calculating the site's sediment risk; and second, receiving water risk during periods of soil exposure (i.e. grading and site stabilization). Both factors are used to determine the site-specific Risk Level(s). LUPs can be determined to be Type 1 based on the flowchart in Attachment A.1.

48. Although this General Permit does not mandate specific setback distances, dischargers are encouraged to set back their construction activities from streams and wetlands whenever feasible to reduce the risk of impacting water quality (e.g., natural stream stability and habitat function). Because there is a reduced risk to receiving waters when setbacks are used, this General Permit gives credit to setbacks in the risk determination and post-construction storm water performance standards. The risk calculation and runoff reduction mechanisms in this General Permit are expected to facilitate compliance with any Regional Water Board and local agency setback requirements, and to encourage voluntary setbacks wherever practicable.

49. Rain events can occur at any time of the year in California. Therefore, a Rain Event Action Plan (REAP) is necessary for Risk Level 2 and 3 traditional construction projects (LUPs exempt) to ensure that active construction sites have adequate erosion and sediment controls implemented prior to the onset of a storm event, even if construction is planned only during the dry season.

50. Soil particles smaller than 0.02 millimeters (mm) (i.e., finer than medium silt) do not settle easily using conventional measures for sediment control (i.e., sediment basins). Given their long settling time, dislodging these soils results in a significant risk that fine particles will be released into surface waters and cause unacceptable downstream impacts. If operated correctly, an Active Treatment System (ATS[5]) can prevent or reduce the release of fine particles from construction sites.

[5] An ATS is a treatment system that employs chemical coagulation, chemical flocculation, or electro coagulation in order to reduce turbidity caused by fine suspended sediment.

Use of an ATS can effectively reduce a site's risk of impacting receiving waters.

51. Dischargers located in a watershed area where a Total Maximum Daily Load (TMDL) has been adopted or approved by the Regional Water Board or U.S. EPA may be required by a separate Regional Water Board action to implement additional BMPs, conduct additional monitoring activities, and/or comply with an applicable waste load allocation and implementation schedule. Such dischargers may also be required to obtain an individual Regional Water Board permit specific to the area.

H. Effluent Standards

52. The State Water Board convened a blue ribbon panel of storm water experts that submitted a report entitled, “The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities,” dated June 19, 2006. The panel concluded that numeric limits or action levels are technically feasible to control construction storm water discharges, provided that certain conditions are considered. The panel also concluded that numeric effluent limitations (NELs) are feasible for discharges from construction sites that utilize an ATS. The State Water Board has incorporated the expert panel’s suggestions into this General Permit, which includes numeric action levels (NALs) for pH and turbidity, and special numeric limits for ATS discharges.

Determining Compliance with Numeric Limitations

53. This General Permit sets a pH NAL of 6.5 to 8.5, and a turbidity NAL of 250 NTU. The purpose of the NAL and its associated monitoring requirement is to provide operational information regarding the performance of the measures used at the site to minimize the discharge of pollutants and to protect beneficial uses and receiving waters from the adverse effects of construction-related storm water discharges. An exceedance of a NAL does not constitute a violation of this General Permit.

54. This General Permit requires dischargers with NAL exceedances to immediately implement additional BMPs and revise their Storm Water Pollution Prevention Plans (SWPPPs) accordingly to either prevent pollutants and authorized non-storm water discharges from contaminating storm water, or to substantially reduce the pollutants to levels consistently below the NALs. NAL exceedances are reported in the State Water Boards SMARTS system, and the discharger is

required to provide an NAL Exceedance Report when requested by a Regional Water Board.

I. Receiving Water Limitations

55. This General Permit requires all enrolled dischargers to determine the receiving waters potentially affected by their discharges and to comply with all applicable water quality standards, including any more stringent standards applicable to a water body.

J. Sampling, Monitoring, Reporting and Record Keeping

56. Visual monitoring of storm water and non-storm water discharges is required for all sites subject to this General Permit.

57. Records of all visual monitoring inspections are required to remain on-site during the construction period and for a minimum of three years.

58. For all Risk Level 3/LUP Type 3 and Risk Level 2/LUP Type 2 sites, this General Permit requires effluent monitoring for pH and turbidity. Sampling, analysis and monitoring requirements for effluent monitoring for pH and turbidity are contained in this General Permit.

59. Risk Level 3 and LUP Type 3 sites with effluent that exceeds the Receiving Water Monitoring Triggers contained in this General Permit and with direct discharges to receiving water are required to conduct receiving water monitoring. An exceedance of a Receiving Water Monitoring Trigger does not constitute a violation of this General Permit.

60. This General Permit establishes a 5 year, 24 hour (expressed in inches of rainfall) as an exemptions to the receiving water monitoring requirements for Risk Level 3 and LUP Type 3 dischargers.

61. If run-on is caused by a forest fire or any other natural disaster, then receiving water monitoring triggers do not apply.

62. For Risk Level 3 and LUP Type 3 sites larger than 30 acres and with direct discharges to receiving waters, this General Permit requires bioassessment sampling before and after site completion to determine if significant degradation to the receiving water's biota has occurred. Bioassessment sampling guidelines are contained in this General Permit.

63. A summary and evaluation of the sampling and analysis results will be submitted in the Annual Reports.

64. This General Permit contains sampling, analysis and monitoring requirements for non-visible pollutants at all sites subject to this General Permit.

65. Compliance with the General Permit relies upon dischargers to electronically self-report any discharge violations and to comply with any Regional Water Board enforcement actions.

66. This General Permit requires that all dischargers maintain a paper or electronic copy of all required records for three years from the date generated or date submitted, whichever is last. These records must be available at the construction site until construction is completed. For LUPs, these documents may be retained in a crew member's vehicle and made available upon request.

K. Active Treatment System (ATS) Requirements

67. Active treatment systems add chemicals to facilitate flocculation, coagulation and filtration of suspended sediment particles. The uncontrolled release of these chemicals to the environment can negatively affect the beneficial uses of receiving waters and/or degrade water quality (e.g., acute and chronic toxicity). Additionally, the batch storage and treatment of storm water through an ATS' can potentially cause physical impacts on receiving waters if storage volume is inadequate or due to sudden releases of the ATS batches and improperly designed outfalls.

68. If designed, operated and maintained properly an ATS can achieve very high removal rates of suspended sediment (measured as turbidity), albeit at sometimes significantly higher costs than traditional erosion/sediment control practices. As a result, this General Permit establishes NELs consistent with the expected level of typical ATS performance.

69. This General Permit requires discharges of storm water associated with construction activity that undergo active treatment to comply with special operational and effluent limitations to ensure that these discharges do not adversely affect the beneficial uses of the receiving waters or cause degradation of their water quality.

70. For ATS discharges, this General Permit establishes technology-based NELs for turbidity.

71. This General Permit establishes a 10 year, 24 hour (expressed in inches of rainfall) Compliance Storm Event exemption from the technology-based numeric effluent limitations for ATS discharges. Exceedances of the ATS turbidity NEL constitutes a violation of this General Permit.

L. Post-Construction Requirements

72. This General Permit includes performance standards for post-construction that are consistent with State Water Board Resolution No. 2005-0006, "Resolution Adopting the Concept of Sustainability as a Core Value for State Water Board Programs and Directing Its Incorporation," and 2008-0030, “Requiring Sustainable Water Resources Management.“ The requirement for all construction sites to match pre-project hydrology will help ensure that the physical and biological integrity of aquatic ecosystems are sustained. This “runoff reduction” approach is analogous in principle to Low Impact Development (LID) and will serve to protect related watersheds and waterbodies from both hydrologic-based and pollution impacts associated with the post-construction landscape.

73. LUP projects are not subject to post-construction requirements due to the nature of their construction to return project sites to pre-construction conditions.

M. Storm Water Pollution Prevention Plan Requirements

74. This General Permit requires the development of a site-specific SWPPP. The SWPPP must include the information needed to demonstrate compliance with all requirements of this General Permit, and must be kept on the construction site and be available for review. The discharger shall ensure that a QSD develops the SWPPP.

75. To ensure proper site oversight, this General Permit requires a Qualified SWPPP Practitioner to oversee implementation of the BMPs required to comply with this General Permit.

N. Regional Water Board Authorities

76. Regional Water Boards are responsible for implementation and enforcement of this General Permit. A general approach to permitting is not always suitable for every construction site and environmental circumstances. Therefore, this General Permit recognizes that Regional Water Boards must have some flexibility and authority to alter, approve, exempt, or rescind permit authority granted under this

General Permit in order to protect the beneficial uses of our receiving waters and prevent degradation of water quality.

IT IS HEREBY ORDERED that all dischargers subject to this General Permit shall comply with the following conditions and requirements (including all conditions and requirements as set forth in Attachments A, B, C, D, E and F)[6]:

II. CONDITIONS FOR PERMIT COVERAGE

A. Linear Underground/Overhead Projects (LUPs)

1. Linear Underground/Overhead Projects (LUPs) include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g. telephone, telegraph, radio or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/ or pavement repair or replacement, and stockpile/borrow locations.

2. The Legally Responsible Person is responsible for obtaining coverage under the General Permit where the construction of pipelines, utility lines, fiber-optic cables, or other linear underground/overhead projects will occur across several properties unless the LUP construction activities are covered under another construction storm water permit.

3. Only LUPs shall comply with the conditions and requirements in Attachment A, A.1 & A.2 of this Order. The balance of this Order is not applicable to LUPs except as indicated in Attachment A.

[6] These attachments are part of the General Permit itself and are not separate documents that are capable of being updated independently by the State Water Board.

B. Obtaining Permit Coverage Traditional Construction Sites

1. The Legally Responsible Person (LRP) (see Special Provisions, Electronic Signature and Certification Requirements, Section IV.I.1) must obtain coverage under this General Permit.

2. To obtain coverage, the LRP must electronically file Permit Registration Documents (PRDs) prior to the commencement of construction activity. Failure to obtain coverage under this General Permit for storm water discharges to waters of the United States is a violation of the CWA and the California Water Code.

3. PRDs shall consist of:

   a. Notice of Intent (NOI)
   b. Risk Assessment (Section VIII)
   c. Site Map
   d. Storm Water Pollution Prevention Plan (Section XIV)
   e. Annual Fee
   f. Signed Certification Statement

   Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted.

   Attachment B contains additional PRD information. Dischargers must electronically file the PRDs, and mail the appropriate annual fee to the State Water Board.

4. This permit is effective on July 1, 2010.

   a. **Dischargers Obtaining Coverage On or After July 1, 2010:** All dischargers requiring coverage on or after July 1, 2010, shall electronically file their PRDs prior to the commencement of construction activities, and mail the appropriate annual fee no later than seven days prior to the commencement of construction activities. Permit coverage shall not commence until the PRDs and the annual fee are received by the State Water Board, and a WDID number is assigned and sent by SMARTS.

   b. **Dischargers Covered Under 99-08-DWQ and 2003-0007-DWQ:** Existing dischargers subject to State Water Board Order No. 99-08-DWQ (existing dischargers) will continue coverage under 99-08-DWQ until July 1, 2010. After July 1, 2010, all NOIs subject to State Water Board Order No. 99-08-DWQ will be terminated.

Existing dischargers shall electronically file their PRDs no later than July 1, 2010. If an existing discharger's site acreage subject to the annual fee has changed, it shall mail a revised annual fee no less than seven days after receiving the revised annual fee notification, **or else lose permit coverage**. All existing dischargers shall be exempt from the risk determination requirements in Section VIII of this General Permit until two years after permit adoption. All existing dischargers are therefore subject to Risk Level 1 requirements regardless of their site's sediment and receiving water risks. However, a Regional Board retains the authority to require an existing discharger to comply with the Section VIII risk determination requirements.

5. The discharger is only considered covered by this General Permit upon receipt of a Waste Discharger Identification (WDID) number assigned and sent by the State Water Board Storm water Multi-Application and Report Tracking System (SMARTS). In order to demonstrate compliance with this General Permit, the discharger must obtain a WDID number and must present documentation of a valid WDID upon demand.

6. During the period this permit is subject to review by the U.S. EPA, the prior permit (State Water Board Order No. 99-08-DWQ) remains in effect. Existing dischargers under the prior permit will continue to have coverage under State Water Board Order No. 99-08-DWQ until this General Permit takes effect on July 1, 2010. Dischargers who complete their projects and electronically file an NOT prior to July 1, 2010, are not required to obtain coverage under this General Permit.

7. Small Construction Rainfall Erosivity Waiver

   EPA's Small Construction Erosivity Waiver applies to sites between one and five acres demonstrating that there are no adverse water quality impacts.

   Dischargers eligible for a Rainfall Erosivity Waiver based on low erosivity potential shall complete the electronic Notice of Intent (NOI) and Sediment Risk form through the State Water Board's SMARTS system, certifying that the construction activity will take place during a period when the value of the rainfall erosivity factor is less than five. Where the LRP changes or another LRP is added during construction, the new LRP must also submit a waiver certification through the SMARTS system.

   If a small construction site continues beyond the projected completion date given on the waiver certification, the LRP shall recalculate the

rainfall erosivity factor for the new project duration and submit this information through the SMARTS system. If the new R factor is below five (5), the discharger shall update through SMARTS all applicable information on the waiver certification and retain a copy of the revised waiver onsite. The LRP shall submit the new waiver certification 30 days prior to the projected completion date listed on the original waiver form to assure exemption from permitting requirements is uninterrupted. If the new R factor is five (5) or above, the LRP shall be required to apply for coverage under this Order.

8. In the case of a public emergency that requires immediate construction activities, a discharger shall submit a brief description of the emergency construction activity within five days of the onset of construction, and then shall submit all PRDs within thirty days.

C. Revising Permit Coverage for Change of Acreage or New Ownership

1. The discharger may reduce or increase the total acreage covered under this General Permit when a portion of the site is complete and/or conditions for termination of coverage have been met (See Section II.D Conditions for Termination of Coverage); when ownership of a portion of the site is sold to a different entity; or when new acreage, subject to this General Permit, is added to the site.

2. Within 30 days of a reduction or increase in total disturbed acreage, the discharger shall electronically file revisions to the PRDs that include:

   a. A revised NOI indicating the new project size;

   b. A revised site map showing the acreage of the site completed, acreage currently under construction, acreage sold/transferred or added, and acreage currently stabilized in accordance with the Conditions for Termination of Coverage in Section II.D below.

   c. SWPPP revisions, as appropriate; and

   d. Certification that any new landowners have been notified of applicable requirements to obtain General Permit coverage. The certification shall include the name, address, telephone number, and e-mail address of the new landowner.

   e. If the project acreage has increased, dischargers shall mail payment of revised annual fees within 14 days of receiving the revised annual fee notification.

3. The discharger shall continue coverage under the General Permit for any parcel that has not achieved "Final Stabilization" as defined in Section II.D.

4. When an LRP with active General Permit coverage transfers its LRP status to another person or entity that qualifies as an LRP, the existing LRP shall inform the new LRP of the General Permit's requirements. In order for the new LRP to continue the construction activity on its parcel of property, the new LRP, or the new LRP's approved signatory, must submit PRDs in accordance with this General Permit's requirements.

D. Conditions for Termination of Coverage

1. Within 90 days of when construction is complete or ownership has been transferred, the discharger shall electronically file a Notice of Termination (NOT), a final site map, and photos through the State Water Boards SMARTS system. Filing a NOT certifies that all General Permit requirements have been met. The Regional Water Board will consider a construction site complete only when all portions of the site have been transferred to a new owner, or all of the following conditions have been met:

    a. For purposes of "final stabilization," the site will not pose any additional sediment discharge risk than it did prior to the commencement of construction activity;

    b. There is no potential for construction-related storm water pollutants to be discharged into site runoff;

    c. Final stabilization has been reached;

    d. Construction materials and wastes have been disposed of properly;

    e. Compliance with the Post-Construction Standards in Section XIII of this General Permit has been demonstrated;

    f. Post-construction storm water management measures have been installed and a long-term maintenance plan[7] has been established; and

    g. All construction-related equipment, materials and any temporary BMPs no longer needed are removed from the site.

[7] For the purposes of this requirement a long-term maintenance plan will be designed for a minimum of five years, and will describe the procedures to ensure that the post-construction storm water management measures are adequately maintained.

2. The discharger shall certify that final stabilization conditions are satisfied in their NOT. Failure to certify shall result in continuation of permit coverage and annual billing.

3. The NOT must demonstrate through photos, RUSLE or RUSLE2, or results of testing and analysis that the site meets all of the conditions above (Section II.D.1) and the final stabilization condition (Section II.D.1.a) is attained by one of the following methods:

   a. “70% final cover method,” no computational proof required

      OR:

   b. “RUSLE or RUSLE2 method,” computational proof required

      OR:

   c. “Custom method”, the discharger shall demonstrate in some other manner than a or b, above, that the site complies with the “final stabilization” requirement in Section II.D.1.a.

III. DISCHARGE PROHIBITIONS

A. Dischargers shall not violate any discharge prohibitions contained in applicable Basin Plans or statewide water quality control plans. Waste discharges to Areas of Special Biological Significance (ASBS) are prohibited by the California Ocean Plan, unless granted an exception issued by the State Water Board.

B. All discharges are prohibited except for the storm water and non-storm water discharges specifically authorized by this General Permit or another NPDES permit.

C. Authorized non-storm water discharges may include those from de-chlorinated potable water sources such as: fire hydrant flushing, irrigation of vegetative erosion control measures, pipe flushing and testing, water to control dust, uncontaminated ground water from dewatering, and other discharges not subject to a separate general NPDES permit adopted by a Regional Water Board. The discharge of non-storm water is authorized under the following conditions:

1. The discharge does not cause or contribute to a violation of any water quality standard;

2. The discharge does not violate any other provision of this General Permit;

3. The discharge is not prohibited by the applicable Basin Plan;

4. The discharger has included and implemented specific BMPs required by this General Permit to prevent or reduce the contact of the non-storm water discharge with construction materials or equipment.

5. The discharge does not contain toxic constituents in toxic amounts or (other) significant quantities of pollutants;

6. The discharge is monitored and meets the applicable NALs; and

7. The discharger reports the sampling information in the Annual Report.

If any of the above conditions are not satisfied, the discharge is not authorized by this General Permit. The discharger shall notify the Regional Water Board of any anticipated non-storm water discharges not already authorized by this General Permit or another NPDES permit, to determine whether a separate NPDES permit is necessary.

D. Debris resulting from construction activities are prohibited from being discharged from construction sites.

E. When soil contamination is found or suspected and a responsible party is not identified, or the responsible party fails to promptly take the appropriate action, the discharger shall have those soils sampled and tested to ensure proper handling and public safety measures are implemented. The discharger shall notify the appropriate local, State, and federal agency(ies) when contaminated soil is found at a construction site, and will notify the appropriate Regional Water Board.

IV. SPECIAL PROVISIONS

A. Duty to Comply

1. The discharger shall comply with all of the conditions of this General Permit. Any permit noncompliance constitutes a violation of the Clean Water Act (CWA) and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action and/or removal from General Permit coverage.

2. The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement.

B. General Permit Actions

1. This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a General Permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not annul any General Permit condition.

2. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the CWA for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this General Permit, this General Permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition and the dischargers so notified.

C. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit.

D. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this General Permit, which has a reasonable likelihood of adversely affecting human health or the environment.

E. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems installed by a discharger when necessary to achieve compliance with the conditions of this General Permit.

F. Property Rights

This General Permit does not convey any property rights of any sort or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor does it authorize any infringement of Federal, State, or local laws or regulations.

G. Duty to Maintain Records and Provide Information

1. The discharger shall maintain a paper or electronic copy of all required records, including a copy of this General Permit, for three years from the date generated or date submitted, whichever is last. These records shall be available at the construction site until construction is completed.

2. The discharger shall furnish the Regional Water Board, State Water Board, or U.S. EPA, within a reasonable time, any requested information to determine compliance with this General Permit. The discharger shall also furnish, upon request, copies of records that are required to be kept by this General Permit.

H. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, U.S. EPA, and/or, in the case of construction sites which discharge through a municipal separate storm sewer, an authorized representative of the municipal operator of the separate storm sewer system receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the discharger's premises at reasonable times where a regulated construction activity is being conducted or where records must be kept under the conditions of this General Permit;

2. Access and copy at reasonable times any records that must be kept under the conditions of this General Permit;

3. Inspect at reasonable times the complete construction site, including any off-site staging areas or material storage areas, and the erosion/sediment controls; and

4. Sample or monitor at reasonable times for the purpose of ensuring General Permit compliance.

I. Electronic Signature and Certification Requirements

1. All Permit Registration Documents (PRDs) and Notices of Termination (NOTs) shall be electronically signed, certified, and submitted via SMARTS to the State Water Board. Either the Legally Responsible Person (LRP), as defined in Appendix 5 – Glossary, or a person legally authorized to sign and certify PRDs and NOTs on behalf of the LRP (the LRP's Approved Signatory, as defined in Appendix 5 - Glossary) must submit all information electronically via SMARTS.

2. Changes to Authorization. If an Approved Signatory's authorization is no longer accurate, a new authorization satisfying the requirements of paragraph (a) of this section must be submitted via SMARTS prior to or together with any reports, information or applications to be signed by an Approved Signatory.

3. All Annual Reports, or other information required by the General Permit (other than PRDs and NOTs) or requested by the Regional Water Board, State Water Board, U.S. EPA, or local storm water management agency shall be certified and submitted by the LRP or the LRP's Approved Signatory.

J. Certification

Any person signing documents under Section IV.I above, shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

K. Anticipated Noncompliance

The discharger shall give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the construction activity, which may result in noncompliance with General Permit requirements.

L. Bypass

Bypass[8] is prohibited. The Regional Water Board may take enforcement action against the discharger for bypass unless:

1. Bypass was unavoidable to prevent loss of life, personal injury or severe property damage;[9]

2. There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment downtime or preventative maintenance;

3. The discharger submitted a notice at least ten days in advance of the need for a bypass to the Regional Water Board; or

4. The discharger may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to assure efficient operation. In such a case, the above bypass conditions are not applicable. The discharger shall submit notice of an unanticipated bypass as required.

M. Upset

1. A discharger that wishes to establish the affirmative defense of an upset[10] in an action brought for noncompliance shall demonstrate,

---

[8] The intentional diversion of waste streams from any portion of a treatment facility

[9] Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

[10] An exceptional incident in which there is unintentional and temporary noncompliance the technology based numeric effluent limitations because of factors beyond the reasonable control of the discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

through properly signed, contemporaneous operating logs, or other relevant evidence that:

a. An upset occurred and that the discharger can identify the cause(s) of the upset

b. The treatment facility was being properly operated by the time of the upset

c. The discharger submitted notice of the upset as required; and

d. The discharger complied with any remedial measures required

2. No determination made before an action of noncompliance occurs, such as during administrative review of claims that noncompliance was caused by an upset, is final administrative action subject to judicial review.

3. In any enforcement proceeding, the discharger seeking to establish the occurrence of an upset has the burden of proof

N. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this General Permit, including reports of compliance or noncompliance shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years or by both.

O. Oil and Hazardous Substance Liability

Nothing in this General Permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject to under Section 311 of the CWA.

P. Severability

The provisions of this General Permit are severable; and, if any provision of this General Permit or the application of any provision of this General Permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this General Permit shall not be affected thereby.

Q. Reopener Clause

This General Permit may be modified, revoked and reissued, or terminated for cause due to promulgation of amended regulations, receipt of U.S. EPA guidance concerning regulated activities, judicial decision, or in accordance with 40 Code of Federal Regulations (CFR) 122.62, 122.63, 122.64, and 124.5.

R. Penalties for Violations of Permit Conditions

1. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the CWA or any permit condition or limitation implementing any such section in a permit issued under Section 402. Any person who violates any permit condition of this General Permit is subject to a civil penalty not to exceed $37,500[11] per calendar day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

2. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, which in some cases are greater than those under the CWA.

S. Transfers

This General Permit is not transferable.

T. Continuation of Expired Permit

This General Permit continues in force and effect until a new General Permit is issued or the SWRCB rescinds this General Permit. Only those dischargers authorized to discharge under the expiring General Permit are covered by the continued General Permit.

[11] May be further adjusted in accordance with the Federal Civil Penalties Inflation Adjustment Act.

V. EFFLUENT STANDARDS & RECEIVING WATER MONITORING

A. Narrative Effluent Limitations

1. Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

2. Dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

Table 1- Numeric Action Levels, Test Methods, Detection Limits, and Reporting Units

Parameter	Test Method	Discharge Type	Min. Detection Limit	Units	Numeric Action Level
pH	Field test with calibrated portable instrument	Risk Level 2	0.2	pH units	lower NAL = 6.5 upper NAL = 8.5
		Risk Level 3			lower NAL = 6.5 upper NAL = 8.5
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	Risk Level 2	1	NTU	250 NTU
		Risk Level 3			250 NTU

B. Numeric Action Levels (NALs)

1. For Risk Level 2 and 3 dischargers, the lower storm event average NAL for pH is 6.5 pH units and the upper storm event average NAL for

pH is 8.5 pH units. The discharger shall take actions as described below if the discharge is outside of this range of pH values.

2. For Risk Level 2 and 3 dischargers, the NAL storm event daily average for turbidity is 250 NTU. The discharger shall take actions as described below if the discharge is outside of this range of turbidity values.

3. Whenever the results from a storm event daily average indicate that the discharge is below the lower NAL for pH, exceeds the upper NAL for pH, or exceeds the turbidity NAL (as listed in Table 1), the discharger shall conduct a construction site and run-on evaluation to determine whether pollutant source(s) associated with the site's construction activity may have caused or contributed to the NAL exceedance and shall immediately implement corrective actions if they are needed.

4. The site evaluation shall be documented in the SWPPP and specifically address whether the source(s) of the pollutants causing the exceedance of the NAL:

   a. Are related to the construction activities and whether additional BMPs are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) determine what corrective action(s) were taken or will be taken and with a description of the schedule for completion.

      AND/OR:

   b. Are related to the run-on associated with the construction site location and whether additional BMPs measures are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) what corrective action(s) were taken or will be taken with a description of the schedule for completion.

C. Receiving Water Monitoring Triggers

1. The receiving water monitoring triggers for Risk Level 3 dischargers with direct discharges to surface waters are triggered when the daily average effluent pH values during any site phase when there is a high risk of pH discharge[12] fall outside of the range of 6.0 and 9.0 pH units, or when the daily average effluent turbidity exceeds 500 NTU.

2. Risk Level 3 dischargers with with direct discharges to surface waters shall conduct receiving water monitoring whenever their effluent monitoring results exceed the receiving water monitoring triggers. If the pH trigger is exceeded, the receiving water shall be monitored for pH for the duration of coverage under this General Permit. If the turbidity trigger is exceeded, the receiving water shall be monitored for turbidity and SSC for the duration of coverage under this general permit.

3. Risk Level 3 dischargers with direct discharges to surfaces waters shall initiate receiving water monitoring when the triggers are exceeded unless the storm event causing the exceedance is determined after the fact to equal to or greater than the 5-year 24-hour storm (expressed in inches of rainfall) as determined by using these maps:

   http://www.wrcc.dri.edu/pcpnfreq/nca5y24.gif
   http://www.wrcc.dri.edu/pcpnfreq/sca5y24.gif

   Verification of the 5-year 24-hour storm event shall be done by reporting on-site rain gauge readings as well as nearby governmental rain gauge readings.

4. If run-on is caused by a forest fire or any other natural disaster, then receiving water monitoring triggers do not apply.

[12] A period of high risk of pH discharge is defined as a project's complete utilities phase, complete vertical build phase, and any portion of any phase where significant amounts of materials are placed directly on the land at the site in a manner that could result in significant alterations of the background pH of the discharges.

VI. RECEIVING WATER LIMITATIONS

A. The discharger shall ensure that storm water discharges and authorized non-storm water discharges to any surface or ground water will not adversely affect human health or the environment.

B. The discharger shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants in quantities that threaten to cause pollution or a public nuisance.

C. The discharger shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants that cause or contribute to an exceedance of any applicable water quality objectives or water quality standards (collectively, WQS) contained in a Statewide Water Quality Control Plan, the California Toxics Rule, the National Toxics Rule, or the applicable Regional Water Board's Water Quality Control Plan (Basin Plan).

D. Dischargers located within the watershed of a CWA § 303(d) impaired water body, for which a TMDL has been approved by the U.S. EPA, shall comply with the approved TMDL if it identifies "construction activity" or land disturbance as a source of the pollution.

VII. TRAINING QUALIFICATIONS AND CERTIFICATION REQUIREMENTS

A. General

The discharger shall ensure that all persons responsible for implementing requirements of this General Permit shall be appropriately trained in accordance with this Section. Training should be both formal and informal, occur on an ongoing basis, and should include training offered by recognized governmental agencies or professional organizations. Those responsible for preparing and amending SWPPPs shall comply with the requirements in this Section VII.

The discharger shall provide documentation of all training for persons responsible for implementing the requirements of this General Permit in the Annual Reports.

B. SWPPP Certification Requirements

1. **Qualified SWPPP Developer:** The discharger shall ensure that SWPPPs are written, amended and certified by a Qualified SWPPP Developer (QSD). A QSD shall have one of the following registrations or certifications, and appropriate experience, as required for:

   a. A California registered professional civil engineer;

   b. A California registered professional geologist or engineering geologist;

   c. A California registered landscape architect;

   d. A professional hydrologist registered through the American Institute of Hydrology;

   e. A Certified Professional in Erosion and Sediment Control (CPESC) ™ registered through Enviro Cert International, Inc.;

   f. A Certified Professional in Storm Water Quality (CPSWQ) ™ registered through Enviro Cert International, Inc.; or

   g. A professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (NICET).

Effective two years after the adoption date of this General Permit, a QSD shall have attended a State Water Board-sponsored or approved QSD training course.

2. The discharger shall list the name and telephone number of the currently designated Qualified SWPPP Developer(s) in the SWPPP.

3. **Qualified SWPPP Practitioner:** The discharger shall ensure that all BMPs required by this General Permit are implemented by a Qualified SWPPP Practitioner (QSP). A QSP is a person responsible for non-storm water and storm water visual observations, sampling and analysis. Effective two years from the date of adoption of this General Permit, a QSP shall be either a QSD or have one of the following certifications:

   a. A certified erosion, sediment and storm water inspector registered through Enviro Cert International, Inc.; or

   b. A certified inspector of sediment and erosion control registered through Certified Inspector of Sediment and Erosion Control, Inc.

   Effective two years after the adoption date of this General Permit, a QSP shall have attended a State Water Board-sponsored or approved QSP training course.

4. The LRP shall list in the SWPPP, the name of any Approved Signatory, and provide a copy of the written agreement or other mechanism that provides this authority from the LRP in the SWPPP.

5. The discharger shall include, in the SWPPP, a list of names of all contractors, subcontractors, and individuals who will be directed by the Qualified SWPPP Practitioner. This list shall include telephone numbers and work addresses. Specific areas of responsibility of each subcontractor and emergency contact numbers shall also be included.

6. The discharger shall ensure that the SWPPP and each amendment will be signed by the Qualified SWPPP Developer. The discharger shall include a listing of the date of initial preparation and the date of each amendment in the SWPPP.

VIII. RISK DETERMINATION

The discharger shall calculate the site's sediment risk and receiving water risk during periods of soil exposure (i.e. grading and site stabilization) and use the calculated risks to determine a Risk Level(s) using the methodology in

Appendix 1. For any site that spans two or more planning watersheds,[13] the discharger shall calculate a separate Risk Level for each planning watershed. The discharger shall notify the State Water Board of the site's Risk Level determination(s) and shall include this determination as a part of submitting the PRDs. If a discharger ends up with more than one Risk Level determination, the Regional Water Board may choose to break the project into separate levels of implementation.

IX. RISK LEVEL 1 REQUIREMENTS

Risk Level 1 Dischargers shall comply with the requirements included in Attachment C of this General Permit.

X. RISK LEVEL 2 REQUIREMENTS

Risk Level 2 Dischargers shall comply with the requirements included in Attachment D of this General Permit.

XI. RISK LEVEL 3 REQUIREMENTS

Risk Level 3 Dischargers shall comply with the requirements included in Attachment E of this General Permit.

XII. ACTIVE TREATMENT SYSTEMS (ATS)

Dischargers choosing to implement an ATS on their site shall comply with all of the requirements in Attachment F of this General Permit.

[13] Planning watershed: defined by the Calwater Watershed documents as a watershed that ranges in size from approximately 3,000 to 10,000 acres http://cain.ice.ucdavis.edu/calwater/calwfaq.html, http://gis.ca.gov/catalog/BrowseRecord.epl?id=22175 .

XIII. POST-CONSTRUCTION STANDARDS

A. All dischargers shall comply with the following runoff reduction requirements unless they are located within an area subject to post-construction standards of an active Phase I or II municipal separate storm sewer system (MS4) permit that has an approved Storm Water Management Plan.

1. This provision shall take effect three years from the adoption date of this permit, or later at the discretion of the Executive Officer of the Regional Board.

2. The discharger shall demonstrate compliance with the requirements of this section by submitting with their NOI a map and worksheets in accordance with the instructions in Appendix 2. The discharger shall use non-structural controls unless the discharger demonstrates that non-structural controls are infeasible or that structural controls will produce greater reduction in water quality impacts.

3. The discharger shall, through the use of non-structural and structural measures as described in Appendix 2, replicate the pre-project water balance (for this permit, defined as the volume of rainfall that ends up as runoff) for the smallest storms up to the 85th percentile storm event (or the smallest storm event that generates runoff, whichever is larger). Dischargers shall inform Regional Water Board staff at least 30 days prior to the use of any structural control measure used to comply with this requirement. Volume that cannot be addressed using non-structural practices shall be captured in structural practices and approved by the Regional Water Board. When seeking Regional Board approval for the use of structural practices, dischargers shall document the infeasibility of using non-structural practices on the project site, or document that there will be fewer water quality impacts through the use of structural practices.

4. For sites whose disturbed area exceeds two acres, the discharger shall preserve the pre-construction drainage density (miles of stream length per square mile of drainage area) for all drainage areas within the area serving a first order stream[14] or larger stream and ensure that post-project time of runoff concentration is equal or greater than pre-project time of concentration.

[14] A first order stream is defined as a stream with no tributaries.

B. All dischargers shall implement BMPs to reduce pollutants in storm water discharges that are reasonably foreseeable after all construction phases have been completed at the site (Post-construction BMPs).

XIV. SWPPP REQUIREMENTS

A. The discharger shall ensure that the Storm Water Pollution Prevention Plans (SWPPPs) for all traditional project sites are developed and amended or revised by a QSD. The SWPPP shall be designed to address the following objectives:

1. All pollutants and their sources, including sources of sediment associated with construction, construction site erosion and all other activities associated with construction activity are controlled;

2. Where not otherwise required to be under a Regional Water Board permit, all non-storm water discharges are identified and either eliminated, controlled, or treated;

3. Site BMPs are effective and result in the reduction or elimination of pollutants in storm water discharges and authorized non-storm water discharges from construction activity to the BAT/BCT standard;

4. Calculations and design details as well as BMP controls for site run-on are complete and correct, and

5. Stabilization BMPs installed to reduce or eliminate pollutants after construction are completed.

B. To demonstrate compliance with requirements of this General Permit, the QSD shall include information in the SWPPP that supports the conclusions, selections, use, and maintenance of BMPs.

C. The discharger shall make the SWPPP available at the construction site during working hours while construction is occurring and shall be made available upon request by a State or Municipal inspector. When the original SWPPP is retained by a crewmember in a construction vehicle and is not currently at the construction site, current copies of the BMPs and map/drawing will be left with the field crew and the original SWPPP shall be made available via a request by radio/telephone.

XV. REGIONAL WATER BOARD AUTHORITIES

A. In the case where the Regional Water Board does not agree with the discharger's self-reported risk level (e.g., they determine themselves to be a Level 1 Risk when they are actually a Level 2 Risk site), Regional Water Boards may either direct the discharger to reevaluate the Risk Level(s) for their site or terminate coverage under this General Permit.

B. Regional Water Boards may terminate coverage under this General Permit for dischargers who fail to comply with its requirements or where they determine that an individual NPDES permit is appropriate.

C. Regional Water Boards may require dischargers to submit a Report of Waste Discharge / NPDES permit application for Regional Water Board consideration of individual requirements.

D. Regional Water Boards may require additional Monitoring and Reporting Program Requirements, including sampling and analysis of discharges to sediment-impaired water bodies.

E. Regional Water Boards may require dischargers to retain records for more than the three years required by this General Permit.

XVI. ANNUAL REPORTING REQUIREMENTS

A. All dischargers shall prepare and electronically submit an Annual Report no later than September 1 of each year.

B. The discharger shall certify each Annual Report in accordance with the Special Provisions.

C. The discharger shall retain an electronic or paper copy of each Annual Report for a minimum of three years after the date the annual report is filed.

D. The discharger shall include storm water monitoring information in the Annual Report consisting of:

1. a summary and evaluation of all sampling and analysis results, including copies of laboratory reports;

2. the analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as "less than the method detection limit");

3. a summary of all corrective actions taken during the compliance year;

4. identification of any compliance activities or corrective actions that were not implemented;

5. a summary of all violations of the General Permit;

6. the names of individual(s) who performed the facility inspections, sampling, visual observation (inspections), and/or measurements;

7. the date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation (rain gauge); and

8. the visual observation and sample collection exception records and reports specified in Attachments C, D, and E.

E. The discharger shall provide training information in the Annual Report consisting of:

1. documentation of all training for individuals responsible for all activities associated with compliance with this General Permit;

2. documentation of all training for individuals responsible for BMP installation, inspection, maintenance, and repair; and

3. documentation of all training for individuals responsible for overseeing, revising, and amending the SWPPP.

ATTACHMENT A
Linear Underground/ Overhead Requirements

A. DEFINITION OF LINEAR UNDERGROUND/OVERHEAD PROJECTS 1
B. LINEAR PROJECT PERMIT REGISTRATION DOCUMENTS (PRDs) 3
C. LINEAR PROJECT TERMINATION OF COVERAGE REQUIREMENTS..4
D. DISCHARGE PROHIBITIONS 6
E. SPECIAL PROVISIONS.....8
F. EFFLUENT STANDARDS & RECEIVING WATER MONITORING 13
G. RECEIVING WATER LIMITATIONS 16
H. TRAINING QUALIFICATIONS 17
I. TYPES OF LINEAR PROJECTS 19
J. LUP TYPE-SPECIFIC REQUIREMENTS 20
K. STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REQUIREMENTS 28
L. REGIONAL WATER BOARD AUTHORITIES 29
M. MONITORING AND REPORTING REQUIREMENTS 31

All Linear Underground/Overhead project dischargers who submit permit registration documents (PRDs) indicating their intention to be regulated under the provisions of this General Permit shall comply with the following:

A. DEFINITION OF LINEAR UNDERGROUND/OVERHEAD PROJECTS

1. Linear Underground/Overhead Projects (LUPs) include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquiescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g., telephone, telegraph, radio, or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/ or pavement repair or replacement, and stockpile/borrow locations.

2. LUP evaluation shall consist of two tasks:

a. Confirm that the project or project section(s) qualifies as an LUP. The State Water Board website contains a project determination guidance flowchart. http://www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtml

b. Identify which Type(s) (1, 2 or 3 described in Section I below) are applicable to the project or project sections based on project sediment and receiving water risk. (See Attachment A.1)

3. A Legally Responsible Person (LRP) for a Linear Underground/Overhead project is required to obtain CGP coverage under one or more permit registration document (PRD) electronic submittals to the State Water Board's Storm Water Multi-Application and Report Tracking (SMARTs) system. Attachment A.1 contains a flow chart to be used when determining if a linear project qualifies for coverage and to determine LUP Types. Since a LUP may be constructed within both developed and undeveloped locations and portions of LUPs may be constructed by different contractors, LUPs may be broken into logical permit sections. Sections may be determined based on portions of a project conducted by one contractor. Other situations may also occur, such as the time period in which the sections of a project will be constructed (e.g. project phases), for which separate permit coverage is possible. For projects that are broken into separate sections, a description of how each section relates to the overall project and the definition of the boundaries between sections shall be clearly stated.

4. Where construction activities transverse or enter into different Regional Water Board jurisdictions, LRPs shall obtain permit coverage for each Regional Water Board area involved prior to the commencement of construction activities.

5. Small Construction Rainfall Erosivity Waiver

EPA's Small Construction Erosivity Waiver applies to sites between one and five acres demonstrating that there are no adverse water quality impacts.

Dischargers eligible for a Rainfall Erosivity Waiver based on low erosivity potential shall complete the electronic Notice of Intent (NOI) and Sediment Risk form through the State Water Board's SMARTS system, certifying that the construction activity will take place during a period when the value of the rainfall erosivity factor is less than five. Where the LRP changes or another LRP is added during construction, the new LRP must also submit a waiver certification through the SMARTS system.

If a small linear construction site continues beyond the projected completion date given on the waiver certification, the LRP shall recalculate the rainfall erosivity factor for the new project duration and submit this information through the SMARTS system. If the new R factor is below five (5), the discharger shall update through SMARTS all applicable information on the waiver certification and retain a copy of the revised waiver onsite. The LRP shall submit the new waiver certification 30 days prior to the projected completion date listed on the original waiver form to assure exemption from permitting requirements is uninterrupted. If the new R factor is five (5) or above, the LRP shall be required to apply for coverage under this Order.

B. LINEAR PROJECT PERMIT REGISTRATION DOCUMENTS (PRDs)

Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted. PRDs shall consist of the following:

1. Notice of Intent (NOI)

Prior to construction activities, the LRP of a proposed linear underground/overhead project shall utilize the processes and methods provided in Attachment A.2, Permit Registration Documents (PRDs) – General Instructions for Linear Underground/Overhead Projects to comply with the Construction General Permit.

2. Site Maps

LRPs submitting PRDs shall include at least 3 maps. The first map will be a zoomed[1] 1000-1500 ft vicinity map that shows the starting point of the project. The second will be a zoomed map of 1000-1500 ft showing the ending location of the project. The third will be a larger view vicinity map, 1000 ft to 2000 ft, displaying the entire project location depending on the project size, and indicating the LUP type (1, 2 or 3) areas within the total project footprint.

3. Drawings

LRPs submitting PRDs shall include a construction drawing(s) or other appropriate drawing(s) or map(s) that shows the locations of storm drain

[1] An image with a close-up/enhanced detailed view of site features that show minute details such as streets and neighboring structures.
Or: An image with a close-up/enhanced detailed view of the site's surrounding infrastructure.
Or: An image with a close up detailed view of the project and its surroundings.

inlets and waterbodies[2] that may receive discharges from the construction activities and that shows the locations of BMPs to be installed for all those BMPs that can be illustrated on the revisable drawing(s) or map(s). If storm drain inlets, waterbodies, and/or BMPs cannot be adequately shown on the drawing(s) or map(s) they should be described in detail within the SWPPP.

4. Storm Water Pollution Prevention Plan (SWPPP)

LUP dischargers shall comply with the SWPPP Preparation, Implementation, and Oversight requirements in Section K of this Attachment.

5. Contact information

LUP dischargers shall include contact information for all contractors (or subcontractors) responsible for each area of an LUP project. This should include the names, telephone numbers, and addresses of contact personnel. Specific areas of responsibility of each contact, and emergency contact numbers should also be included.

6. In the case of a public emergency that requires immediate construction activities, a discharger shall submit a brief description of the emergency construction activity within five days of the onset of construction, and then shall submit all PRDs within thirty days.

C. LINEAR PROJECT TERMINATION OF COVERAGE REQUIREMENTS

The LRP may terminate coverage of an LUP when construction activities are completed by submitting an electronic notice of termination (NOT) through the State Water Board's SMARTS system. Termination requirements are different depending on the complexity of the LUP. An LUP is considered complete when: (a) there is no potential for construction-related storm water pollution; (b) all elements of the SWPPP have been completed; (c) construction materials and waste have been disposed of properly; (d) the site is in compliance with all local storm water management requirements; and (e) the LRP submits a notice of termination (NOT) and has received approval for termination from the appropriate Regional Water Board office.

1. LUP Stabilization Requirements

The LUP discharger shall ensure that all disturbed areas of the construction site are stabilized prior to termination of coverage under this General Permit. Final stabilization for the purposes of submitting an NOT

[2] Includes basin(s) that the MS4 storm sewer systems may drain to for Hydromodification or Hydrological Conditional of Concerns under the MS4 permits.

is satisfied when all soil disturbing activities are completed and one of the following criteria is met:

a. In disturbed areas that were vegetated prior to construction activities of the LUP, the area disturbed must be re-established to a uniform vegetative cover equivalent to 70 percent coverage of the preconstruction vegetative conditions. Where preconstruction vegetation covers less than 100 percent of the surface, such as in arid areas, the 70 percent coverage criteria is adjusted as follows: if the preconstruction vegetation covers 50 percent of the ground surface, 70 percent of 50 percent (.70 X .50=.35) would require 35 percent total uniform surface coverage; or

b. Where no vegetation is present prior to construction, the site is returned to its original line and grade and/or compacted to achieve stabilization; or

c. Equivalent stabilization measures have been employed. These measures include, but are not limited to, the use of such BMPs as blankets, reinforced channel liners, soil cement, fiber matrices, geotextiles, or other erosion resistant soil coverings or treatments.

2. LUP Termination of Coverage Requirements

The LRP shall file an NOT through the State Water Board's SMARTS system. By submitting an NOT, the LRP is certifying that construction activities for an LUP are complete and that the project is in full compliance with requirements of this General Permit and that it is now compliant with soil stabilization requirements where appropriate. Upon approval by the appropriate Regional Water Board office, permit coverage will be terminated.

3. Revising Coverage for Change of Acreage

When the LRP of a portion of an LUP construction project changes, or when a phase within a multi-phase project is completed, the LRP may reduce the total acreage covered by this General Permit. In reducing the acreage covered by this General Permit, the LRP shall electronically file revisions to the PRDs that include:

a. a revised NOI indicating the new project size;

b. a revised site map showing the acreage of the project completed, acreage currently under construction, acreage sold, transferred or added, and acreage currently stabilized.

c. SWPPP revisions, as appropriate; and

d. certification that any new LRPs have been notified of applicable requirements to obtain General Permit coverage. The certification shall include the name, address, telephone number, and e-mail address (if known) of the new LRP.

If the project acreage has increased, dischargers shall mail payment of revised annual fees within 14 days of receiving the revised annual fee notification.

D. DISCHARGE PROHIBITIONS

1. LUP dischargers shall not violate any discharge prohibitions contained in applicable Basin Plans or statewide water quality control plans. Waste discharges to Areas of Special Biological Significance (ASBS) are prohibited by the California Ocean Plan, unless granted an exception issued by the State Water Board.

2. LUP dischargers are prohibited from discharging non-storm water that is not otherwise authorized by this General Permit. Non-storm water discharges authorized by this General Permit[3] may include, fire hydrant flushing, irrigation of vegetative erosion control measures, pipe flushing and testing, water to control dust, street cleaning, dewatering,[4] uncontaminated groundwater from dewatering, and other discharges not subject to a separate general NPDES permit adopted by a Regional Water Board. Such discharges are allowed by this General Permit provided they are not relied upon to clean up failed or inadequate construction or post-construction BMPs designed to keep materials on site. These authorized non-storm water discharges:

[3] Dischargers must identify all authorized non-storm water discharges in the LUP's SWPPP and identify BMPs that will be implemented to either eliminate or reduce pollutants in non-storm water discharges. Regional Water Boards may direct the discharger to discontinue discharging such non-storm water discharges if determined that such discharges discharge significant pollutants or threaten water quality.
[4] Dewatering activities may be prohibited or need coverage under a separate permit issued by the Regional Water Boards. Dischargers shall check with the appropriate Regional Water Boards for any required permit or basin plan conditions prior to initial dewatering activities to land, storm drains, or waterbodies.

a. Shall not cause or contribute to a violation of any water quality standard;

b. Shall not violate any other provision of this General Permit;

c. Shall not violate any applicable Basin Plan;

d. Shall comply with BMPs as described in the SWPPP;

e. Shall not contain toxic constituents in toxic amounts or (other) significant quantities of pollutants;

f. Shall be monitored and meets the applicable NALs; and

g. Shall be reported by the discharger in the Annual Report.

If any of the above conditions are not satisfied, the discharge is not authorized by this General Permit. The discharger shall notify the Regional Water Board of any anticipated non-storm water discharges not authorized by this General Permit to determine the need for a separate NPDES permit.

Additionally, some LUP dischargers may be required to obtain a separate permit if the applicable Regional Water Board has adopted a General Permit for dewatering discharges. Wherever feasible, alternatives, that do not result in the discharge of non-storm water, shall be implemented in accordance with this Attachment's Section K.2 - SWPPP Implementation Schedule.

3. LUP dischargers shall ensure that trench spoils or any other soils disturbed during construction activities that are contaminated[5] are not discharged with storm water or non-storm water discharges into any storm drain or water body except pursuant to an NPDES permit.

When soil contamination is found or suspected and a responsible party is not identified, or the responsible party fails to promptly take the appropriate action, the LUP discharger shall have those soils sampled and tested to ensure that proper handling and public safety measures are

[5] Contaminated soil contains pollutants in concentrations that exceed the appropriate thresholds that various regulatory agencies set for those substances. Preliminary testing of potentially contaminated soils will be based on odor, soil discoloration, or prior history of the site's chemical use and storage and other similar factors. When soil contamination is found or suspected and a responsible party is not identified, or the responsible party fails to promptly take the appropriate action, the discharger shall have those soils sampled and tested to ensure proper handling and public safety measures are implemented. The legally responsible person will notify the appropriate local, State, or federal agency(ies) when contaminated soil is found at a construction site, and will notify the Regional Water Board by submitting an NOT at the completion of the project.

implemented. The LUP discharger shall notify the appropriate local, State, and federal agency(ies) when contaminated soil is found at a construction site, and will notify the appropriate Regional Water Board.

4. Discharging any pollutant-laden water that will cause or contribute to an exceedance of the applicable Regional Water Board's Basin Plan from a dewatering site or sediment basin into any receiving water or storm drain is prohibited.

5. Debris[6] resulting from construction activities are prohibited from being discharged from construction project sites.

E. SPECIAL PROVISIONS

1. Duty to Comply

a. The LUP discharger must comply with all of the conditions of this General Permit. Any permit noncompliance constitutes a violation of the Clean Water Act (CWA) and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action and/or removal from General Permit coverage.

b. The LUP discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement.

2. General Permit Actions

a. This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a General Permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not annul any General Permit condition.

[6] Litter, rubble, discarded refuse, and remains of something destroyed.

b. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the CWA for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this General Permit, this General Permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition and the dischargers so notified.

3. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for an LUP discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit.

4. Duty to Mitigate

The LUP discharger shall take all responsible steps to minimize or prevent any discharge in violation of this General Permit, which has a reasonable likelihood of adversely affecting human health or the environment.

5. Proper Operation and Maintenance

The LUP discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this General Permit and with the requirements of the Storm Water Pollution Prevention Plan (SWPPP). Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems installed by a discharger when necessary to achieve compliance with the conditions of this General Permit.

6. Property Rights

This General Permit does not convey any property rights of any sort or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor does it authorize any infringement of Federal, State, or local laws or regulations.

7. Duty to Maintain Records and Provide Information

a. The LUP discharger shall maintain a paper or electronic copy of all required records, including a copy of this General Permit, for three years from the date generated or date submitted, whichever is last. These records shall be kept at the construction site or in a crew

member's vehicle until construction is completed, and shall be made available upon request.

b. The LUP discharger shall furnish the Regional Water Board, State Water Board, or USEPA, within a reasonable time, any requested information to determine compliance with this General Permit. The LUP discharger shall also furnish, upon request, copies of records that are required to be kept by this General Permit.

8. Inspection and Entry

The LUP discharger shall allow the Regional Water Board, State Water Board, USEPA, and/or, in the case of construction sites which discharge through a municipal separate storm sewer, an authorized representative of the municipal operator of the separate storm sewer system receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the discharger's premises at reasonable times where a regulated construction activity is being conducted or where records must be kept under the conditions of this General Permit;

b. Access and copy at reasonable times any records that must be kept under the conditions of this General Permit;

c. Inspect at reasonable times the complete construction site, including any off-site staging areas or material storage areas, and the erosion/sediment controls; and

d. Sample or monitor at reasonable times for the purpose of ensuring General Permit compliance.

9. Electronic Signature and Certification Requirements

a. All Permit Registration Documents (PRDs) and Notices of Termination (NOTs) shall be electronically signed, certified, and submitted via SMARTS to the State Water Board. Either the Legally Responsible Person (LRP), as defined in Appendix 5 – Glossary, or a person legally authorized to sign and certify PRDs and NOTs on behalf of the LRP (the LRP's Approved Signatory, as defined in Appendix 5 - Glossary) must submit all information electronically via SMARTS.

b. Changes to Authorization. If an Approved Signatory's authorization is no longer accurate, a new authorization satisfying the requirements of paragraph (a) of this section must be submitted via SMARTS prior to or

together with any reports, information or applications to be signed by an Approved Signatory.

c. All SWPPP revisions, annual reports, or other information required by the General Permit (other than PRDs and NOTs) or requested by the Regional Water Board, State Water Board, USEPA, or local storm water management agency shall be certified and submitted by the LRP or the LRP's Approved Signatory.

10. Certification

Any person signing documents under Section E.9 above, shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

11. Anticipated Noncompliance

The LUP discharger shall give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the construction activity, which may result in noncompliance with General Permit requirements.

12. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this General Permit, including reports of compliance or noncompliance shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years or by both.

13. Oil and Hazardous Substance Liability

Nothing in this General Permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the LUP discharger is or may be subject to under Section 311 of the CWA.

14. Severability

The provisions of this General Permit are severable; and, if any provision of this General Permit or the application of any provision of this General Permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this General Permit shall not be affected thereby.

15. Reopener Clause

This General Permit may be modified, revoked and reissued, or terminated for cause due to promulgation of amended regulations, receipt of USEPA guidance concerning regulated activities, judicial decision, or in accordance with 40 Code of Federal Regulations (CFR) 122.62, 122.63, 122.64, and 124.5.

16. Penalties for Violations of Permit Conditions

a. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the CWA or any permit condition or limitation implementing any such section in a permit issued under Section 402. Any person who violates any permit condition of this General Permit is subject to a civil penalty not to exceed $37,500[7] per calendar day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

b. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, which in some cases are greater than those under the CWA.

17. Transfers

This General Permit is not transferable. A new LRP of an ongoing construction activity must submit PRDs in accordance with the requirements of this General Permit to be authorized to discharge under this General Permit. An LRP who is a property owner with active General Permit coverage who sells a fraction or all the land shall inform the new property owner(s) of the requirements of this General Permit.

18. Continuation of Expired Permit

This General Permit continues in force and effect until a new General Permit is issued or the SWRCB rescinds this General Permit. Only those

[7] May be further adjusted in accordance with the Federal Civil Penalties Inflation Adjustment Act

dischargers authorized to discharge under the expiring General Permit are covered by the continued General Permit.

F. EFFLUENT STANDARDS & RECEIVING WATER MONITORING

1. Narrative Effluent Limitations

a. LUP dischargers shall ensure that storm water discharges and authorized non-storm water discharges regulated by this General Permit do not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

b. LUP dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of structural or non-structural controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

Table 1. Numeric Action Levels, Test Methods, Detection Limits, and Reporting Units

Parameter	Test Method	Discharge Type	Min. Detection Limit	Units	Numeric Action Level
pH	Field test with calibrated portable instrument	LUP Type 2	0.2	pH units	lower NAL = 6.5 upper NAL = 8.5
		LUP Type 3			lower NAL = 6.5 upper NAL = 8.5
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	LUP Type 2	1	NTU	250 NTU
		LUP Type 3			250 NTU

2. Numeric Action Levels (NALs)

a. For LUP Type 2 and 3 dischargers, the lower storm event daily average NAL for pH is 6.5 pH units and the upper storm event daily average NAL for pH is 8.5 pH units. The LUP discharger shall take actions as described below if the storm event daily average discharge is outside of this range of pH values.

b. For LUP Type 2 and 3 dischargers, the storm event daily average NAL for turbidity is 250 NTU. The discharger shall take actions as described below if the storm event daily average discharge is outside of this range of turbidity values.

c. Whenever daily average analytical effluent monitoring results indicate that the discharge is below the lower NAL for pH, exceeds the upper NAL for pH, or exceeds the turbidity NAL (as listed in Table 1), the LUP discharger shall conduct a construction site and run-on evaluation to determine whether pollutant source(s) associated with the site's construction activity may have caused or contributed to the NAL exceedance and shall immediately implement corrective actions if they are needed.

d. The site evaluation will be documented in the SWPPP and specifically address whether the source(s) of the pollutants causing the exceedance of the NAL:

i Are related to the construction activities and whether additional BMPs or SWPPP implementation measures are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) determine what corrective action(s) were taken or will be taken and with a description of the schedule for completion.

AND/OR:

ii Are related to the run-on associated with the construction site location and whether additional BMPs or SWPPP implementation measures are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) decide what corrective action(s) were taken or will be taken, including a description of the schedule for completion.

3. Receiving Water Monitoring Triggers

a. The receiving water monitoring triggers for LUP Type 3 dischargers with direct discharges to surface waters are triggered when the daily average effluent pH values during any site phase when there is a high risk of pH discharge[8] fall outside of the range of 6.0 and 9.0 pH units, or when the daily average effluent turbidity exceeds 500 NTU.

b. LUP Type 3 dischargers with direct discharges to surface waters shall conduct receiving water monitoring whenever their effluent monitoring results exceed the receiving water monitoring triggers. If the pH trigger is exceeded, the receiving water shall be monitored for pH for the duration of coverage under this General Permit. If the turbidity trigger is exceeded, the receiving water shall be monitored for turbidity and SSC for the duration of coverage under this General Permit.

c. LUP Type 3 dischargers with direct discharges to surfaces waters shall initiate receiving water monitoring when the triggers are exceeded unless the storm event causing the exceedance is determined after the fact to equal to or greater than the 5-year 24-hour storm (expressed in inches of rainfall) as determined by using these maps:

   http://www.wrcc.dri.edu/pcpnfreq/nca5y24.gif
   http://www.wrcc.dri.edu/pcpnfreq/sca5y24.gif

   Verification of the 5-year 24-hour storm event shall be done by reporting on-site rain gauge readings as well as nearby governmental rain gauge readings.

d. If run-on is caused by a forest fire or any other natural disaster, then receiving water monitoring triggers do not apply.

G. RECEIVING WATER LIMITATIONS

1. LUP dischargers shall ensure that storm water discharges and authorized non-storm water discharges to any surface or ground water will not adversely affect human health or the environment.

2. LUP dischargers shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants in quantities that threaten to cause pollution or a public nuisance.

3. LUP dischargers shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants that cause or

[8] A period of high risk of pH discharge is defined as a project's complete utilities phase, complete vertical build phase, and any portion of any phase where significant amounts of materials are placed directly on the land at the site in a manner that could result in significant alterations of the background pH of the discharges.

contribute to an exceedance of any applicable water quality objectives or water quality standards (collectively, WQS) contained in a Statewide Water Quality Control Plan, the California Toxics Rule, the National Toxics Rule, or the applicable Regional Water Board's Water Quality Control Plan (Basin Plan).

H. TRAINING QUALIFICATIONS

1. General

All persons responsible for implementing requirements of this General Permit shall be appropriately trained. Training should be both formal and informal, occur on an ongoing basis, and should include training offered by recognized governmental agencies or professional organizations. Persons responsible for preparing, amending and certifying SWPPPs shall comply with the requirements in this Section H.

2. SWPPP Certification Requirements

a. **Qualified SWPPP Developer:** The LUP discharger shall ensure that all SWPPPs be written, amended and certified by a Qualified SWPPP Developer (QSD). A QSD shall have one of the following registrations or certifications, and appropriate experience, as required for:

i A California registered professional civil engineer;

ii A California registered professional geologist or engineering geologist;

iii A California registered landscape architect;

iv A professional hydrologist registered through the American Institute of Hydrology;

v A certified professional in erosion and sediment control (CPESC) ™ registered through Enviro Cert International, Inc;

vi A certified professional in storm water quality (CPSWQ)™ registered through Enviro Cert International, Inc.; or

vii A certified professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (NICET).

Effective two years after the adoption date of this General Permit, a QSD shall have attended a State Water Board-sponsored or approved QSD training course.

b. The LUP discharger shall ensure that the SWPPP is written and amended, as needed, to address the specific circumstances for each construction site covered by this General Permit prior to commencement of construction activity for any stage.

c. The LUP discharger shall list the name and telephone number of the currently designated Qualified SWPPP Developer(s) in the SWPPP.

d. **Qualified SWPPP Practitioner:** The LUP discharger shall ensure that all elements of any SWPPP for each project will be implemented by a Qualified SWPPP Practitioner (QSP). A QSP is a person responsible for non-storm water and storm water visual observations, sampling and analysis, and for ensuring full compliance with the permit and implementation of all elements of the SWPPP. Effective two years from the date of adoption of this General Permit, a QSP shall be either a QSD or have one of the following certifications:

   i A certified erosion, sediment and storm water inspector registered through Certified Professional in Erosion and Sediment Control, Inc.; or

   ii A certified inspector of sediment and erosion control registered through Certified Inspector of Sediment and Erosion Control, Inc.

   Effective two years after the adoption date of this General Permit, a QSP shall have attended a State Water Board-sponsored or approved QSP training course.

e. The LUP discharger shall ensure that the SWPPP include a list of names of all contractors, subcontractors, and individuals who will be directed by the Qualified SWPPP Practitioner, and who is ultimately responsible for implementation of the SWPPP. This list shall include telephone numbers and work addresses. Specific areas of responsibility of each subcontractor and emergency contact numbers shall also be included.

f. The LUP discharger shall ensure that the SWPPP and each amendment be signed by the Qualified SWPPP Developer. The LUP discharger shall include a listing of the date of initial preparation and the dates of each amendment in the SWPPP.

I. TYPES OF LINEAR PROJECTS

This attachment establishes three types (Type 1, 2 & 3) of complexity for areas within an LUP or project section based on threat to water quality. Project area Types are determined through Attachment A.1.

The Type 1 requirements below establish the baseline requirements for all LUPs subject to this General Permit. Additional requirements for Type 2 and Type 3 LUPs are labeled.

1. Type 1 LUPs*:*

LUP dischargers with areas of a LUP designated as Type 1 shall comply with the requirements in this Attachment. Type 1 LUPs are:

a. Those construction areas where 70 percent or more of the construction activity occurs on a paved surface and where areas disturbed during construction will be returned to preconstruction conditions or equivalent protection established at the end of the construction activities for the day; or

b. Where greater than 30 percent of construction activities occur within the non-paved shoulders or land immediately adjacent to paved surfaces, or where construction occurs on unpaved improved roads, including their shoulders or land immediately adjacent to them where:

   i Areas disturbed during construction will be returned to preconstruction conditions or equivalent protection is established at the end of the construction activities for the day to minimize the potential for erosion and sediment deposition, and

   ii Areas where established vegetation was disturbed during construction will be stabilized and re-vegetated by the end of project. When required, adequate temporary stabilization BMPs will be installed and maintained until vegetation is established to meet minimum cover requirements established in this General Permit for final stabilization.

c. Where the risk determination is as follows:

   i Low sediment risk, low receiving water risk, or

   ii Low sediment risk, medium receiving water risk, or

   iii Medium sediment risk, low receiving water risk

2. Type 2 LUPs:

Type 2 LUPs are determined by the Combined Risk Matrix in Attachment A.1. Type 2 LUPs have the specified combination of risk:

d. High sediment risk, low receiving water risk, or

e. Medium sediment risk, medium receiving water risk, or

f. Low sediment risk, high receiving water risk

Receiving water risk is either considered "Low" for those areas of the project that are not in close proximity to a sensitive receiving watershed, "Medium" for those areas of the project within a sensitive receiving watershed yet outside of the flood plain of a sensitive receiving water body, and "High" where the soil disturbance is within close proximity to a sensitive receiving water body. Project sediment risk is calculated based on the Risk Factor Worksheet in Attachment C of this General Permit.

3. Type 3 LUPs:

Type 3 LUPs are determined by the Combined Risk Matrix in Attachment A.1. Type 3 LUPs have the specified combination of risk:

a. High sediment risk, high receiving water risk, or

b. High sediment risk, medium receiving water risk, or

c. Medium sediment risk, high receiving water risk

Receiving water risk is either considered "Medium" for those areas of the project within a sensitive receiving watershed yet outside of the flood plain of a sensitive receiving water body, or "High" where the soil disturbance is within close proximity to a sensitive receiving water body. Project sediment risk is calculated based on the Risk Factor Worksheet in Attachment C.

J. LUP TYPE-SPECIFIC REQUIREMENTS

1. Effluent Standards

a. Narrative – LUP dischargers shall comply with the narrative effluent standards below.

i Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

ii LUP dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

b. Numeric – LUP Type 1 dischargers are not subject to a numeric effluent standard

c. Numeric –LUP Type 2 dischargers are subject to a pH NAL of 6.5-8.5, and a turbidity NAL of 250 NTU.

d. Numeric – LUP Type 3 dischargers are subject to a pH NAL of 6.5-8.5, and a turbidity NAL of 250 NTU.

2. Good Site Management "Housekeeping"

a. LUP dischargers shall implement good site management (i.e., "housekeeping") measures for construction materials that could potentially be a threat to water quality if discharged. At a minimum, the good housekeeping measures shall consist of the following:

i Identify the products used and/or expected to be used and the end products that are produced and/or expected to be produced. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

ii Cover and berm loose stockpiled construction materials that are not actively being used (i.e. soil, spoils, aggregate, fly-ash, stucco, hydrated lime, etc.).

iii Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).

iv Minimize exposure of construction materials to precipitation (not applicable to materials designed to be outdoors and exposed to the environment).

v Implement BMPs to control the off-site tracking of loose construction and landscape materials.

b. LUP dischargers shall implement good housekeeping measures for waste management, which, at a minimum, shall consist of the following:

i Prevent disposal of any rinse or wash waters or materials on impervious or pervious site surfaces or into the storm drain system.

ii Ensure the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the storm water drainage system or receiving water.

iii Clean or replace sanitation facilities and inspecting them regularly for leaks and spills.

iv Cover waste disposal containers at the end of every business day and during a rain event.

v Prevent discharges from waste disposal containers to the storm water drainage system or receiving water.

vi Contain and securely protect stockpiled waste material from wind and rain at all times unless actively being used.

vii Implement procedures that effectively address hazardous and non-hazardous spills.

viii Develop a spill response and implementation element of the SWPPP prior to commencement of construction activities. The SWPPP shall require that:

(1) Equipment and materials for cleanup of spills shall be available on site and that spills and leaks shall be cleaned up immediately and disposed of properly; and

(2) Appropriate spill response personnel are assigned and trained.

ix Ensure the containment of concrete washout areas and other washout areas that may contain additional pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

c. LUP dischargers shall implement good housekeeping for vehicle storage and maintenance, which, at a minimum, shall consist of the following:

   i Prevent oil, grease, or fuel from leaking into the ground, storm drains or surface waters.

   ii Implement appropriate BMPs whenever equipment or vehicles are fueled, maintained or stored.

   iii Clean leaks immediately and disposing of leaked materials properly.

d. LUP dischargers shall implement good housekeeping for landscape materials, which, at a minimum, shall consist of the following:

   i Contain stockpiled materials such as mulches and topsoil when they are not actively being used.

   ii Contain fertilizers and other landscape materials when they are not actively being used.

   iii Discontinue the application of any erodible landscape material at least 2 days before a forecasted rain event[9] or during periods of precipitation.

   iv Applying erodible landscape material at quantities and application rates according to manufacture recommendations or based on written specifications by knowledgeable and experienced field personnel.

   v Stacking erodible landscape material on pallets and covering or storing such materials when not being used or applied.

e. LUP dischargers shall conduct an assessment and create a list of potential pollutant sources and identify any areas of the site where additional BMPs are necessary to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. This potential pollutant list shall be kept with the SWPPP and shall identify all non-visible pollutants which are known, or should be known, to occur on the construction site. At a minimum, when developing BMPs, LUP dischargers shall do the following:

[9] 50% or greater chance of producing precipitation.

i Consider the quantity, physical characteristics (e.g., liquid, powder, solid), and locations of each potential pollutant source handled, produced, stored, recycled, or disposed of at the site.

ii Consider the degree to which pollutants associated with those materials may be exposed to and mobilized by contact with storm water.

iii Consider the direct and indirect pathways that pollutants may be exposed to storm water or authorized non-storm water discharges. This shall include an assessment of past spills or leaks, non-storm water discharges, and discharges from adjoining areas.

iv Ensure retention of sampling, visual observation, and inspection records.

v Ensure effectiveness of existing BMPs to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges.

f. LUP dischargers shall implement good housekeeping measures on the construction site to control the air deposition of site materials and from site operations.

3. Non-Storm Water Management

a. LUP dischargers shall implement measures to control all non-storm water discharges during construction.

b. LUP dischargers shall wash vehicles in such a manner as to prevent non-storm water discharges to surface waters or MS4 drainage systems.

c. LUP dischargers shall clean streets in such a manner as to prevent unauthorized non-storm water discharges from reaching surface water or MS4 drainage systems.

4. Erosion Control

a. LUP dischargers shall implement effective wind erosion control.

b. LUP dischargers shall provide effective soil cover for inactive[10] areas and all finished slopes, and utility backfill.

[10] Areas of construction activity that have been disturbed and are not scheduled to be re-disturbed for at least 14 days

c. LUP dischargers shall limit the use of plastic materials when more sustainable, environmentally friendly alternatives exist. Where plastic materials are deemed necessary, the discharger shall consider the use of plastic materials resistant to solar degradation.

5. Sediment Controls

a. LUP dischargers shall establish and maintain effective perimeter controls as needed, and implement effective BMPs for all construction entrances and exits to sufficiently control erosion and sediment discharges from the site.

b. On sites where sediment basins are to be used, LUP dischargers shall, at minimum, design sediment basins according to the guidance provided in CASQA's Construction BMP Handbook.

c. **Additional LUP Type 2 & 3 Requirement:** LUP Type 2 & 3 dischargers shall apply linear sediment controls along the toe of the slope, face of the slope, and at the grade breaks of exposed slopes to comply with sheet flow lengths[11] in accordance with Table 2 below.

Table 2 – Critical Slope/Sheet Flow Length Combinations

Slope Percentage	Sheet flow length not to exceed
0-25%	20 feet
25-50%	15 feet
Over 50%	10 feet

d. **Additional LUP Type 2 & 3 Requirement:** LUP Type 2 & 3 dischargers shall ensure that construction activity traffic to and from the project is limited to entrances and exits that employ effective controls to prevent off-site tracking of sediment.

e. **Additional LUP Type 2 & 3 Requirement:** LUP Type 2 & 3 dischargers shall ensure that all storm drain inlets and perimeter controls, runoff control BMPs, and pollutant controls at entrances and exits (e.g. tire washoff locations) are maintained and protected from activities that reduce their effectiveness.

f. **Additional LUP Type 2 & 3 Requirement:** LUP Type 2 & 3 dischargers shall inspect all immediate access roads. At a minimum daily and prior to any rain event, the discharger shall remove any

[11] Sheet flow length is the length that shallow, low velocity flow travels across a site.

sediment or other construction activity-related materials that are deposited on the roads (by vacuuming or sweeping).

g. **Additional LUP Type 3 Requirement:** The Regional Water Board may require LUP Type 3 dischargers to implement additional site-specific sediment control requirements if the implementation of the other requirements in this section are not adequately protecting the receiving waters.

6. Run-on and Run-off Controls

a. LUP dischargers shall effectively manage all run-on, all runoff within the site and all runoff that discharges off the site. Run-on from off site-shall be directed away from all disturbed areas or shall collectively be in compliance with the effluent limitations in this Attachment.

b. Run-on and runoff controls are not required for Type 1 LUPs unless the evaluation of quantity and quality of run-on and runoff deems them necessary or visual inspections show that the site requires such controls.

7. Inspection, Maintenance and Repair

a. All inspection, maintenance repair and sampling activities at the discharger's LUP location shall be performed or supervised by a QSP representing the discharger. The QSP may delegate any or all of these activities to an employee trained to do the task(s) appropriately, but shall ensure adequate deployment.

b. LUP dischargers shall conduct visual inspections and observations daily during working hours (not recorded). At least once each 24-hour period during extended storm events, **LUP Type 2 & 3 dischargers** shall conduct visual inspections to identify and record BMPs that need maintenance to operate effectively, that have failed, or that could fail to operate as intended. Inspectors shall be the QSP or be trained by the QSP.

c. Upon identifying failures or other shortcomings, as directed by the QSP, LUP dischargers shall begin implementing repairs or design changes to BMPs within 72 hours of identification and complete the changes as soon as possible.

d. For each pre- and post-rain event inspection required, LUP dischargers shall complete an inspection checklist, using a form provided by the State Water Board or Regional Water Board or in an alternative format that includes the information described below.

e. The LUP discharger shall ensure that the checklist remains on-site or with the SWPPP. At a minimum, an inspection checklist should include:

i Inspection date and date the inspection report was written.

ii Weather information, including presence or absence of precipitation, estimate of beginning of qualifying storm event, duration of event, time elapsed since last storm, and approximate amount of rainfall in inches.

iii Site information, including stage of construction, activities completed, and approximate area of the site exposed.

iv A description of any BMPs evaluated and any deficiencies noted.

v If the construction site is safely accessible during inclement weather, list the observations of all BMPs: erosion controls, sediment controls, chemical and waste controls, and non-storm water controls. Otherwise, list the results of visual inspections at all relevant outfalls, discharge points, downstream locations and any projected maintenance activities.

vi Report the presence of noticeable odors or of any visible sheen on the surface of any discharges.

vii Any corrective actions required, including any necessary changes to the SWPPP and the associated implementation dates.

viii Photographs taken during the inspection, if any.

ix Inspector's name, title, and signature.

K. STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REQUIREMENTS

1. Objectives

SWPPPs for all LUPs shall be developed and amended or revised by a QSD. The SWPPP shall be designed to address the following objectives:

a. All pollutants and their sources, including sources of sediment, associated with construction activities associated with LUP activity are controlled;

b. All non-storm water discharges are identified and either eliminated, controlled, or treated;

c. BMPs are effective and result in the reduction or elimination of pollutants in storm water discharges and authorized non-storm water discharges from LUPs during construction; and

d. Stabilization BMPs installed to reduce or eliminate pollutants after construction is completed are effective and maintained.

2. SWPPP Implementation Schedule

a. LUPs for which PRDs have been submitted to the State Water Board shall develop a site/project location SWPPP prior to the start of land-disturbing activity in accordance with this Section and shall implement the SWPPP concurrently with commencement of soil-disturbing activities.

b. For an ongoing LUP involving a change in the LRP, the new LRP shall review the existing SWPPP and amend it, if necessary, or develop a new SWPPP within 15 calendar days to conform to the requirements set forth in this General Permit.

3. Availability

The SWPPP shall be available at the construction site during working hours while construction is occurring and shall be made available upon request by a State or Municipal inspector. When the original SWPPP is retained by a crewmember in a construction vehicle and is not currently at the construction site, copies of the BMPs and map/drawing will be left with the field crew and the original SWPPP shall be made available via a request by radio/telephone.

L. REGIONAL WATER BOARD AUTHORITIES

1. Regional Water Boards shall administer the provisions of this General Permit. Administration of this General Permit may include, but is not limited to, requesting the submittal of SWPPPs, reviewing SWPPPs, reviewing monitoring and sampling and analysis reports, conducting compliance inspections, gathering site information by any medium including sampling, photo and video documentation, and taking enforcement actions.

2. Regional Water Boards may terminate coverage under this General Permit for dischargers who fail to comply with its requirements or where they determine that an individual NPDES permit is appropriate.

3. Regional Water Boards may issue separate permits for discharges of storm water associated with construction activity to individual dischargers, categories of dischargers, or dischargers in a geographic area. Upon issuance of such permits by a Regional Water Board, dischargers subject to those permits shall no longer be regulated by this General Permit.

4. Regional Water Boards may direct the discharger to reevaluate the LUP Type(s) for the project (or elements/areas of the project) and impose the appropriate level of requirements.

5. Regional Water Boards may terminate coverage under this General Permit for dischargers who negligently or with willful intent incorrectly determine or report their LUP Type (e.g., they determine themselves to be a LUP Type 1 when they are actually a Type 2).

6. Regional Water Boards may review PRDs and reject or accept applications for permit coverage or may require dischargers to submit a Report of Waste Discharge / NPDES permit application for Regional Water Board consideration of individual requirements.

7. Regional Water Boards may impose additional requirements on dischargers to satisfy TMDL implementation requirements or to satisfy provisions in their Basin Plans.

8. Regional Water Boards may require additional Monitoring and Reporting Program Requirements, including sampling and analysis of discharges to sediment-impaired water bodies.

9. Regional Water Boards may require dischargers to retain records for more than the three years required by this General Permit.

10. Based on an LUP's threat to water quality and complexity, the Regional Water Board may determine on a case-by-case basis that an LUP, or a portion of an LUP, is not eligible for the linear project requirements contained in this Attachment, and require that the discharger comply with all standard requirements in this General Permit.

11. The Regional Water Board may require additional monitoring and reporting program requirements including sampling and analysis of discharges to CWA § 303(d)-listed water bodies. Additional requirements imposed by the Regional Water Board shall be consistent with the overall monitoring effort in the receiving waters.

M. MONITORING AND REPORTING REQUIREMENTS

Table 3. LUP Summary of Monitoring Requirements

LUP Type	Visual Inspections				Sample Collection		
	Daily Site BMP	Pre-storm Event / Baseline	Daily Storm BMP	Post Storm	Storm Water Discharge	Receiving Water	Non-Visible (when applicable)
1	X						x
2	X	X	X	X	X		x
3	X	X	X	X	X	X	x

1. Objectives

LUP dischargers shall prepare a monitoring and reporting program (M&RP) prior to the start of construction and immediately implement the program at the start of construction for LUPs. The monitoring program must be implemented at the appropriate level to protect water quality at all times throughout the life of the project. The M&RP must be a part of the SWPPP, included as an appendix or separate SWPPP chapter.

2. M&RP Implementation Schedule

a. LUP dischargers shall implement the requirements of this Section at the time of commencement of construction activity. LUP dischargers are responsible for implementing these requirements until construction activity is complete and the site is stabilized.

b. LUP dischargers shall revise the M&RP when:

i Site conditions or construction activities change such that a change in monitoring is required to comply with the requirements and intent of this General Permit.

ii The Regional Water Board requires the discharger to revise its M&RP based on its review of the document. Revisions may include, but not be limited to, conducting additional site inspections, submitting reports, and certifications. Revisions shall be submitted via postal mail or electronic e-mail.

iii The Regional Water Board may require additional monitoring and reporting program requirements including sampling and analysis of discharges to CWA § 303(d)-listed water bodies. Additional requirements imposed by the Regional Water Board shall be consistent with the overall monitoring effort in the receiving waters.

3. LUP Type 1 Monitoring and Reporting Requirements

a. LUP Type 1 Inspection Requirements

i LUP Type 1 dischargers shall ensure that all inspections are conducted by trained personnel. The name(s) and contact number(s) of the assigned inspection personnel should be listed in the SWPPP.

ii LUP Type 1 dischargers shall ensure that all visual inspections are conducted daily during working hours and in conjunction with other daily activities in areas where active construction is occurring.

iii LUP Type 1 dischargers shall ensure that photographs of the site taken before, during, and after storm events are taken during inspections, and submitted through the State Water Board's SMARTS website once every three rain events.

iv LUP Type 1 dischargers shall conduct daily visual inspections to verify that:

(1) Appropriate BMPs for storm water and non-storm water are being implemented in areas where active construction is occurring (including staging areas);

(2) Project excavations are closed, with properly protected spoils, and that road surfaces are cleaned of excavated material and construction materials such as chemicals by either removing or storing the material in protective storage containers at the end of every construction day;

(3) Land areas disturbed during construction are returned to pre-construction conditions or an equivalent protection is used at the end of each workday to eliminate or minimize erosion and the possible discharge of sediment or other pollutants during a rain event.

v Inspections may be discontinued in non-active construction areas where soil-disturbing activities are completed and final soil stabilization is achieved (e.g., paving is completed, substructures

are installed, vegetation meets minimum cover requirements for final stabilization, or other stabilization requirements are met).

vi Inspection programs are required for LUP Type 1 projects where temporary and permanent stabilization BMPs are installed and are to be monitored after active construction is completed. Inspection activities shall continue until adequate permanent stabilization is established and, in areas where re-vegetation is chosen, until minimum vegetative coverage is established in accordance with Section C.1 of this Attachment.

b. <u>LUP Type 1 Monitoring Requirements for Non-Visible Pollutants</u>

LUP Type 1 dischargers shall implement sampling and analysis requirements to monitor non-visible pollutants associated with (1) construction sites; (2) activities producing pollutants that are not visually detectable in storm water discharges; and (3) activities which could cause or contribute to an exceedance of water quality objectives in the receiving waters.

i Sampling and analysis for non-visible pollutants is only required where the LUP Type 1 discharger believes pollutants associated with construction activities have the potential to be discharged with storm water runoff due to a spill or in the event there was a breach, malfunction, failure and/or leak of any BMP. Also, failure to implement BMPs may require sample collection.

(1) Visual observations made during the monitoring program described above will help the LUP Type 1 discharger determine when to collect samples.

(2) The LUP Type 1 discharger is not required to sample if one of the conditions described above (e.g., breach or spill) occurs and the site is cleaned of material and pollutants and/or BMPs are implemented prior to the next storm event.

ii LUP Type 1 dischargers shall collect samples down-gradient from all discharge locations where the visual observations were made triggering the monitoring, and which can be safely accessed. For sites where sampling and analysis is required, personnel trained in water quality sampling procedures shall collect storm water samples.

iii If sampling for non-visible pollutant parameters is required, LUP Type 1 dischargers shall ensure that samples be analyzed for parameters indicating the presence of pollutants identified in the pollutant source assessment required in Section J.2.a.i.

iv LUP Type 1 dischargers shall collect samples during the first two hours of discharge from rain events that occur during business hours and which generate runoff.

v LUP Type 1 dischargers shall ensure that a sufficiently large sample of storm water that has not come into contact with the disturbed soil or the materials stored or used on-site (uncontaminated sample[12]) will be collected for comparison with the discharge sample. Samples shall be collected during the first two hours of discharge from rain events that occur during daylight hours and which generate runoff.

vi LUP Type 1 dischargers shall compare the uncontaminated sample to the samples of discharge using field analysis or through laboratory analysis. Analyses may include, but are not limited to, indicator parameters such as: pH, specific conductance, dissolved oxygen, conductivity, salinity, and Total Dissolved Solids (TDS).

vii For laboratory analyses, all sampling, sample preservation, and other analyses must be conducted according to test procedures pursuant to 40 C.F.R. Part 136. LUP Type 1 dischargers shall ensure that field samples are collected and analyzed according to manufacturer specifications of the sampling devices employed. Portable meters shall be calibrated according to manufacturer's specification.

viii LUP Type 1 dischargers shall ensure that all field and/or analytical data are kept in the SWPPP document.

c. <u>LUP Type 1 Visual Observation Exceptions</u>

i LUP Type 1 dischargers shall be prepared to collect samples and conduct visual observation (inspections) to meet the minimum visual observation requirements of this Attachment. The Type 1 LUP discharger is not required to physically collect samples or conduct visual observation (inspections) under the following conditions:

(1) During dangerous weather conditions such as flooding and electrical storms;

(2) Outside of scheduled site business hours.

(3) When access to the site is unsafe due to storm events.

[12] Sample collected at a location unaffected by contruction activities.

ii If the LUP Type 1 discharger does not collect the required samples or visual observation (inspections) due to these exceptions, an explanation why the sampling or visual observation (inspections) were not conducted shall be included in both the SWPPP and the Annual Report.

d. Particle Size Analysis for Risk Justification

LUP Type 1 dischargers utilizing justifying an alternative project risk shall report a soil particle size analysis used to determine the RUSLE K-Factor. ASTM D-422 (Standard Test Method for Particle-Size Analysis of Soils), as revised, shall be used to determine the percentages of sand, very fine sand, silt, and clay on the site.

4. LUP Type 2 & 3 Monitoring and Reporting Requirements

a. LUP Type 2 & 3 Inspection Requirements

i LUP Type 2 & 3 dischargers shall ensure that all inspections are conducted by trained personnel. The name(s) and contact number(s) of the assigned inspection personnel should be listed in the SWPPP.

ii LUP Type 2 & 3 dischargers shall ensure that all visual inspections are conducted daily during working hours and in conjunction with other daily activities in areas where active construction is occurring.

iii LUP Type 2 & 3 dischargers shall ensure that photographs of the site taken before, during, and after storm events are taken during inspections, and submitted through the State Water Board's SMARTS website once every three rain events.

iv LUP Type 2 & 3 dischargers shall conduct daily visual inspections to verify that appropriate BMPs for storm water and non-storm water are being implemented and in place in areas where active construction is occurring (including staging areas).

v LUP Type 2 & 3 dischargers shall conduct inspections of the construction site prior to anticipated storm events, during extended storm events, and after actual storm events to identify areas contributing to a discharge of storm water associated with construction activity. Pre-storm inspections are to ensure that BMPs are properly installed and maintained; post-storm inspections are to assure that BMPs have functioned adequately. During

extended storm events, inspections shall be required during normal working hours for each 24-hour period.

vi Inspections may be discontinued in non-active construction areas where soil-disturbing activities are completed and final soil stabilization is achieved (e.g., paving is completed, substructures are installed, vegetation meets minimum cover requirements for final stabilization, or other stabilization requirements are met).

vii LUP Type 2 & 3 dischargers shall implement a monitoring program for inspecting projects that require temporary and permanent stabilization BMPs after active construction is complete. Inspections shall ensure that the BMPs are adequate and maintained. Inspection activities shall continue until adequate permanent stabilization is established and, in vegetated areas, until minimum vegetative coverage is established in accordance with Section C.1 of this Attachment.

viii If possible, LUP Type 2 & 3 dischargers shall install a rain gauge on-site at an accessible and secure location with readings made during all storm event inspections. When readings are unavailable, data from the closest rain gauge with publically available data may be used.

ix LUP Type 2 & 3 dischargers shall Include and maintain a log of the inspections conducted in the SWPPP. The log will provide the date and time of the inspection and who conducted the inspection.

b. <u>LUP Type 2 & 3 Storm Water Effluent Monitoring Requirements</u>

Table 4. LUP Type 2 & 3 Effluent Monitoring Requirements

LUP Type	Frequency	Effluent Monitoring
2	Minimum of 3 samples per day characterizing discharges associated with construction activity from the project active areas of construction.	Turbidity, pH, and non-visible pollutant parameters (if applicable)
3	Minimum of 3 samples per day characterizing discharges associated with construction activity from the project active areas of construction.	turbidity, pH, and non-visible pollutant parameters (if applicable)

i LUP Type 2 & 3 dischargers shall collect storm water grab samples from sampling locations characterizing discharges associated with activity from the LUP active areas of construction. At a minimum, 3 samples shall be collected per day of discharge.

ii LUP Type 2 & 3 dischargers shall collect samples of stored or contained storm water that is discharged subsequent to a storm event producing precipitation of ½ inch or more at the time of discharge.

iii LUP Type 2 & 3 dischargers shall ensure that storm water grab sample(s) obtained be representative of the flow and characteristics of the discharge.

iv LUP Type 2 & 3 dischargers shall analyze their effluent samples for:

(1) pH and turbidity
(2) Any additional parameter for which monitoring is required by the Regional Water Board.

c. <u>LUP Type 2 & 3 Storm Water Effluent Sampling Locations</u>

i LUP Type 2 & 3 dischargers shall perform sampling and analysis of storm water discharges to characterize discharges associated with construction activity from the entire disturbed project or area.

ii LUP Type 2 & 3 dischargers may monitor and report run-on from surrounding areas if there is reason to believe run-on may contribute to exceedance of NALs.

iii LUP Type 2 & 3 dischargers shall select analytical test methods from the list provided in Table 5 below.

iv LUP Type 2 & 3 dischargers shall ensure that all storm water sample collection preservation and handling shall be conducted in accordance with the “Storm Water Sample Collection and Handling Instructions” below.

d. <u>LUP Type 3 Receiving Water Monitoring Requirements</u>

i In the event that an LUP Type 3 discharger’s effluent exceeds the receiving water monitoring triggers of 500 NTU turbidity or pH range of 6.0-9.0, contained in this General Permit and has a direct discharge to receiving waters, the LUP discharger shall subsequently sample Receiving Waters (RWs) for turbidity, pH (if applicable) and SSC for the duration of coverage under this General Permit. In the event that an LUP Tupe 3 discharger utilizing ATS with direct discharges into receiving waters discharges effluent that exceeds the NELs in this permit, the discharger shall

subsequently sample RWs for turbidity, pH (if applicable), and SSC for the duration of coverage under this General Permit.

ii LUP Type 3 dischargers that meet the project criteria in Appendix 3 of this General Permit and have more than 30 acres of soil disturbance in the project area or project section area designated as Type 3, shall comply with the Bioassessment requirements prior to commencement of construction activity.

iii LUP Type 3 dischargers shall obtain RW samples in accordance with the requirements of the Receiving Water Sampling Locations section (Section M.4.c. of this Attachment).

e. LUP Type 3 Receiving Water Sampling Locations

i **Upstream/up-gradient RW samples**: LUP Type 3 dischargers shall obtain any required upstream/up-gradient receiving water samples from a representative and accessible location as close as possible to and upstream from the effluent discharge point.

ii **Downstream/down-gradient RW samples**: LUP Type 3 dischargers shall obtain any required downstream/down-gradient receiving water samples from a representative and accessible location as close as possible to and downstream from the effluent discharge point.

iii If two or more discharge locations discharge to the same receiving water, LUP Type 3 dischargers may sample the receiving water at a single upstream and downstream location.

f. LUP Type 2 & 3 Monitoring Requirements for Non-Visible Pollutants

LUP Type 2 & 3 dischargers shall implement sampling and analysis requirements to monitor non-visible pollutants associated with (1) construction sites; (2) activities producing pollutants that are not visually detectable in storm water discharges; and (3) activities which could cause or contribute to an exceedance of water quality objectives in the receiving waters.

i Sampling and analysis for non-visible pollutants is only required where LUP Type 2 & 3 dischargers believe pollutants associated with construction activities have the potential to be discharged with storm water runoff due to a spill or in the event there was a breach, malfunction, failure and/or leak of any BMP. Also, failure to implement BMPs may require sample collection.

(1) Visual observations made during the monitoring program described above will help LUP Type 2 & 3 dischargers determine when to collect samples.

(2) LUP Type 2 & 3 dischargers are not required to sample if one of the conditions described above (e.g., breach or spill) occurs and the site is cleaned of material and pollutants and/or BMPs are implemented prior to the next storm event.

ii LUP Type 2 & 3 dischargers shall collect samples down-gradient from the discharge locations where the visual observations were made triggering the monitoring and which can be safely accessed. For sites where sampling and analysis is required, personnel trained in water quality sampling procedures shall collect storm water samples.

iii If sampling for non-visible pollutant parameters is required, LUP Type 2 & 3 dischargers shall ensure that samples be analyzed for parameters indicating the presence of pollutants identified in the pollutant source assessment required in Section J.2.a.i.

iv LUP Type 2 & 3 dischargers shall collect samples during the first two hours of discharge from rain events that occur during business hours and which generate runoff.

v LUP Type 2 & 3 dischargers shall ensure that a sufficiently large sample of storm water that has not come into contact with the disturbed soil or the materials stored or used on-site (uncontaminated sample[13]) will be collected for comparison with the discharge sample. Samples shall be collected during the first two hours of discharge from rain events that occur during daylight hours and which generate runoff.

vi LUP Type 2 & 3 dischargers shall compare the uncontaminated sample to the samples of discharge using field analysis or through laboratory analysis. Analyses may include, but are not limited to, indicator parameters such as: pH, specific conductance, dissolved oxygen, conductivity, salinity, and Total Dissolved Solids (TDS).

vii For laboratory analyses, all sampling, sample preservation, and other analyses must be conducted according to test procedures pursuant to 40 C.F.R. Part 136. LUP Type 2 & 3 dischargers shall ensure that field samples are collected and analyzed according to manufacturer specifications of the sampling devices employed.

[13] Sample collected at a location unaffected by construction activities

Portable meters shall be calibrated according to manufacturer's specification.

viii LUP Type 2 & 3 dischargers shall ensure that all field and/or analytical data are kept in the SWPPP document.

g. LUP Type 2 & 3 Visual Observation and Sample Collection Exceptions

i LUP Type 2 & 3 dischargers shall be prepared to collect samples and conduct visual observation (inspections) to meet the minimum visual observation requirements of this Attachment. Type 2 & 3 LUP dischargers are not required to physically collect samples or conduct visual observation (inspections) under the following conditions:

(1) During dangerous weather conditions such as flooding and electrical storms;

(2) Outside of scheduled site business hours.

(3) When access to the site is unsafe due to storm events.

ii If the LUP Type 2 or 3 discharger does not collect the required samples or visual observation (inspections) due to these exceptions, an explanation why the sampling or visual observation (inspections) were not conducted shall be included in both the SWPPP and the Annual Report.

h. LUP Type 2 & 3 Storm Water Sample Collection and Handling Instructions

LUP Type 2 & 3 dischargers shall refer to Table 5 below for test Methods, detection Limits, and reporting Units. During storm water sample collection and handling, the LUP Type 2 & 3 discharger shall:

i Identify the parameters required for testing and the number of storm water discharge points that will be sampled. Request the laboratory to provide the appropriate number of sample containers, types of containers, sample container labels, blank chain of custody forms, and sample preservation instructions.

ii Determine how to ship the samples to the laboratory. The testing laboratory should receive samples within 48 hours of the physical sampling (unless otherwise required by the laboratory). The options are to either deliver the samples to the laboratory, arrange to have the laboratory pick them up, or ship them overnight to the laboratory.

iii Use only the sample containers provided by the laboratory to collect and store samples. Use of any other type of containers could contaminate your samples.

iv Prevent sample contamination, by not touching, or putting anything into the sample containers before collecting storm water samples.

v Not overfilling sample containers. Overfilling can change the analytical results.

vi Tightly screw the cap of each sample container without stripping the threads of the cap.

vii Complete and attach a label to each sample container. The label shall identify the date and time of sample collection, the person taking the sample, and the sample collection location or discharge point. The label should also identify any sample containers that have been preserved.

viii Carefully pack sample containers into an ice chest or refrigerator to prevent breakage and maintain temperature during shipment. Remember to place frozen ice packs into the shipping container. Samples should be kept as close to 4° C (39° F) as possible until arriving at the laboratory. Do not freeze samples.

ix Complete a Chain of Custody form for each set of samples. The Chain of Custody form shall include the discharger's name, address, and phone number, identification of each sample container and sample collection point, person collecting the samples, the date and time each sample container was filled, and the analysis that is required for each sample container.

x Upon shipping/delivering the sample containers, obtain both the signatures of the persons relinquishing and receiving the sample containers.

xi Designate and train personnel to collect, maintain, and ship samples in accordance with the above sample protocols and good laboratory practices.

xii Refer to the Surface Water Ambient Monitoring Program's (SWAMP) 2008 Quality Assurance Program Plan (QAPrP) for more

information on sampling collection and analysis. See http://www.waterboards.ca.gov/water_issues/programs/swamp/[14]

Table 5. Test Methods, Detection Limits, Reporting Units and Applicable NALs

Parameter	Test Method	Discharge Type	Min. Detection Limit	Reporting Units	Numeric Action Levels	(LUP Type 3) Receiving Water Monitoring Trigger
pH	Field test with calibrated portable instrument	Type 2 & 3	0.2	pH units	Lower = 6.5 upper = 8.5	Lower = 6.0 upper = 9.0
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	Type 2 & 3	1	NTU	250 NTU	500 NTU
SSC	ASTM Method D 3977-97[15]	Type 3 if Receiving Water Monitoring Trigger is exceeded	5	Mg/L	N/A	N/A
Bioassessment	(STE) Level I of (SAFIT),[16] fixed-count of 600 org/sample	Type 3 LUPs > 30 acres	N/A	N/A	N/A	N/A

i. <u>LUP Type 2 & 3 Monitoring Methods</u>

i The LUP Type 2 or 3 discharger's project M&RP shall include a description of the following items:

(1) Visual observation locations, visual observation procedures, and visual observation follow-up and tracking procedures.

[14] Additional information regarding SWAMP's QAPrP can be found at: http://www.waterboards.ca.gov/water_issues/programs/swamp/.

[15] ASTM, 1999, Standard Test Method for Determining Sediment Concentration in Water Samples: American Society of Testing and Materials, D 3977-97, Vol. 11.02, pp. 389-394

[16] The current SAFIT STEs (28 November 2006) list requirements for both the Level I and Level II taxonomic effort, and are located at: http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf. When new editions are published by SAFIT, they will supersede all previous editions. All editions will be posted at the State Water Board's SWAMP website.

(2) Sampling locations, and sample collection and handling procedures. This shall include detailed procedures for sample collection, storage, preservation, and shipping to the testing lab to assure that consistent quality control and quality assurance is maintained. Dischargers shall attach to the monitoring program a copy of the Chain of Custody form used when handling and shipping samples.

(3) Identification of the analytical methods and related method detection limits (if applicable) for each parameter required in Section M.4.f above.

ii LUP Type 2 & 3 dischargers shall ensure that all sampling and sample preservation be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment (including a discharger's own field instruments for measuring pH and turbidity) shall be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. All laboratory analyses shall be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this General Permit or by the Regional Water Board. With the exception of field analysis conducted by the discharger for turbidity and pH, all analyses shall be sent to and conducted at a laboratory certified for such analyses by the State Department of Health Services (SSC exception). The LUP discharger shall conduct its own field analysis of pH and may conduct its own field analysis of turbidity if the discharger has sufficient capability (qualified and trained employees, properly calibrated and maintained field instruments, etc.) to adequately perform the field analysis.

j. <u>LUP Type 2 & 3 Analytical Methods</u>

LUP Type 2 & 3 dischargers shall refer to Table 5 above for test Methods, detection Limits, and reporting Units.

i **pH**: LUP Type 2 & 3 dischargers shall perform pH analysis on-site with a calibrated pH meter or pH test kit. The LUP discharger shall record pH monitoring results on paper and retain these records in accordance with Section M.4.o, below.

ii **Turbidity**: LUP Type 2 & 3 dischargers shall perform turbidity analysis using a calibrated turbidity meter (turbidimeter), either on-site or at an accredited lab. Acceptable test methods include Standard Method 2130 or USEPA Method 180.1. The results shall

be recorded in the site log book in Nephelometric Turbidity Units (NTU).

iii **Suspended sediment concentration (SSC)**: LUP Type 3 dischargers exceeding the turbidity Receiving Water Monitoring Trigger, shall perform SSC analysis using ASTM Method D3977-97.

iv **Bioassessment**: LUP Type 3 dischargers shall perform bioassessment sampling and analysis according to Appendix 3 of this General Permit.

k. Watershed Monitoring Option

If an LUP Type 2 or 3 discharger is part of a qualified regional watershed-based monitoring program the LUP Type 2 or 3 discharger may be eligible for relief from the monitoring requirements in this Attachment. The Regional Water Board may approve proposals to substitute an acceptable watershed-based monitoring program if it determines that the watershed-based monitoring program will provide information to determine each discharger's compliance with the requirements of this General Permit.

l. Particle Size Analysis for Risk Justification

LUP Type 2 & 3 dischargers justifying an alternative project risk shall report a soil particle size analysis used to determine the RUSLE K-Factor. ASTM D-422 (Standard Test Method for Particle-Size Analysis of Soils), as revised, shall be used to determine the percentages of sand, very fine sand, silt, and clay on the site.

m. NAL Exceedance Report

i In the event that any effluent sample exceeds an applicable NAL, the Regional Water Boards may require LUP Type 2 & 3 dischargers to submit NAL Exceedance Reports.

ii LUP Type 2 & 3 dischargers shall certify each NAL Exceedance Report in accordance with the Special Provisions for Construction Activity.

iii LUP Type 2 & 3 dischargers shall retain an electronic or paper copy of each NAL Exceedance Report for a minimum of three years after the date the exceedance report is filed.

iv LUP Type 2 & 3 dischargers shall include in the NAL Exceedance Report:

(1) the analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as "less than the method detection limit"); and
(2) the date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation.
(3) Description of the current BMPs associated with the effluent sample that exceeded the NAL and the proposed corrective actions taken.

n. Monitoring Records

LUP Type 2 & 3 dischargers shall ensure that records of all storm water monitoring information and copies of all reports (including Annual Reports) required by this General Permit be retained for a period of at least three years. LUP Type 2 & 3 dischargers may retain records off-site and make them available upon request. These records shall include:

i The date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation (rain gauge);

ii The individual(s) who performed the facility inspections, sampling, visual observation (inspections), and or measurements;

iii The date and approximate time of analyses;

iv The individual(s) who performed the analyses;

v A summary of all analytical results from the last three years, the method detection limits and reporting units, the analytical techniques or methods used, and all chain of custody forms;

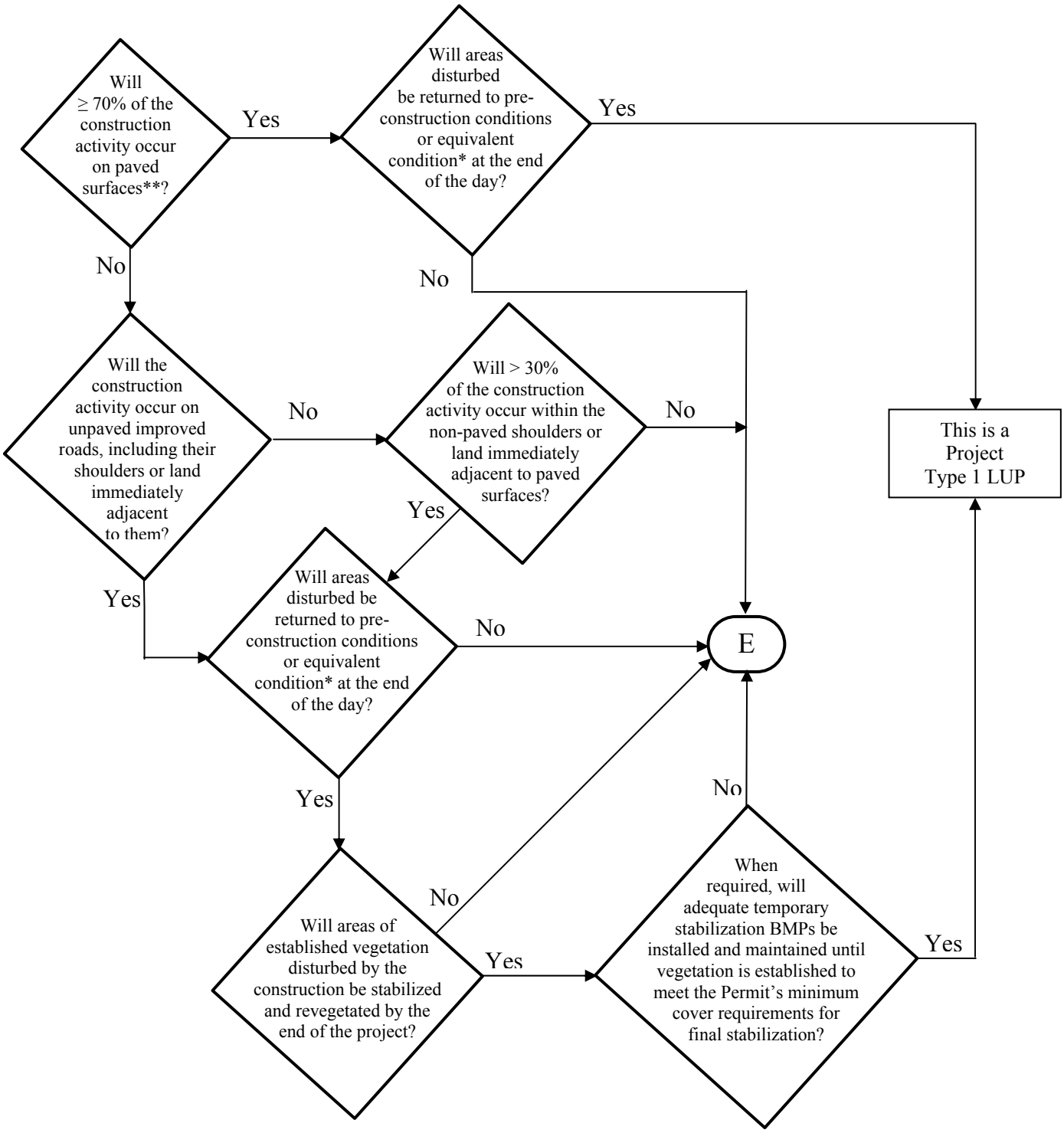
vi Quality assurance/quality control records and results;

vii Non-storm water discharge inspections and visual observation (inspections) and storm water discharge visual observation records (see Section M.4.a above);

viii Visual observation and sample collection exception records (see Section M.4.g above); and

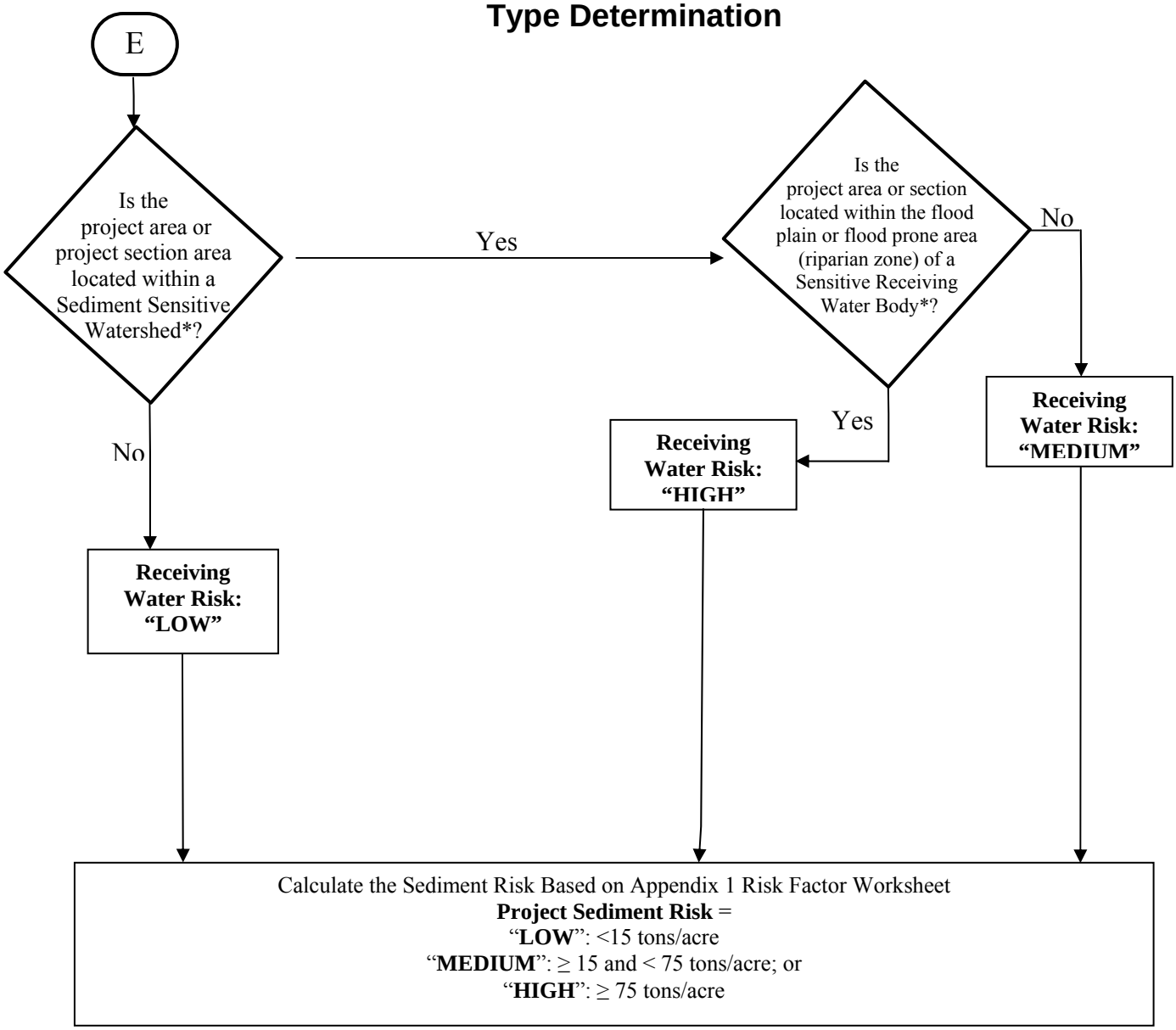
ix The records of any corrective actions and follow-up activities that resulted from analytical results, visual observation (inspections), or inspections.

ATTACHMENT A.1
LUP Project Area or Project Section Area Type Determination



*See Definition of Terms
** Or: "Will < 30% of the soil disturbance occur on unpaved surfaces?

ATTACHMENT A.1
LUP Project Area or Project Section Area Type Determination



* See Definition of Terms

PROJECT SEDIMENT RISK

RECEIVING WATER RISK	**LOW**	**MEDIUM**	**HIGH**
LOW	Type 1	Type 1	Type 2
MEDIUM	Type 1	Type 2	Type 3
HIGH	Type 2	Type 3	Type 3

ATTACHMENT A.1
Definition of Terms

1. **Equivalent Condition** – Means disturbed soils such as those from trench excavation are required to be hauled away, backfilled into the trench, and/or covered (e.g., metal plates, pavement, plastic covers over spoil piles) at the end of the construction day.
2. **Linear Construction Activity** – Linear construction activity consists of underground/ overhead facilities that typically include, but are not limited to, any conveyance, pipe or pipeline for the transportation of any gaseous, liquid (including water, wastewater for domestic municipal services), liquescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g., telephone, telegraph, radio or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment and associated ancillary facilities) and include, but are not limited to, underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/ tower pad and cable/ wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/ borrow locations.
3. **Sediment Sensitive Receiving Water Body –** Defined as a water body segment that is listed on EPA's approved CWA 303(d) list for sedimentation/siltation, turbidity, or is designated with beneficial uses of SPAWN, MIGRATORY, and COLD.
4. **Sediment Sensitive Watershed –** Defined as a watershed draining into a receiving water body listed on EPA's approved CWA 303(d) list for sedimentation/siltation, turbidity, or a water body designated with beneficial uses of SPAWN, MIGRATORY, and COLD.

ATTACHMENT A.2
PERMIT REGISTRATION DOCUMENTS (PRDs)
GENERAL INSTRUCTIONS FOR LINEAR UNDERGROUND/OVERHEAD PROJECTS TO COMPLY WITH THE CONSTRUCTION GENERAL PERMIT

GENERAL INSTRUCTIONS

Who Must Submit

This permit is effective on July 1, 2010.

The Legally Responsible Person (LRP) for construction activities associated with linear underground/overhead project (LUP) must electronically apply for coverage under this General Permit on or after July 1, 2010. If it is determined that the LUP construction activities require an NPDES permit, the Legally Responsible Person[1] (LRP) shall submit PRDs for this General Permit in accordance with the following:

LUPs associated with Private or Municipal Development Projects

1. For LUPs associated with pre-development and pre-redevelopment construction activities:

   The LRP must obtain coverage[2] under this General Permit for its pre-development and pre-redevelopment construction activities where the total disturbed land area of these construction activities is greater than 1 acre.

2. For LUPs associated with new development and redevelopment construction projects:

   The LRP must obtain coverage under this General Permit for LUP construction activities associated with new development and redevelopment projects where the total disturbed land area of the LUP is greater than 1 acre. Coverage under this permit is not required where the same LUP construction activities are covered by another NPDES permit.

LUPs not associated with private or municipal new development or redevelopment projects:

The LRP must obtain coverage under this General Permit on or after July 1, 2010 for its LUP construction activities where the total disturbed land area is greater than 1 acre.

PRD Submittal Requirements

Prior to the start of construction activities a LRP must submit PRDs and fees to the State Water Board for each LUP.

New and Ongoing LUPs

Dischargers of new LUPs that commence construction activities after the adoption date of this General Permit shall file PRDs prior to the commencement of construction and implement the SWPPP upon the start of construction.

---

[1] person possessing the title of the land on which the construction activities will occur for the regulated site

[2] obtain coverage means filing PRDs for the project.

PERMIT REGISTRATION DOCUMENTS (PRDs)
GENERAL INSTRUCTIONS (CONTINUED)

Dischargers of ongoing LUPs that are currently covered under State Water Board Order No. 2003-0007 (Small LUP General Permit) shall electronically file Permit Registration Documents no later than July 1, 2010. After July 1, 2010, all NOIs subject to State Water Board Order No. 2003-0007-DWQ will be terminated. All existing dischargers shall be exempt from the risk determination requirements in Attachment A. All existing dischargers are therefore subject to LUP Type 1 requirements regardless of their project's sediment and receiving water risks. However, a Regional Board retains the authority to require an existing discharger to comply with the risk determination requirements in Attachment A.

Where to Apply

The Permit Registration Documents (PRDs) can be found at www.waterboards.ca.gov/water_issues/programs/stormwater/

Fees

The annual fee for storm water permits are established through the State of California Code of Regulations.

When Permit Coverage Commences

To obtain coverage under the General Permit, the LRP must include the complete PRDs and the annual fee. All PRDs deemed incomplete will be rejected with an explanation as to what is required to complete submittal. Upon receipt of complete PRDs and associated fee, each discharger will be sent a waste discharger's identification (WDID) number.

Projects and Activities Not Defined As Construction Activity

1. LUP construction activity does not include routine maintenance projects to maintain original line and grade, hydraulic capacity, or original purpose of the facility. Routine maintenance projects are projects associated with operations and maintenance activities that are conducted on existing lines and facilities and within existing right-of-way, easements, franchise agreements or other legally binding agreements of the discharger. Routine maintenance projects include, but are not limited to projects that are conducted to:

    - Maintain the original purpose of the facility, or hydraulic capacity.
    - Update existing lines[3] and facilities to comply with applicable codes, standards and regulations regardless if such projects result in increased capacity.
    - Repairing leaks.

    Routine maintenance does not include construction of new[4] lines or facilities resulting from compliance with applicable codes, standards and regulations.

[3] Update existing lines includes replacing existing lines with new materials or pipes.
[4] New lines are those that are not associated with existing facilities and are not part of a project to update or replace existing lines.

Routine maintenance projects do not include those areas of maintenance projects that are outside of an existing right-of-way, franchise, easements, or agreements. When a project must acquire new areas, those areas may be subject to this General Permit based on the area of disturbed land outside the original right-of-way, easement, or agreement.

2. LUP construction activity does not include field activities associated with the planning and design of a project (e.g., activities associated with route selection).

3. Tie-ins conducted immediately adjacent to “energized” or “pressurized” facilities by the discharger are not considered small construction activities where all other LUP construction activities associated with the tie-in are covered by a NOI and SWPPP of a third party or municipal agency.

Calculating Land Disturbance Areas of LUPs

The total land area disturbed for LUPs is the sum of the:

- Surface areas of trenches, laterals and ancillary facilities, plus
- Area of the base of stockpiles on unpaved surfaces, plus
- Surface area of the borrow area, plus
- Areas of paved surfaces constructed for the project, plus
- Areas of new roads constructed or areas of major reconstruction to existing roads (e.g. improvements to two-track surfaces or road widening) for the sole purpose of accessing construction activities or as part of the final project, plus
- Equipment and material storage, staging, and preparation areas (laydown areas) not on paved surfaces, plus
- Soil areas outside the surface area of trenches, laterals and ancillary facilities that will be graded, and/or disturbed by the use of construction equipment, vehicles and machinery during construction activities.

Stockpiling Areas

Stockpiling areas, borrow areas and the removal of soils from a construction site may or may not be included when calculating the area of disturbed soil for a site depending on the following conditions:

- For stockpiling of soils onsite or immediately adjacent to a LUP site and the stockpile is not on a paved surface, the area of the base of the stockpile is to be included in the disturbed area calculation.

- The surface area of borrow areas that are onsite or immediately adjacent to a project site are to be included in the disturbed area calculation.

- For soil that is hauled offsite to a location owned or operated by the discharger that is not a paved surface, the area of the base of the stockpile is to be included in the disturbed area calculation except when the offsite location is already subject to a separate storm water permit.

PERMIT REGISTRATION DOCUMENTS (PRDs)
GENERAL INSTRUCTIONS (CONTINUED)

- For soil that is brought to the project from an off-site location owned or operated by the discharger the surface area of the borrow pit is to be included in the disturbed area calculation except when the offsite location is already subject to a separate storm water permit.

- Trench spoils on a paved surface that are either returned to the trench or excavation or hauled away from the project daily for disposal or reuse will not be included in the disturbed area calculation.

If you have any questions concerning submittal of PRDs, please call the State Water Board at (866) 563-3107.

ATTACHMENT B
PERMIT REGISTRATION DOCUMENTS (PRDs) TO COMPLY WITH THE TERMS OF THE GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH CONSTRUCTION ACTIVITY

GENERAL INSTRUCTIONS

A. All Linear Construction Projects shall comply with the PRD requirements in Attachment A.2 of this Order.

B. Who Must Submit

Discharges of storm water associated with construction that results in the disturbance of one acre or more of land must apply for coverage under the General Construction Storm Water Permit (General Permit). Any construction activity that is a part of a larger common plan of development or sale must also be permitted, regardless of size. (For example, if 0.5 acre of a 20-acre subdivision is disturbed by the construction activities of discharger A and the remaining 19.5 acres is to be developed by discharger B, discharger A must obtain a General Storm Water Permit for the 0.5 acre project).

Other discharges from construction activities that are covered under this General Permit can be found in the General Permit Section II.B.

It is the LRP's responsibility to obtain coverage under this General Permit by electronically submitting complete PRDs (Permit Registration Documents).

In all cases, the proper procedures for submitting the PRDs must be completed before construction can commence.

C. Construction Activity Not Covered By This General Permit

Discharges from construction that are not covered under this General Permit can be found in the General Permit Sections II.A &B..

D. Annual Fees and Fee Calculation

Annual fees are calculated based upon the total area of land to be disturbed not the total size of the acreage owned. However, the calculation includes all acres to be disturbed during the duration of the project. For example, if 10 acres are scheduled to be disturbed the first year and 10 in each subsequent year for 5 years, the annual fees would be based upon 50 acres of disturbance. The State Water Board will evaluate adding acreage to an existing Permit Waste Discharge Identification (WDID) number on a case-by-case basis. In general, any acreage to be considered must be contiguous to the permitted land area and the existing

SWPPP must be appropriate for the construction activity and topography of the acreage under consideration. As acreage is built out and stabilized or sold, the Change of Information (COI) form enables the applicant to remove those acres from inclusion in the annual fee calculation. Checks should be made payable to: State Water Board.

The Annual fees are established through regulations adopted by the State Water Board. The total annual fee is the current base fee plus applicable surcharges for all construction sites submitting an NOI, based on the total acreage to be disturbed during the life of the project. Annual fees are subject to change by regulation.

Dischargers that apply for and satisfy the Small Construction Erosivity Wavier requirements shall pay a fee of $200.00 plus an applicable surcharge, see the General Permit Section II.B.7.

E. When to Apply

LRP's proposing to conduct construction activities subject to this General Permit must submit their PRDs prior to the commencement of construction activity.

F. Requirements for Completing Permit Registration Documents (PRDs)

All dischargers required to comply with this General Permit shall electronically submit the required PRDs for their type of construction as defined below.

G. Standard PRD Requirements (All Dischargers)

1. Notice of Intent
2. Risk Assessment (Standard or Site-Specific)
3. Site Map
4. SWPPP
5. Annual Fee
6. Certification

H. Additional PRD Requirements Related to Construction Type

1. Discharger in unincorporated areas of the State (not covered under an adopted Phase I or II SUSMP requirements) and that are not a linear project shall also submit a completed:
   a. Post-Construction Water Balance Calculator (Appendix 2).

2. Dischargers who are proposing to implement ATS shall submit:
   a. Complete ATS Plan in accordance with Attachment F at least 14 days prior to the planned operation of the ATS and a paper copy shall be available onsite during ATS operation.

b. Certification proof that design done by a professional in accordance with Attachment F.

3. Dischargers who are proposing an alternate Risk Justification:
   a. Particle Size Analysis.

I. Exceptions to Standard PRD Requirements

Construction sites with an R value less than 5 as determined in the Risk Assessment are not required to submit a SWPPP.

J. Description of PRDs

1. Notice of Intent (NOI)

2. Site Map(s) Includes:
   a. The project's surrounding area (vicinity)
   b. Site layout
   c. Construction site boundaries
   d. Drainage areas
   e. Discharge locations
   f. Sampling locations
   g. Areas of soil disturbance (temporary or permanent)
   h. Active areas of soil disturbance (cut or fill)
   i. Locations of all runoff BMPs
   j. Locations of all erosion control BMPs
   k. Locations of all sediment control BMPs
   l. ATS location (if applicable)
   m. Locations of sensitive habitats, watercourses, or other features which are not to be disturbed
   n. Locations of all post-construction BMPs
   o. Locations of storage areas for waste, vehicles, service, loading/unloading of materials, access (entrance/exits) points to construction site, fueling, and water storage, water transfer for dust control and compaction practices

3. **SWPPPs**
   A site-specific SWPPP shall be developed by each discharger and shall be submitted with the PRDs.

4. **Risk Assessment**
   All dischargers shall use the Risk Assessment procedure as describe in the General Permit Appendix 1.

   a. The Standard Risk Assessment includes utilization of the following:
      i. Receiving water Risk Assessment interactive map

ii. EPA Rainfall Erosivity Factor Calculator Website
iii. Sediment Risk interactive map
iv. Sediment sensitive water bodies list

b. The Site-Specific Risk Assessment includes the completion of the hand calculated R value Risk Calculator

5. **Post-Construction Water Balance Calculator**
All dischargers subject to this requirement shall complete the Water Balance Calculator (in Appendix 2) in accordance with the instructions.

6. **ATS Design Document and Certification**
All dischargers using ATS must submit electronically their system design (as well as any supporting documentation) and proof that the system was designed by a qualified ATS design professional (See Attachment F).

To obtain coverage under the General Permit PRDs must be included and completed. If any of the required items are missing, the PRD submittal is considered incomplete and will be rejected. Upon receipt of a complete PRD submittal, the State Water Board will process the application package in the order received and assign a (WDID) number.

Questions?

If you have any questions on completing the PRDs please email stormwater@waterboards.ca.gov or call (866) 563-3107.

ATTACHMENT C
RISK LEVEL 1 REQUIREMENTS

A. Effluent Standards

[These requirements are the same as those in the General Permit order.]

1. Narrative – Risk Level 1 dischargers shall comply with the narrative effluent standards listed below:

    a. Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

    b. Dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

2. Numeric – Risk Level 1 dischargers are not subject to a numeric effluent standard.

B. Good Site Management "Housekeeping"

1. Risk Level 1 dischargers shall implement good site management (i.e., "housekeeping") measures for construction materials that could potentially be a threat to water quality if discharged. At a minimum, Risk Level 1 dischargers shall implement the following good housekeeping measures:

    a. Conduct an inventory of the products used and/or expected to be used and the end products that are produced and/or expected to be produced. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

    b. Cover and berm loose stockpiled construction materials that are not actively being used (i.e. soil, spoils, aggregate, fly-ash, stucco, hydrated lime, etc.).

c. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).

d. Minimize exposure of construction materials to precipitation. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

e. Implement BMPs to prevent the off-site tracking of loose construction and landscape materials.

2. Risk Level 1 dischargers shall implement good housekeeping measures for waste management, which, at a minimum, shall consist of the following:

a. Prevent disposal of any rinse or wash waters or materials on impervious or pervious site surfaces or into the storm drain system.

b. Ensure the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the storm water drainage system or receiving water.

c. Clean or replace sanitation facilities and inspecting them regularly for leaks and spills.

d. Cover waste disposal containers at the end of every business day and during a rain event.

e. Prevent discharges from waste disposal containers to the storm water drainage system or receiving water.

f. Contain and securely protect stockpiled waste material from wind and rain at all times unless actively being used.

g. Implement procedures that effectively address hazardous and non-hazardous spills.

h. Develop a spill response and implementation element of the SWPPP prior to commencement of construction activities. The SWPPP shall require that:

i. Equipment and materials for cleanup of spills shall be available on site and that spills and leaks shall be cleaned up immediately and disposed of properly; and

ii. Appropriate spill response personnel are assigned and trained.

i. Ensure the containment of concrete washout areas and other washout areas that may contain additional pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

3. Risk Level 1 dischargers shall implement good housekeeping for vehicle storage and maintenance, which, at a minimum, shall consist of the following:

   a. Prevent oil, grease, or fuel to leak in to the ground, storm drains or surface waters.

   b. Place all equipment or vehicles, which are to be fueled, maintained and stored in a designated area fitted with appropriate BMPs.

   c. Clean leaks immediately and disposing of leaked materials properly.

4. Risk Level 1 dischargers shall implement good housekeeping for landscape materials, which, at a minimum, shall consist of the following:

   a. Contain stockpiled materials such as mulches and topsoil when they are not actively being used.

   b. Contain fertilizers and other landscape materials when they are not actively being used.

   c. Discontinue the application of any erodible landscape material within 2 days before a forecasted rain event or during periods of precipitation.

   d. Apply erodible landscape material at quantities and application rates according to manufacture recommendations or based on written specifications by knowledgeable and experienced field personnel.

   e. Stack erodible landscape material on pallets and covering or storing such materials when not being used or applied.

5. Risk Level 1 dischargers shall conduct an assessment and create a list of potential pollutant sources and identify any areas of the site where additional BMPs are necessary to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. This potential pollutant list shall be kept with the SWPPP and shall identify

all non-visible pollutants which are known, or should be known, to occur on the construction site. At a minimum, when developing BMPs, Risk Level 1 dischargers shall do the following:

a. Consider the quantity, physical characteristics (e.g., liquid, powder, solid), and locations of each potential pollutant source handled, produced, stored, recycled, or disposed of at the site.

b. Consider the degree to which pollutants associated with those materials may be exposed to and mobilized by contact with storm water.

c. Consider the direct and indirect pathways that pollutants may be exposed to storm water or authorized non-storm water discharges. This shall include an assessment of past spills or leaks, non-storm water discharges, and discharges from adjoining areas.

d. Ensure retention of sampling, visual observation, and inspection records.

e. Ensure effectiveness of existing BMPs to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges.

6. Risk Level 1 dischargers shall implement good housekeeping measures on the construction site to control the air deposition of site materials and from site operations. Such particulates can include, but are not limited to, sediment, nutrients, trash, metals, bacteria, oil and grease and organics.

C. Non-Storm Water Management

1. Risk Level 1 dischargers shall implement measures to control all non-storm water discharges during construction.

2. Risk Level 1 dischargers shall wash vehicles in such a manner as to prevent non-storm water discharges to surface waters or MS4 drainage systems.

3. Risk Level 1 dischargers shall clean streets in such a manner as to prevent unauthorized non-storm water discharges from reaching surface water or MS4 drainage systems.

D. Erosion Control

1. Risk Level 1 dischargers shall implement effective wind erosion control.

2. Risk Level 1 dischargers shall provide effective soil cover for inactive[1] areas and all finished slopes, open space, utility backfill, and completed lots.

3. Risk Level 1 dischargers shall limit the use of plastic materials when more sustainable, environmentally friendly alternatives exist. Where plastic materials are deemed necessary, the discharger shall consider the use of plastic materials resistant to solar degradation.

E. Sediment Controls

1. Risk Level 1 dischargers shall establish and maintain effective perimeter controls and stabilize all construction entrances and exits to sufficiently control erosion and sediment discharges from the site.

2. On sites where sediment basins are to be used, Risk Level 1 dischargers shall, at minimum, design sediment basins according to the method provided in CASQA's Construction BMP Guidance Handbook.

F. Run-on and Runoff Controls

Risk Level 1 dischargers shall effectively manage all run-on, all runoff within the site and all runoff that discharges off the site. Run-on from off site shall be directed away from all disturbed areas or shall collectively be in compliance with the effluent limitations in this General Permit.

G. Inspection, Maintenance and Repair

1. Risk Level 1 dischargers shall ensure that all inspection, maintenance repair and sampling activities at the project location shall be performed or supervised by a Qualified SWPPP Practitioner (QSP) representing the discharger. The QSP may delegate any or all of these activities to an employee trained to do the task(s) appropriately, but shall ensure adequate deployment.

2. Risk Level 1 dischargers shall perform weekly inspections and observations, and at least once each 24-hour period during extended

[1] Inactive areas of construction are areas of construction activity that have been disturbed and are not scheduled to be re-disturbed for at least 14 days.

storm events, to identify and record BMPs that need maintenance to operate effectively, that have failed, or that could fail to operate as intended. Inspectors shall be the QSP or be trained by the QSP.

3. Upon identifying failures or other shortcomings, as directed by the QSP, Risk Level 1 dischargers shall begin implementing repairs or design changes to BMPs within 72 hours of identification and complete the changes as soon as possible.

4. For each inspection required, Risk Level 1 dischargers shall complete an inspection checklist, using a form provided by the State Water Board or Regional Water Board or in an alternative format.

5. Risk Level 1 dischargers shall ensure that checklists shall remain onsite with the SWPPP and at a minimum, shall include:

    a. Inspection date and date the inspection report was written.

    b. Weather information, including presence or absence of precipitation, estimate of beginning of qualifying storm event, duration of event, time elapsed since last storm, and approximate amount of rainfall in inches.

    c. Site information, including stage of construction, activities completed, and approximate area of the site exposed.

    d. A description of any BMPs evaluated and any deficiencies noted.

    e. If the construction site is safely accessible during inclement weather, list the observations of all BMPs: erosion controls, sediment controls, chemical and waste controls, and non-storm water controls. Otherwise, list the results of visual inspections at all relevant outfalls, discharge points, downstream locations and any projected maintenance activities.

    f. Report the presence of noticeable odors or of any visible sheen on the surface of any discharges.

    g. Any corrective actions required, including any necessary changes to the SWPPP and the associated implementation dates.

    h. Photographs taken during the inspection, if any.

    i. Inspector’s name, title, and signature.

H. Rain Event Action Plan

Not required for Risk Level 1 dischargers.

I. Risk Level 1 Monitoring and Reporting Requirements

Table 1- Summary of Monitoring Requirements

Risk Level	Visual Inspections					Sample Collection	
	Quarterly Non-storm Water Discharge	Pre-storm Event		Daily Storm BMP	Post Storm	Storm Water Discharge	Receiving Water
		Baseline	REAP				
1	X	X		X	X		

1. **Construction Site Monitoring Program Requirements**

   a. Pursuant to Water Code Sections 13383 and 13267, all dischargers subject to this General Permit shall develop and implement a written site-specific Construction Site Monitoring Program (CSMP) in accordance with the requirements of this Section. The CSMP shall include all monitoring procedures and instructions, location maps, forms, and checklists as required in this section. The CSMP shall be developed prior to the commencement of construction activities, and revised as necessary to reflect project revisions. The CSMP shall be a part of the Storm Water Pollution Prevention Plan (SWPPP), included as an appendix or separate SWPPP chapter.

   b. Existing dischargers registered under the State Water Board Order No. 99-08-DWQ shall make and implement necessary revisions to their Monitoring Programs to reflect the changes in this General Permit in a timely manner, but no later than July 1, 2010. Existing dischargers shall continue to implement their existing Monitoring Programs in compliance with State Water Board Order No. 99-08-DWQ until the necessary revisions are completed according to the schedule above.

   c. When a change of ownership occurs for all or any portion of the construction site prior to completion or final stabilization, the new discharger shall comply with these requirements as of the date the ownership change occurs.

2. **Objectives**

   The CSMP shall be developed and implemented to address the following objectives:

   a. To demonstrate that the site is in compliance with the Discharge Prohibitions;

b. To determine whether non-visible pollutants are present at the construction site and are causing or contributing to exceedances of water quality objectives;

c. To determine whether immediate corrective actions, additional Best Management Practice (BMP) implementation, or SWPPP revisions are necessary to reduce pollutants in storm water discharges and authorized non-storm water discharges; and

d. To determine whether BMPs included in the SWPPP are effective in preventing or reducing pollutants in storm water discharges and authorized non-storm water discharges.

3. **Risk Level 1 - Visual Monitoring (Inspection) Requirements for Qualifying Rain Events**

a. Risk Level 1 dischargers shall visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event.

b. Risk Level 1 dischargers shall visually observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Stored or contained storm water that will likely discharge after operating hours due to anticipated precipitation shall be observed prior to the discharge during operating hours.

c. Risk Level 1 dischargers shall conduct visual observations (inspections) during business hours only.

d. Risk Level 1 dischargers shall record the time, date and rain gauge reading of all qualifying rain events.

e. Within 2 business days (48 hours) prior to each qualifying rain event, Risk Level 1 dischargers shall visually observe (inspect):

i. All storm water drainage areas to identify any spills, leaks, or uncontrolled pollutant sources. If needed, the discharger shall implement appropriate corrective actions.

ii. All BMPs to identify whether they have been properly implemented in accordance with the SWPPP. If needed, the discharger shall implement appropriate corrective actions.

iii. Any storm water storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.

f. For the visual observations (inspections) described in e.i and e.iii above, Risk Level 1 dischargers shall observe the presence or absence of floating and suspended materials, a sheen on the surface, discolorations, turbidity, odors, and source(s) of any observed pollutants.

g. Within two business days (48 hours) after each qualifying rain event, Risk Level 1 dischargers shall conduct post rain event visual observations (inspections) to (1) identify whether BMPs were adequately designed, implemented, and effective, and (2) identify additional BMPs and revise the SWPPP accordingly.

h. Risk Level 1 dischargers shall maintain on-site records of all visual observations (inspections), personnel performing the observations, observation dates, weather conditions, locations observed, and corrective actions taken in response to the observations.

4. **Risk Level 1 – Visual Observation Exemptions**

a. Risk Level 1 dischargers shall be prepared to conduct visual observation (inspections) until the minimum requirements of Section I.3 above are completed. Risk Level 1 dischargers are not required to conduct visual observation (inspections) under the following conditions:

i. During dangerous weather conditions such as flooding and electrical storms.

ii. Outside of scheduled site business hours.

b. If no required visual observations (inspections) are collected due to these exceptions, Risk Level 1 dischargers shall include an explanation in their SWPPP and in the Annual Report documenting why the visual observations (inspections) were not conducted.

5. **Risk Level 1 – Monitoring Methods**

Risk Level 1 dischargers shall include a description of the visual observation locations, visual observation procedures, and visual observation follow-up and tracking procedures in the CSMP.

6. **Risk Level 1 – Non-Storm Water Discharge Monitoring Requirements**

a. Visual Monitoring Requirements:

   i. Risk Level 1 dischargers shall visually observe (inspect) each drainage area for the presence of (or indications of prior) unauthorized and authorized non-storm water discharges and their sources.

   ii. Risk Level 1 dischargers shall conduct one visual observation (inspection) quarterly in each of the following periods: January-March, April-June, July-September, and October-December. Visual observation (inspections) are only required during daylight hours (sunrise to sunset).

   iii. Risk Level 1 dischargers shall ensure that visual observations (inspections) document the presence or evidence of any non-storm water discharge (authorized or unauthorized), pollutant characteristics (floating and suspended material, sheen, discoloration, turbidity, odor, etc.), and source. Risk Level 1 dischargers shall maintain on-site records indicating the personnel performing the visual observation (inspections), the dates and approximate time each drainage area and non-storm water discharge was observed, and the response taken to eliminate unauthorized non-storm water discharges and to reduce or prevent pollutants from contacting non-storm water discharges.

7. **Risk Level 1 – Non-Visible Pollutant Monitoring Requirements**

   a. Risk Level 1 dischargers shall collect one or more samples during any breach, malfunction, leakage, or spill observed during a visual inspection which could result in the discharge of pollutants to surface waters that would not be visually detectable in storm water.

   b. Risk Level 1 dischargers shall ensure that water samples are large enough to characterize the site conditions.

   c. Risk Level 1 dischargers shall collect samples at all discharge locations that can be safely accessed.

   d. Risk Level 1 dischargers shall collect samples during the first two hours of discharge from rain events that occur during business hours and which generate runoff.

   e. Risk Level 1 dischargers shall analyze samples for all non-visible pollutant parameters (if applicable) - parameters indicating the

presence of pollutants identified in the pollutant source assessment required (Risk Level 1 dischargers shall modify their CSMPs to address these additional parameters in accordance with any updated SWPPP pollutant source assessment).

f. Risk Level 1 dischargers shall collect a sample of storm water that has not come in contact with the disturbed soil or the materials stored or used on-site (uncontaminated sample) for comparison with the discharge sample.

g. Risk Level 1 dischargers shall compare the uncontaminated sample to the samples of discharge using field analysis or through laboratory analysis.[2]

h. Risk Level 1 dischargers shall keep all field /or analytical data in the SWPPP document.

8. **Risk Level 1 – Particle Size Analysis for Project Risk Justification**

Risk Level 1 dischargers justifying an alternative project risk shall report a soil particle size analysis used to determine the RUSLE K-Factor. ASTM D-422 (Standard Test Method for Particle-Size Analysis of Soils), as revised, shall be used to determine the percentages of sand, very fine sand, silt, and clay on the site.

9. **Risk Level 1 – Records**

Risk Level 1 dischargers shall retain records of all storm water monitoring information and copies of all reports (including Annual Reports) for a period of at least three years. Risk Level 1 dischargers shall retain all records on-site while construction is ongoing. These records include:

a. The date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation.

b. The individual(s) who performed the facility inspections, sampling, visual observation (inspections), and or measurements.

c. The date and approximate time of analyses.

d. The individual(s) who performed the analyses.

[2] For laboratory analysis, all sampling, sample preservation, and analyses must be conducted according to test procedures under 40 CFR Part 136. Field discharge samples shall be collected and analyzed according to the specifications of the manufacturer of the sampling devices employed.

e. A summary of all analytical results from the last three years, the method detection limits and reporting units, and the analytical techniques or methods used.

f. Rain gauge readings from site inspections.

g. Quality assurance/quality control records and results.

h. Non-storm water discharge inspections and visual observation (inspections) and storm water discharge visual observation records (see Sections I.3 and I.6 above).

i. Visual observation and sample collection exception records (see Section I.4 above).

j. The records of any corrective actions and follow-up activities that resulted from analytical results, visual observation (inspections), or inspections.

ATTACHMENT D
RISK LEVEL 2 REQUIREMENTS

A. Effluent Standards

[These requirements are the same as those in the General Permit order.]

1. Narrative – Risk Level 2 dischargers shall comply with the narrative effluent standards listed below:

    a. Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

    b. Dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

2. Numeric – Risk level 2 dischargers are subject to a pH NAL of 6.5-8.5, and a turbidity NAL of 250 NTU.

B. Good Site Management "Housekeeping"

1. Risk Level 2 dischargers shall implement good site management (i.e., "housekeeping") measures for construction materials that could potentially be a threat to water quality if discharged. At a minimum, Risk Level 2 dischargers shall implement the following good housekeeping measures:

    a. Conduct an inventory of the products used and/or expected to be used and the end products that are produced and/or expected to be produced. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

    b. Cover and berm loose stockpiled construction materials that are not actively being used (i.e. soil, spoils, aggregate, fly-ash, stucco, hydrated lime, etc.).

c. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).

d. Minimize exposure of construction materials to precipitation. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

e. Implement BMPs to prevent the off-site tracking of loose construction and landscape materials.

2. Risk Level 2 dischargers shall implement good housekeeping measures for waste management, which, at a minimum, shall consist of the following:

a. Prevent disposal of any rinse or wash waters or materials on impervious or pervious site surfaces or into the storm drain system.

b. Ensure the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the storm water drainage system or receiving water.

c. Clean or replace sanitation facilities and inspecting them regularly for leaks and spills.

d. Cover waste disposal containers at the end of every business day and during a rain event.

e. Prevent discharges from waste disposal containers to the storm water drainage system or receiving water.

f. Contain and securely protect stockpiled waste material from wind and rain at all times unless actively being used.

g. Implement procedures that effectively address hazardous and non-hazardous spills.

h. Develop a spill response and implementation element of the SWPPP prior to commencement of construction activities. The SWPPP shall require:

i. Equipment and materials for cleanup of spills shall be available on site and that spills and leaks shall be cleaned up immediately and disposed of properly.

ii. Appropriate spill response personnel are assigned and trained.

i. Ensure the containment of concrete washout areas and other washout areas that may contain additional pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

3. Risk Level 2 dischargers shall implement good housekeeping for vehicle storage and maintenance, which, at a minimum, shall consist of the following:

   a. Prevent oil, grease, or fuel to leak in to the ground, storm drains or surface waters.

   b. Place all equipment or vehicles, which are to be fueled, maintained and stored in a designated area fitted with appropriate BMPs.

   c. Clean leaks immediately and disposing of leaked materials properly.

4. Risk Level 2 dischargers shall implement good housekeeping for landscape materials, which, at a minimum, shall consist of the following:

   a. Contain stockpiled materials such as mulches and topsoil when they are not actively being used.

   b. Contain all fertilizers and other landscape materials when they are not actively being used.

   c. Discontinue the application of any erodible landscape material within 2 days before a forecasted rain event or during periods of precipitation.

   d. Apply erodible landscape material at quantities and application rates according to manufacture recommendations or based on written specifications by knowledgeable and experienced field personnel.

   e. Stack erodible landscape material on pallets and covering or storing such materials when not being used or applied.

5. Risk Level 2 dischargers shall conduct an assessment and create a list of potential pollutant sources and identify any areas of the site where additional BMPs are necessary to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. This potential pollutant list shall be kept with the SWPPP and shall identify

all non-visible pollutants which are known, or should be known, to occur on the construction site. At a minimum, when developing BMPs, Risk Level 2 dischargers shall do the following:

a. Consider the quantity, physical characteristics (e.g., liquid, powder, solid), and locations of each potential pollutant source handled, produced, stored, recycled, or disposed of at the site.

b. Consider the degree to which pollutants associated with those materials may be exposed to and mobilized by contact with storm water.

c. Consider the direct and indirect pathways that pollutants may be exposed to storm water or authorized non-storm water discharges. This shall include an assessment of past spills or leaks, non-storm water discharges, and discharges from adjoining areas.

d. Ensure retention of sampling, visual observation, and inspection records.

e. Ensure effectiveness of existing BMPs to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges.

6. Risk Level 2 dischargers shall implement good housekeeping measures on the construction site to control the air deposition of site materials and from site operations. Such particulates can include, but are not limited to, sediment, nutrients, trash, metals, bacteria, oil and grease and organics.

7. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall document all housekeeping BMPs in the SWPPP and REAP(s) in accordance with the nature and phase of the construction project. Construction phases at traditional land development projects include Grading and Land Development Phase, Streets and Utilities, or Vertical Construction for traditional land development projects.

C. Non-Storm Water Management

1. Risk Level 2 dischargers shall implement measures to control all non-storm water discharges during construction.

2. Risk Level 2 dischargers shall wash vehicles in such a manner as to prevent non-storm water discharges to surface waters or MS4 drainage systems.

3. Risk Level 2 dischargers shall clean streets in such a manner as to prevent unauthorized non-storm water discharges from reaching surface water or MS4 drainage systems.

D. Erosion Control

1. Risk Level 2 dischargers shall implement effective wind erosion control.

2. Risk Level 2 dischargers shall provide effective soil cover for inactive[1] areas and all finished slopes, open space, utility backfill, and completed lots.

3. Risk Level 2 dischargers shall limit the use of plastic materials when more sustainable, environmentally friendly alternatives exist. Where plastic materials are deemed necessary, the discharger shall consider the use of plastic materials resistant to solar degradation.

E. Sediment Controls

1. Risk Level 2 dischargers shall establish and maintain effective perimeter controls and stabilize all construction entrances and exits to sufficiently control erosion and sediment discharges from the site.

2. On sites where sediment basins are to be used, Risk Level 2 dischargers shall, at minimum, design sediment basins according to the method provided in CASQA's Construction BMP Guidance Handbook.

3. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall implement appropriate erosion control BMPs (runoff control and soil stabilization) in conjunction with sediment control BMPs for areas under active[2] construction.

4. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall apply linear sediment controls along the toe of the slope, face of the slope, and at the grade breaks of exposed slopes to comply with sheet flow lengths[3] in accordance with Table 1.

---

[1] Inactive areas of construction are areas of construction activity that have been disturbed and are not scheduled to be re-disturbed for at least 14 days.
[2] Active areas of construction are areas undergoing land surface disturbance. This includes construction activity during the preliminary stage, mass grading stage, streets and utilities stage and the vertical construction stage.
[3] Sheet flow length is the length that shallow, low velocity flow travels across a site.

Table 1 - Critical Slope/Sheet Flow Length Combinations

Slope Percentage	Sheet flow length not to exceed
0-25%	20 feet
25-50%	15 feet
Over 50%	10 feet

5. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall ensure that construction activity traffic to and from the project is limited to entrances and exits that employ effective controls to prevent offsite tracking of sediment.

6. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall ensure that all storm drain inlets and perimeter controls, runoff control BMPs, and pollutant controls at entrances and exits (e.g. tire washoff locations) are maintained and protected from activities that reduce their effectiveness.

7. **Additional Risk Level 2 Requirement:** Risk Level 2 dischargers shall inspect on a daily basis all immediate access roads daily. At a minimum daily (when necessary) and prior to any rain event, the discharger shall remove any sediment or other construction activity-related materials that are deposited on the roads (by vacuuming or sweeping).

F. Run-on and Run-off Controls

Risk Level 2 dischargers shall effectively manage all run-on, all runoff within the site and all runoff that discharges off the site. Run-on from off site shall be directed away from all disturbed areas or shall collectively be in compliance with the effluent limitations in this General Permit.

G. Inspection, Maintenance and Repair

1. Risk Level 2 dischargers shall ensure that all inspection, maintenance repair and sampling activities at the project location shall be performed or supervised by a Qualified SWPPP Practitioner (QSP) representing the discharger. The QSP may delegate any or all of these activities to an employee appropriately trained to do the task(s).

2. Risk Level 2 dischargers shall perform weekly inspections and observations, and at least once each 24-hour period during extended storm events, to identify and record BMPs that need maintenance to operate effectively, that have failed, or that could fail to operate as intended. Inspectors shall be the QSP or be trained by the QSP.

3. Upon identifying failures or other shortcomings, as directed by the QSP, Risk Level 2 dischargers shall begin implementing repairs or design changes to BMPs within 72 hours of identification and complete the changes as soon as possible.

4. For each inspection required, Risk Level 2 dischargers shall complete an inspection checklist, using a form provided by the State Water Board or Regional Water Board or in an alternative format.

5. Risk Level 2 dischargers shall ensure that checklists shall remain onsite with the SWPPP and at a minimum, shall include:

    a. Inspection date and date the inspection report was written.

    b. Weather information, including presence or absence of precipitation, estimate of beginning of qualifying storm event, duration of event, time elapsed since last storm, and approximate amount of rainfall in inches.

    c. Site information, including stage of construction, activities completed, and approximate area of the site exposed.

    d. A description of any BMPs evaluated and any deficiencies noted.

    e. If the construction site is safely accessible during inclement weather, list the observations of all BMPs: erosion controls, sediment controls, chemical and waste controls, and non-storm water controls. Otherwise, list the results of visual inspections at all relevant outfalls, discharge points, downstream locations and any projected maintenance activities.

    f. Report the presence of noticeable odors or of any visible sheen on the surface of any discharges.

    g. Any corrective actions required, including any necessary changes to the SWPPP and the associated implementation dates.

    h. Photographs taken during the inspection, if any.

    i. Inspector's name, title, and signature.

H. Rain Event Action Plan

1. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP develop a Rain Event Action Plan (REAP) 48 hours prior to any

likely precipitation event. A likely precipitation event is any weather pattern that is forecast to have a 50% or greater probability of producing precipitation in the project area. The discharger shall ensure a QSP obtain a printed copy of precipitation forecast information from the National Weather Service Forecast Office (e.g., by entering the zip code of the project's location at http://www.srh.noaa.gov/forecast).

2. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP develop the REAPs for all phases of construction (i.e., Grading and Land Development, Streets and Utilities, Vertical Construction, Final Landscaping and Site Stabilization).

3. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP ensure that the REAP include, at a minimum, the following site information:

   a. Site Address
   b. Calculated Risk Level (2 or 3)
   c. Site Storm Water Manager Information including the name, company, and 24-hour emergency telephone number
   d. Erosion and Sediment Control Provider information including the name, company, and 24-hour emergency telephone number
   e. Storm Water Sampling Agent information including the name, company, and 24-hour emergency telephone number

4. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP include in the REAP, at a minimum, the following project phase information:

   a. Activities associated with each construction phase
   b. Trades active on the construction site during each construction phase
   c. Trade contractor information
   d. Suggested actions for each project phase

5. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP develop additional REAPs for project sites where construction activities are indefinitely halted or postponed (Inactive Construction). At a minimum, Inactive Construction REAPs must include:

   a. Site Address
   b. Calculated Risk Level (2 or 3)
   c. Site Storm Water Manager Information including the name, company, and 24-hour emergency telephone number

d. Erosion and Sediment Control Provider information including the name, company, and 24-hour emergency telephone number
e. Storm Water Sampling Agent information including the name, company, and 24-hour emergency telephone number
f. Trades active on site during Inactive Construction
g. Trade contractor information
h. Suggested actions for inactive construction sites

6. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP begin implementation and make the REAP available onsite no later than 24 hours prior to the likely precipitation event.

7. **Additional Risk Level 2 Requirement:** The discharger shall ensure a QSP maintain onsite a paper copy of each REAP onsite in compliance with the record retention requirements of the Special Provisions in this General Permit.

I. Risk Level 2 Monitoring and Reporting Requirements

Table 2- Summary of Monitoring Requirements

Risk Level	Visual Inspections					Sample Collection	
	Quarterly Non-storm Water Discharge	Pre-storm Event		Daily Storm BMP	Post Storm	Storm Water Discharge	Receiving Water
		Baseline	REAP				
2	X	X	X	X	X	X	

1. Construction Site Monitoring Program Requirements

   a. Pursuant to Water Code Sections 13383 and 13267, all dischargers subject to this General Permit shall develop and implement a written site-specific Construction Site Monitoring Program (CSMP) in accordance with the requirements of this Section. The CSMP shall include all monitoring procedures and instructions, location maps, forms, and checklists as required in this section. The CSMP shall be developed prior to the commencement of construction activities, and revised as necessary to reflect project revisions. The CSMP shall be a part of the Storm Water Pollution Prevention Plan (SWPPP), included as an appendix or separate SWPPP chapter.

   b. Existing dischargers registered under the State Water Board Order No. 99-08-DWQ shall make and implement necessary revisions to their Monitoring Program to reflect the changes in this General Permit in a timely manner, but no later than July 1, 2010. Existing dischargers shall continue to implement their existing Monitoring Programs in compliance with State Water Board Order No. 99-08-DWQ until the necessary revisions are completed according to the schedule above.

   c. When a change of ownership occurs for all or any portion of the construction site prior to completion or final stabilization, the new discharger shall comply with these requirements as of the date the ownership change occurs.

2. **Objectives**

   The CSMP shall be developed and implemented to address the following objectives:

   a. To demonstrate that the site is in compliance with the Discharge Prohibitions and applicable Numeric Action Levels (NALs).

b. To determine whether non-visible pollutants are present at the construction site and are causing or contributing to exceedances of water quality objectives.

c. To determine whether immediate corrective actions, additional Best Management Practice (BMP) implementation, or SWPPP revisions are necessary to reduce pollutants in storm water discharges and authorized non-storm water discharges.

d. To determine whether BMPs included in the SWPPP/Rain Event Action Plan (REAP) are effective in preventing or reducing pollutants in storm water discharges and authorized non-storm water discharges.

3. **Risk Level 2 – Visual Monitoring (Inspection) Requirements for Qualifying Rain Events**

a. Risk Level 2 dischargers shall visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event.

b. Risk Level 2 dischargers shall visually observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Stored or contained storm water that will likely discharge after operating hours due to anticipated precipitation shall be observed prior to the discharge during operating hours.

c. Risk Level 2 dischargers shall conduct visual observations (inspections) during business hours only.

d. Risk Level 2 dischargers shall record the time, date and rain gauge reading of all qualifying rain events.

e. Within 2 business days (48 hours) prior to each qualifying rain event, Risk Level 2 dischargers shall visually observe (inspect):

i. all storm water drainage areas to identify any spills, leaks, or uncontrolled pollutant sources. If needed, the discharger shall implement appropriate corrective actions.

ii. all BMPs to identify whether they have been properly implemented in accordance with the SWPPP/REAP. If needed, the discharger shall implement appropriate corrective actions.

iii. any storm water storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.

f. For the visual observations (inspections) described in c.i and c.iii above, Risk Level 2 dischargers shall observe the presence or absence of floating and suspended materials, a sheen on the surface, discolorations, turbidity, odors, and source(s) of any observed pollutants.

g. Within two business days (48 hours) after each qualifying rain event, Risk Level 2 dischargers shall conduct post rain event visual observations (inspections) to (1) identify whether BMPs were adequately designed, implemented, and effective, and (2) identify additional BMPs and revise the SWPPP accordingly.

h. Risk Level 2 dischargers shall maintain on-site records of all visual observations (inspections), personnel performing the observations, observation dates, weather conditions, locations observed, and corrective actions taken in response to the observations.

4. **Risk Level 2 – Water Quality Sampling and Analysis**

a. Risk Level 2 dischargers shall collect storm water grab samples from sampling locations, as defined in Section I.5. The storm water grab sample(s) obtained shall be representative of the flow and characteristics of the discharge.

b. At minimum, Risk Level 2 dischargers shall collect 3 samples per day of the qualifying event.

c. Risk Level 2 dischargers shall ensure that the grab samples collected of stored or contained storm water are from discharges subsequent to a qualifying rain event (producing precipitation of ½ inch or more at the time of discharge).

<u>Storm Water Effluent Monitoring Requirements</u>

d. Risk Level 2 dischargers shall analyze their effluent samples for:

i. pH and turbidity.

ii. Any additional parameters for which monitoring is required by the Regional Water Board.

5. **Risk Level 2 – Storm Water Discharge Water Quality Sampling Locations**

Effluent Sampling Locations

a. Risk Level 2 dischargers shall perform sampling and analysis of storm water discharges to characterize discharges associated with construction activity from the entire project disturbed area.

b. Risk Level 2 dischargers shall collect effluent samples at all discharge points where storm water is discharged off-site.

c. Risk Level 2 dischargers shall ensure that storm water discharge collected and observed represent[4] the effluent in each drainage area based on visual observation of the water and upstream conditions.

d. Risk Level 2 dischargers shall monitor and report site run-on from surrounding areas if there is reason to believe run-on may contribute to an exceedance of NALs.

e. Risk Level 2 dischargers who deploy an ATS on their site, or a portion on their site, shall collect ATS effluent samples and measurements from the discharge pipe or another location representative of the nature of the discharge.

f. Risk Level 2 dischargers shall select analytical test methods from the list provided in Table 3 below.

g. All storm water sample collection preservation and handling shall be conducted in accordance with Section I.7 “Storm Water Sample Collection and Handling Instructions” below.

6. **Risk Level 2 – Visual Observation and Sample Collection Exemptions**

a. Risk Level 2 dischargers shall be prepared to collect samples and conduct visual observation (inspections) until the minimum requirements of Sections I.3 and I.4 above are completed. Risk Level 2 dischargers are not required to physically collect samples or conduct visual observation (inspections) under the following conditions:

[4] For example, if there has been concrete work recently in an area, or drywall scrap is exposed to the rain, a pH sample shall be taken of drainage from the relevant work area. Similarly, if sediment laden water is flowing through some parts of a silt fence, samples shall be taken of the sediment-laden water even if most water flowing through the fence is clear.

i. During dangerous weather conditions such as flooding and electrical storms.

ii. Outside of scheduled site business hours.

b. If no required samples or visual observation (inspections) are collected due to these exceptions, Risk Level 2 dischargers shall include an explanation in their SWPPP and in the Annual Report documenting why the sampling or visual observation (inspections) were not conducted.

7. **Risk Level 2 – Storm Water Sample Collection and Handling Instructions**

a. Risk Level 2 dischargers shall refer to Table 3 below for test methods, detection limits, and reporting units.

b. Risk Level 2 dischargers shall ensure that testing laboratories will receive samples within 48 hours of the physical sampling (unless otherwise required by the laboratory), and shall use only the sample containers provided by the laboratory to collect and store samples.

c. Risk Level 2 dischargers shall designate and train personnel to collect, maintain, and ship samples in accordance with the Surface Water Ambient Monitoring Program's (SWAMP) 2008 Quality Assurance Program Plan (QAPrP).[5]

8. **Risk Level 2 – Monitoring Methods**

a. Risk Level 2 dischargers shall include a description of the following items in the CSMP:

i. Visual observation locations, visual observation procedures, and visual observation follow-up and tracking procedures.

ii. Sampling locations, and sample collection and handling procedures. This shall include detailed procedures for sample collection, storage, preservation, and shipping to the testing lab to assure that consistent quality control and quality assurance is maintained. Dischargers shall attach to the monitoring program

[5] Additional information regarding SWAMP's QAPrP can be found at http://www.waterboards.ca.gov/water_issues/programs/swamp/. QAPrP:http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf.

an example Chain of Custody form used when handling and shipping samples.

iii. Identification of the analytical methods and related method detection limits (if applicable) for each parameter required in Section I.4 above.

b. Risk Level 2 dischargers shall ensure that all sampling and sample preservation are in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment (including a discharger's own field instruments for measuring pH and turbidity) should be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. Risk Level 2 dischargers shall ensure that all laboratory analyses are conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this General Permit or by the Regional Water Board. With the exception of field analysis conducted by the discharger for turbidity and pH, all analyses should be sent to and conducted at a laboratory certified for such analyses by the State Department of Health Services. Risk Level 2 dischargers shall conduct their own field analysis of pH and may conduct their own field analysis of turbidity if the discharger has sufficient capability (qualified and trained employees, properly calibrated and maintained field instruments, etc.) to adequately perform the field analysis.

9. **Risk Level 2 – Analytical Methods**

a. Risk Level 2 dischargers shall refer to Table 3 below for test methods, detection limits, and reporting units.

b. **pH**: Risk Level 2 dischargers shall perform pH analysis on-site with a calibrated pH meter or a pH test kit. Risk Level 2 dischargers shall record pH monitoring results on paper and retain these records in accordance with Section I.14, below.

c. **Turbidity**: Risk Level 2 dischargers shall perform turbidity analysis using a calibrated turbidity meter (turbidimeter), either on-site or at an accredited lab. Acceptable test methods include Standard Method 2130 or USEPA Method 180.1. The results will be recorded in the site log book in Nephelometric Turbidity Units (NTU).

10. **Risk Level 2 - Non-Storm Water Discharge Monitoring Requirements**

a. Visual Monitoring Requirements:

   i. Risk Level 2 dischargers shall visually observe (inspect) each drainage area for the presence of (or indications of prior) unauthorized and authorized non-storm water discharges and their sources.

   ii. Risk Level 2 dischargers shall conduct one visual observation (inspection) quarterly in each of the following periods: January-March, April-June, July-September, and October-December. Visual observation (inspections) are only required during daylight hours (sunrise to sunset).

   iii. Risk Level 2 dischargers shall ensure that visual observations (inspections) document the presence or evidence of any non-storm water discharge (authorized or unauthorized), pollutant characteristics (floating and suspended material, sheen, discoloration, turbidity, odor, etc.), and source. Risk Level 2 dischargers shall maintain on-site records indicating the personnel performing the visual observation (inspections), the dates and approximate time each drainage area and non-storm water discharge was observed, and the response taken to eliminate unauthorized non-storm water discharges and to reduce or prevent pollutants from contacting non-storm water discharges.

b. Effluent Sampling Locations:

   i. Risk Level 2 dischargers shall sample effluent at all discharge points where non-storm water and/or authorized non-storm water is discharged off-site.

   ii. Risk Level 2 dischargers shall send all non-storm water sample analyses to a laboratory certified for such analyses by the State Department of Health Services.

   iii. Risk Level 2 dischargers shall monitor and report run-on from surrounding areas if there is reason to believe run-on may contribute to an exceedance of NALs.

11. **Risk Level 2 – Non-Visible Pollutant Monitoring Requirements**

a. Risk Level 2 dischargers shall collect one or more samples during any breach, malfunction, leakage, or spill observed during a visual

inspection which could result in the discharge of pollutants to surface waters that would not be visually detectable in storm water.

b. Risk Level 2 dischargers shall ensure that water samples are large enough to characterize the site conditions.

c. Risk Level 2 dischargers shall collect samples at all discharge locations that can be safely accessed.

d. Risk Level 2 dischargers shall collect samples during the first two hours of discharge from rain events that occur during business hours and which generate runoff.

e. Risk Level 2 dischargers shall analyze samples for all non-visible pollutant parameters (if applicable) - parameters indicating the presence of pollutants identified in the pollutant source assessment required (Risk Level 2 dischargers shall modify their CSMPs to address these additional parameters in accordance with any updated SWPPP pollutant source assessment).

f. Risk Level 2 dischargers shall collect a sample of storm water that has not come in contact with the disturbed soil or the materials stored or used on-site (uncontaminated sample) for comparison with the discharge sample.

g. Risk Level 2 dischargers shall compare the uncontaminated sample to the samples of discharge using field analysis or through laboratory analysis.[6]

h. Risk Level 2 dischargers shall keep all field /or analytical data in the SWPPP document.

12. **Risk Level 2 – Watershed Monitoring Option**

Risk Level 2 dischargers who are part of a qualified regional watershed-based monitoring program may be eligible for relief from the requirements in Sections I.5. The Regional Water Board may approve proposals to substitute an acceptable watershed-based monitoring program by determining if the watershed-based monitoring program will provide substantially similar monitoring information in evaluating discharger compliance with the requirements of this General Permit.

[6] For laboratory analysis, all sampling, sample preservation, and analyses must be conducted according to test procedures under 40 CFR Part 136. Field discharge samples shall be collected and analyzed according to the specifications of the manufacturer of the sampling devices employed.

13. **Risk Level 2 – Particle Size Analysis for Project Risk Justification**

Risk Level 2 dischargers justifying an alternative project risk shall report a soil particle size analysis used to determine the RUSLE K-Factor. ASTM D-422 (Standard Test Method for Particle-Size Analysis of Soils), as revised, shall be used to determine the percentages of sand, very fine sand, silt, and clay on the site.

14. **Risk Level 2 – Records**

Risk Level 2 dischargers shall retain records of all storm water monitoring information and copies of all reports (including Annual Reports) for a period of at least three years. Risk Level 2 dischargers shall retain all records on-site while construction is ongoing. These records include:

a. The date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation.

b. The individual(s) who performed the facility inspections, sampling, visual observation (inspections), and or measurements.

c. The date and approximate time of analyses.

d. The individual(s) who performed the analyses.

e. A summary of all analytical results from the last three years, the method detection limits and reporting units, the analytical techniques or methods used, and the chain of custody forms.

f. Rain gauge readings from site inspections;

g. Quality assurance/quality control records and results.

h. Non-storm water discharge inspections and visual observation (inspections) and storm water discharge visual observation records (see Sections I.3 and I.10 above).

i. Visual observation and sample collection exception records (see Section I.6 above).

j. The records of any corrective actions and follow-up activities that resulted from analytical results, visual observation (inspections), or inspections.

15. **Risk Level 2 – NAL Exceedance Report**

a. In the event that any effluent sample exceeds an applicable NAL, Risk Level 2 dischargers shall electronically submit all storm event sampling results to the State Water Board no later than 10 days after the conclusion of the storm event. The Regional Boards have the authority to require the submittal of an NAL Exceedance Report.

b. Risk Level 2 dischargers shall certify each NAL Exceedance Report in accordance with the Special Provisions for Construction Activity.

c. Risk Level 2 dischargers shall retain an electronic or paper copy of each NAL Exceedance Report for a minimum of three years after the date the annual report is filed.

d. Risk Level 2 dischargers shall include in the NAL Exceedance Report:

   i. The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as “less than the method detection limit”).

   ii. The date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation.

   iii. A description of the current BMPs associated with the effluent sample that exceeded the NAL and the proposed corrective actions taken.

Table 3 – Risk Level 2 Test Methods, Detection Limits, Reporting Units and Applicable NALs/NELs

Parameter	Test Method / Protocol	Discharge Type	Min. Detection Limit	Reporting Units	Numeric Action Level
pH	Field test with calibrated portable instrument	Risk Level 2 Discharges	0.2	pH units	lower NAL = 6.5 upper NAL = 8.5
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	Risk Level 2 Discharges other than ATS	1	NTU	250 NTU
		For ATS discharges	1	NTU	N/A

ATTACHMENT E
RISK LEVEL 3 REQUIREMENTS

A. Effluent Standards

[These requirements are the same as those in the General Permit order.]

1. Narrative – Risk Level 3 dischargers shall comply with the narrative effluent standards listed below:

    a. Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

    b. Dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

2. Numeric –Risk Level 3 dischargers are subject to a pH NAL of 6.5-8.5, and a turbidity NAL of 250 NTU.

B. Good Site Management "Housekeeping"

1. Risk Level 3 dischargers shall implement good site management (i.e., "housekeeping") measures for construction materials that could potentially be a threat to water quality if discharged. At a minimum, Risk Level 3 dischargers shall implement the following good housekeeping measures:

    a. Conduct an inventory of the products used and/or expected to be used and the end products that are produced and/or expected to be produced. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

    b. Cover and berm loose stockpiled construction materials that are not actively being used (i.e. soil, spoils, aggregate, fly-ash, stucco, hydrated lime, etc.).

c. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).

d. Minimize exposure of construction materials to precipitation. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e. poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).

e. Implement BMPs to prevent the off-site tracking of loose construction and landscape materials.

2. Risk Level 3 dischargers shall implement good housekeeping measures for waste management, which, at a minimum, shall consist of the following:

a. Prevent disposal of any rinse or wash waters or materials on impervious or pervious site surfaces or into the storm drain system.

b. Ensure the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the storm water drainage system or receiving water.

c. Clean or replace sanitation facilities and inspecting them regularly for leaks and spills.

d. Cover waste disposal containers at the end of every business day and during a rain event.

e. Prevent discharges from waste disposal containers to the storm water drainage system or receiving water.

f. Contain and securely protecting stockpiled waste material from wind and rain at all times unless actively being used.

g. Implement procedures that effectively address hazardous and non-hazardous spills.

h. Develop a spill response and implementation element of the SWPPP prior to commencement of construction activities. The SWPPP shall require that:

i. Equipment and materials for cleanup of spills shall be available on site and that spills and leaks shall be cleaned up immediately and disposed of properly; and

ii. Appropriate spill response personnel are assigned and trained.

i. Ensure the containment of concrete washout areas and other washout areas that may contain additional pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

3. Risk Level 3 dischargers shall implement good housekeeping for vehicle storage and maintenance, which, at a minimum, shall consist of the following:

   a. Prevent oil, grease, or fuel to leak in to the ground, storm drains or surface waters.

   b. Place all equipment or vehicles, which are to be fueled, maintained and stored in a designated area fitted with appropriate BMPs.

   c. Clean leaks immediately and disposing of leaked materials properly.

4. Risk Level 3 dischargers shall implement good housekeeping for landscape materials, which, at a minimum, shall consist of the following:

   a. Contain stockpiled materials such as mulches and topsoil when they are not actively being used.

   b. Contain fertilizers and other landscape materials when they are not actively being used.

   c. Discontinuing the application of any erodible landscape material within 2 days before a forecasted rain event or during periods of precipitation.

   d. Applying erodible landscape material at quantities and application rates according to manufacture recommendations or based on written specifications by knowledgeable and experienced field personnel.

   e. Stacking erodible landscape material on pallets and covering or storing such materials when not being used or applied.

5. Risk Level 3 dischargers shall conduct an assessment and create a list of potential pollutant sources and identify any areas of the site where additional BMPs are necessary to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. This potential pollutant list shall be kept with the SWPPP and shall identify

all non-visible pollutants which are known, or should be known, to occur on the construction site. At a minimum, when developing BMPs, Risk Level 3 dischargers shall do the following:

a. Consider the quantity, physical characteristics (e.g., liquid, powder, solid), and locations of each potential pollutant source handled, produced, stored, recycled, or disposed of at the site.

b. Consider the degree to which pollutants associated with those materials may be exposed to and mobilized by contact with storm water.

c. Consider the direct and indirect pathways that pollutants may be exposed to storm water or authorized non-storm water discharges. This shall include an assessment of past spills or leaks, non-storm water discharges, and discharges from adjoining areas.

d. Ensure retention of sampling, visual observation, and inspection records.

e. Ensure effectiveness of existing BMPs to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges.

6. Risk Level 3 dischargers shall implement good housekeeping measures on the construction site to control the air deposition of site materials and from site operations. Such particulates can include, but are not limited to, sediment, nutrients, trash, metals, bacteria, oil and grease and organics.

7. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall document all housekeeping BMPs in the SWPPP and REAP(s) in accordance with the nature and phase of the construction project. Construction phases at traditional land development projects include Grading and Land Development Phase, Streets and Utilities, or Vertical Construction for traditional land development projects.

C. Non-Storm Water Management

1. Risk Level 3 dischargers shall implement measures to control all non-storm water discharges during construction.

2. Risk Level 3 dischargers shall wash vehicles in such a manner as to prevent non-storm water discharges to surface waters or MS4 drainage systems.

3. Risk Level 3 dischargers shall clean streets in such a manner as to prevent unauthorized non-storm water discharges from reaching surface water or MS4 drainage systems.

D. Erosion Control

1. Risk Level 3 dischargers shall implement effective wind erosion control.

2. Risk Level 3 dischargers shall provide effective soil cover for inactive[1] areas and all finished slopes, open space, utility backfill, and completed lots.

3. Dischargers shall limit the use of plastic materials when more sustainable, environmentally friendly alternatives exist. Where plastic materials are deemed necessary, the discharger shall consider the use of plastic materials resistant to solar degradation.

E. Sediment Controls

1. Risk Level 3 dischargers shall establish and maintain effective perimeter controls and stabilize all construction entrances and exits to sufficiently control erosion and sediment discharges from the site.

2. On sites where sediment basins are to be used, Risk Level 3 dischargers shall, at minimum, design sediment basins according to the method provided in CASQA's Construction BMP Guidance Handbook.

3. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall implement appropriate erosion control BMPs (runoff control and soil stabilization) in conjunction with sediment control BMPs for areas under active[2] construction.

4. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall apply linear sediment controls along the toe of the slope, face of the slope, and at the grade breaks of exposed slopes to comply with sheet flow lengths[3] in accordance with Table 1.

---

[1] Inactive areas of construction are areas of construction activity that have been disturbed and are not scheduled to be re-disturbed for at least 14 days.
[2] Active areas of construction are areas undergoing land surface disturbance. This includes construction activity during the preliminary stage, mass grading stage, streets and utilities stage and the vertical construction stage
[3] Sheet flow length is the length that shallow, low velocity flow travels across a site.

Table 1 - Critical Slope/Sheet Flow Length Combinations

Slope Percentage	Sheet flow length not to exceed
0-25%	20 feet
25-50%	15 feet
Over 50%	10 feet

5. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall ensure that construction activity traffic to and from the project is limited to entrances and exits that employ effective controls to prevent offsite tracking of sediment.

6. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall ensure that all storm drain inlets and perimeter controls, runoff control BMPs, and pollutant controls at entrances and exits (e.g. tire washoff locations) are maintained and protected from activities that reduce their effectiveness.

7. **Additional Risk Level 3 Requirement:** Risk Level 3 dischargers shall inspect on a daily basis all immediate access roads daily. At a minimum daily (when necessary) and prior to any rain event, the discharger shall remove any sediment or other construction activity-related materials that are deposited on the roads (by vacuuming or sweeping).

8. **Additional Risk Level 3 Requirement:** The Regional Water Board may require Risk Level 3 dischargers to implement additional site-specific sediment control requirements if the implementation of the other requirements in this section are not adequately protecting the receiving waters.

F. Run-on and Run-off Controls

Risk Level 3 dischargers shall effectively manage all run-on, all runoff within the site and all runoff that discharges off the site. Run-on from off site shall be directed away from all disturbed areas or shall collectively be in compliance with the effluent limitations in this General Permit.

G. Inspection, Maintenance and Repair

1. Risk Level 3 dischargers shall ensure that all inspection, maintenance repair and sampling activities at the project location shall be performed or supervised by a Qualified SWPPP Practitioner (QSP) representing the discharger. The QSP may delegate any or all of these activities to an employee appropriately trained to do the task(s).

2. Risk Level 3 dischargers shall perform weekly inspections and observations, and at least once each 24-hour period during extended storm events, to identify and record BMPs that need maintenance to operate effectively, that have failed, or that could fail to operate as intended. Inspectors shall be the QSP or be trained by the QSP.

3. Upon identifying failures or other shortcomings, as directed by the QSP, Risk Level 3 dischargers shall begin implementing repairs or design changes to BMPs within 72 hours of identification and complete the changes as soon as possible.

4. For each inspection required, Risk Level 3 dischargers shall complete an inspection checklist, using a form provided by the State Water Board or Regional Water Board or in an alternative format.

5. Risk Level 3 dischargers shall ensure that checklists shall remain onsite with the SWPPP and at a minimum, shall include:

    a. Inspection date and date the inspection report was written.

    b. Weather information, including presence or absence of precipitation, estimate of beginning of qualifying storm event, duration of event, time elapsed since last storm, and approximate amount of rainfall in inches.

    c. Site information, including stage of construction, activities completed, and approximate area of the site exposed.

    d. A description of any BMPs evaluated and any deficiencies noted.

    e. If the construction site is safely accessible during inclement weather, list the observations of all BMPs: erosion controls, sediment controls, chemical and waste controls, and non-storm water controls. Otherwise, list the results of visual inspections at all relevant outfalls, discharge points, downstream locations and any projected maintenance activities.

    f. Report the presence of noticeable odors or of any visible sheen on the surface of any discharges.

    g. Any corrective actions required, including any necessary changes to the SWPPP and the associated implementation dates.

    h. Photographs taken during the inspection, if any.

i. Inspector's name, title, and signature.

H. Rain Event Action Plan

1. **Additional Risk Level 3 Requirement:** The discharger shall ensure a QSP develop a Rain Event Action Plan (REAP) 48 hours prior to any likely precipitation event. A likely precipitation event is any weather pattern that is forecast to have a 50% or greater probability of producing precipitation in the project area. The QSP shall obtain a printed copy of precipitation forecast information from the National Weather Service Forecast Office (e.g., by entering the zip code of the project's location at http://www.srh.noaa.gov/forecast).

2. **Additional Risk Level 3 Requirement:** The discharger shall ensure a QSP develop the REAPs for all phases of construction (i.e., Grading and Land Development, Streets and Utilities, Vertical Construction, Final Landscaping and Site Stabilization).

3. **Additional Risk Level 3 Requirement:** The discharger shall ensure a QSP ensure that the REAP include, at a minimum, the following site information:

   a. Site Address.
   b. Calculated Risk Level (2 or 3).
   c. Site Storm Water Manager Information including the name, company, and 24-hour emergency telephone number.
   d. Erosion and Sediment Control Provider information including the name, company, and 24-hour emergency telephone number.
   e. Storm Water Sampling Agent information including the name, company, and 24-hour emergency telephone number.

4. **Additional Risk Level 3 Requirement:** The QSP shall include in the REAP, at a minimum, the following project phase information:

   a. Activities associated with each construction phase.
   b. Trades active on the construction site during each construction phase.
   c. Trade contractor information.
   d. Suggested actions for each project phase.

5. **Additional Risk Level 3 Requirement:** The QSP shall develop additional REAPs for project sites where construction activities are indefinitely halted or postponed (Inactive Construction). At a minimum, Inactive Construction REAPs must include:

a. Site Address.
b. Calculated Risk Level (2 or 3).
c. Site Storm Water Manager Information including the name, company, and 24-hour emergency telephone number.
d. Erosion and Sediment Control Provider information including the name, company, and 24-hour emergency telephone number.
e. Storm Water Sampling Agent information including the name, company, and 24-hour emergency telephone number.
f. Trades active on site during Inactive Construction.
g. Trade contractor information.
h. Suggested actions for inactive construction sites.

6. **Additional Risk Level 3 Requirement:** The discharger shall ensure a QSP begin implementation and make the REAP available onsite no later than 24 hours prior to the likely precipitation event.

7. **Additional Risk Level 3 Requirement:** The discharger shall ensure a QSP maintain onsite a paper copy of each REAP onsite in compliance with the record retention requirements of the Special Provisions in this General Permit.

I. Risk Level 3 Monitoring and Reporting Requirements

Table 2- Summary of Monitoring Requirements

Risk Level	Visual Inspections					Sample Collection	
	Quarterly Non-storm Water Discharge	Pre-storm Event		Daily Storm BMP	Post Storm	Storm Water Discharge	Receiving Water
		Baseline	REAP				
3	X	X	X	X	X	X	X[4]

1. Construction Site Monitoring Program Requirements

   a. Pursuant to Water Code Sections 13383 and 13267, all dischargers subject to this General Permit shall develop and implement a written site-specific Construction Site Monitoring Program (CSMP) in accordance with the requirements of this Section. The CSMP shall include all monitoring procedures and instructions, location maps, forms, and checklists as required in this section. The CSMP shall be developed prior to the commencement of construction activities, and revised as necessary to reflect project revisions. The CSMP shall be a part of the Storm Water Pollution Prevention Plan (SWPPP), included as an appendix or separate SWPPP chapter.

   b. Existing dischargers registered under the State Water Board Order No. 99-08-DWQ shall make and implement necessary revisions to their Monitoring Program to reflect the changes in this General Permit in a timely manner, but no later than July 1, 2010. Existing dischargers shall continue to implement their existing Monitoring Program in compliance with State Water Board Order No. 99-08-DWQ until the necessary revisions are completed according to the schedule above.

   c. When a change of ownership occurs for all or any portion of the construction site prior to completion or final stabilization, the new discharger shall comply with these requirements as of the date the ownership change occurs.

2. **Objectives**

   The CSMP shall be developed and implemented to address the following objectives:

[4] When receiving water monitoring trigger is exceeded

a. To demonstrate that the site is in compliance with the Discharge Prohibitions and applicable Numeric Action Levels (NALs) of this General Permit.

b. To determine whether non-visible pollutants are present at the construction site and are causing or contributing to exceedances of water quality objectives.

c. To determine whether immediate corrective actions, additional Best Management Practice (BMP) implementation, or SWPPP revisions are necessary to reduce pollutants in storm water discharges and authorized non-storm water discharges.

d. To determine whether BMPs included in the SWPPP/Rain Event Action Plan (REAP) are effective in preventing or reducing pollutants in storm water discharges and authorized non-storm water discharges.

3. **Risk Level 3 – Visual Monitoring (Inspection) Requirements for Qualifying Rain Events**

a. Risk Level 3 dischargers shall visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event.

b. Risk Level 3 dischargers shall visually observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Stored or contained storm water that will likely discharge after operating hours due to anticipated precipitation shall be observed prior to the discharge during operating hours.

c. Risk Level 3 dischargers shall conduct visual observations (inspections) during business hours only.

d. Risk Level 3 dischargers shall record the time, date and rain gauge reading of all qualifying rain events.

e. Within 2 business days (48 hours) prior to each qualifying rain event, Risk Level 3 dischargers shall visually observe (inspect):

i. all storm water drainage areas to identify any spills, leaks, or uncontrolled pollutant sources. If needed, the discharger shall implement appropriate corrective actions.

ii. all BMPs to identify whether they have been properly implemented in accordance with the SWPPP/REAP. If needed, the discharger shall implement appropriate corrective actions.

iii. any storm water storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.

f. For the visual observations (inspections) described in c.i. and c.iii above, Risk Level 3 dischargers shall observe the presence or absence of floating and suspended materials, a sheen on the surface, discolorations, turbidity, odors, and source(s) of any observed pollutants.

g. Within two business days (48 hours) after each qualifying rain event, Risk Level 3 dischargers shall conduct post rain event visual observations (inspections) to (1) identify whether BMPs were adequately designed, implemented, and effective, and (2) identify additional BMPs and revise the SWPPP accordingly.

h. Risk Level 3 dischargers shall maintain on-site records of all visual observations (inspections), personnel performing the observations, observation dates, weather conditions, locations observed, and corrective actions taken in response to the observations.

4. **Risk Level 3 – Water Quality Sampling and Analysis**

a. Risk Level 3 dischargers shall collect storm water grab samples from sampling locations, as defined in Section I.5. The storm water grab sample(s) obtained shall be representative of the flow and characteristics of the discharge.

b. At minimum, Risk Level 3 dischargers shall collect 3 samples per day of the qualifying event.

c. Risk Level 3 dischargers shall ensure that the grab samples collected of stored or contained storm water are from discharges subsequent to a qualifying rain event (producing precipitation of ½ inch or more at the time of discharge).

<u>Storm Water Effluent Monitoring Requirements</u>

d. Risk Level 3 dischargers shall analyze their effluent samples for:

i. pH and turbidity.

ii. Any additional parameters for which monitoring is required by the Regional Water Board.

e. Risk 3 dischargers shall electronically submit all storm event sampling results to the State Water Board no later than 10 days after the conclusion of the storm event.

Receiving Water Monitoring Requirements

f. In the event that a Risk Level 3 discharger's effluent exceeds the daily average receiving water monitoring trigger of 500 NTU turbidity or the daily average pH range 6.0-9.0 contained in this General Permit and has a direct discharge into receiving waters, the Risk Level 3 discharger shall subsequently sample receiving waters (RWs) for turbidity, pH (if applicable), and SSC for the duration of coverage under this General Permit. If a Risk Level 3 discharger utilizing ATS with direct discharges into receiving waters discharges effluent that exceeds the NELs in this permit, the discharger shall subsequently sample RWs for turbidity, pH (if applicable), and SSC for the duration of coverage under this General Permit.

g. Risk Level 3 dischargers disturbing 30 acres or more of the landscape and with direct discharges into receiving waters shall conduct or participate in benthic macroinvertebrate bioassessment of RWs prior to commencement of construction activity (See Appendix 3).

h. Risk Level 3 dischargers shall obtain RW samples in accordance with the Receiving Water sampling location section (Section I.5), below.

5. **Risk Level 3 – Storm Water Discharge Water Quality Sampling Locations**

Effluent Sampling Locations

a. Risk Level 3 dischargers shall perform sampling and analysis of storm water discharges to characterize discharges associated with construction activity from the entire project disturbed area.

b. Risk Level 3 dischargers shall collect effluent samples at all discharge points where storm water is discharged off-site.

c. Risk Level 3 dischargers shall ensure that storm water discharge collected and observed represent[5] the effluent in each drainage area based on visual observation of the water and upstream conditions.

d. Risk Level 3 dischargers shall monitor and report site run-on from surrounding areas if there is reason to believe run-on may contribute to an exceedance of NALs.

e. Risk Level 3 dischargers who deploy an ATS on their site, or a portion on their site, shall collect ATS effluent samples and measurements from the discharge pipe or another location representative of the nature of the discharge.

f. Risk Level 3 dischargers shall select analytical test methods from the list provided in Table 3 below.

g. All storm water sample collection preservation and handling shall be conducted in accordance with Section I.7 “Storm Water Sample Collection and Handling Instructions” below.

Receiving Water Sampling Locations

h. **Upstream/up-gradient RW samples**: Risk Level 3 dischargers shall obtain any required upstream/up-gradient receiving water samples from a representative and accessible location as close as possible and upstream from the effluent discharge point.

i. **Downstream/down-gradient RW samples**: Risk Level 3 dischargers shall obtain any required downstream/down-gradient receiving water samples from a representative and accessible location as close as possible and downstream from the effluent discharge point.

j. If two or more discharge locations discharge to the same receiving water, Risk Level 3 dischargers may sample the receiving water at a single upstream and downstream location.

[5] For example, if there has been concrete work recently in an area, or drywall scrap is exposed to the rain, a pH sample shall be taken of drainage from the relevant work area. Similarly, if sediment-laden water is flowing through some parts of a silt fence, samples shall be taken of the sediment laden water even if most water flowing through the fence is clear.

6. **Risk Level 3 – Visual Observation and Sample Collection Exemptions**

   a. Risk Level 3 dischargers shall be prepared to collect samples and conduct visual observation (inspections) until the minimum requirements of Sections I.3 and I.4 above are completed. Risk Level 3 dischargers are not required to physically collect samples or conduct visual observation (inspections) under the following conditions:

      i. During dangerous weather conditions such as flooding and electrical storms.

      ii. Outside of scheduled site business hours.

   b. If no required samples or visual observation (inspections) are collected due to these exceptions, Risk Level 3 dischargers shall include an explanation in their SWPPP and in the Annual Report documenting why the sampling or visual observation (inspections) were not conducted.

7. **Risk Level 3 – Storm Water Sample Collection and Handling Instructions**

   a. Risk Level 3 dischargers shall refer to Table 3 below for test methods, detection limits, and reporting units.

   b. Risk Level 3 dischargers shall ensure that testing laboratories will receive samples within 48 hours of the physical sampling (unless otherwise required by the laboratory), and shall use only the sample containers provided by the laboratory to collect and store samples.

   c. Risk Level 3 dischargers shall designate and train personnel to collect, maintain, and ship samples in accordance with the Surface Water Ambient Monitoring Program's (SWAMP) 2008 Quality Assurance Program Plan (QAPrP).[6]

[6] Additional information regarding SWAMP's QAPrP can be found at http://www.waterboards.ca.gov/water_issues/programs/swamp/.
QAPrP:http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

8. **Risk Level 3 – Monitoring Methods**

   a. Risk Level 3 dischargers shall include a description of the following items in the CSMP:

      i. Visual observation locations, visual observation procedures, and visual observation follow-up and tracking procedures.

      ii. Sampling locations, and sample collection and handling procedures. This shall include detailed procedures for sample collection, storage, preservation, and shipping to the testing lab to assure that consistent quality control and quality assurance is maintained. Dischargers shall attach to the monitoring program an example Chain of Custody form used when handling and shipping samples.

      iii. Identification of the analytical methods and related method detection limits (if applicable) for each parameter required in Section I.4 above.

   b. Risk Level 3 dischargers shall ensure that all sampling and sample preservation are in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association). All monitoring instruments and equipment (including a discharger's own field instruments for measuring pH and turbidity) should be calibrated and maintained in accordance with manufacturers' specifications to ensure accurate measurements. Risk Level 3 dischargers shall ensure that all laboratory analyses are conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this General Permit or by the Regional Water Board. With the exception of field analysis conducted by the discharger for turbidity and pH, all analyses should be sent to and conducted at a laboratory certified for such analyses by the State Department of Health Services (SSC exception). Risk Level 3 dischargers shall conduct their own field analysis of pH and may conduct their own field analysis of turbidity if the discharger has sufficient capability (qualified and trained employees, properly calibrated and maintained field instruments, etc.) to adequately perform the field analysis.

9. **Risk Level 3 – Analytical Methods**

   a. Risk Level 3 dischargers shall refer to Table 3 below for test methods, detection limits, and reporting units.

b. **pH**: Risk Level 3 dischargers shall perform pH analysis on-site with a calibrated pH meter or a pH test kit. Risk Level 3 dischargers shall record pH monitoring results on paper and retain these records in accordance with Section I.14, below.

c. **Turbidity**: Risk Level 3 dischargers shall perform turbidity analysis using a calibrated turbidity meter (turbidimeter), either on-site or at an accredited lab. Acceptable test methods include Standard Method 2130 or USEPA Method 180.1. The results will be recorded in the site log book in Nephelometric Turbidity Units (NTU).

d. **Suspended sediment concentration (SSC)**: Risk Level 3 dischargers that exceed the turbidity Receiving Water Monitoring Trigger shall perform SSC analysis using ASTM Method D3977-97.

e. **Bioassessment**: Risk Level 3 dischargers shall perform bioassessment sampling and analysis according to Appendix 3 of this General Permit.

10. **Risk Level 3 - Non-Storm Water Discharge Monitoring Requirements**

a. Visual Monitoring Requirements:

i. Risk Level 3 dischargers shall visually observe (inspect) each drainage area for the presence of (or indications of prior) unauthorized and authorized non-storm water discharges and their sources.

ii. Risk Level 3 dischargers shall conduct one visual observation (inspection) quarterly in each of the following periods: January-March, April-June, July-September, and October-December. Visual observation (inspections) are only required during daylight hours (sunrise to sunset).

iii. Risk Level 3 dischargers shall ensure that visual observations (inspections) document the presence or evidence of any non-storm water discharge (authorized or unauthorized), pollutant characteristics (floating and suspended material, sheen, discoloration, turbidity, odor, etc.), and source. Risk Level 3 dischargers shall maintain on-site records indicating the personnel performing the visual observation (inspections), the dates and approximate time each drainage area and non-storm water discharge was observed, and the response taken to eliminate unauthorized non-storm water discharges and to

reduce or prevent pollutants from contacting non-storm water discharges.

b. Effluent Sampling Locations:

i. Risk Level 3 dischargers shall sample effluent at all discharge points where non-storm water and/or authorized non-storm water is discharged off-site.

ii. Risk Level 3 dischargers shall send all non-storm water sample analyses to a laboratory certified for such analyses by the State Department of Health Services.

iii. Risk Level 3 dischargers shall monitor and report run-on from surrounding areas if there is reason to believe run-on may contribute to an exceedance of NALs.

11. **Risk Level 3 – Non-Visible Pollutant Monitoring Requirements**

a. Risk Level 3 dischargers shall collect one or more samples during any breach, malfunction, leakage, or spill observed during a visual inspection which could result in the discharge of pollutants to surface waters that would not be visually detectable in storm water.

b. Risk Level 3 dischargers shall ensure that water samples are large enough to characterize the site conditions.

c. Risk Level 3 dischargers shall collect samples at all discharge locations that can be safely accessed.

d. Risk Level 3 dischargers shall collect samples during the first two hours of discharge from rain events that occur during business hours and which generate runoff.

e. Risk Level 3 dischargers shall analyze samples for all non-visible pollutant parameters (if applicable) - parameters indicating the presence of pollutants identified in the pollutant source assessment required (Risk Level 3 dischargers shall modify their CSMPs to address these additional parameters in accordance with any updated SWPPP pollutant source assessment).

f. Risk Level 3 dischargers shall collect a sample of storm water that has not come in contact with the disturbed soil or the materials stored or used on-site (uncontaminated sample) for comparison with the discharge sample.

g. Risk Level 3 dischargers shall compare the uncontaminated sample to the samples of discharge using field analysis or through laboratory analysis.[7]

h. Risk Level 3 dischargers shall keep all field /or analytical data in the SWPPP document.

12. **Risk Level 3 – Watershed Monitoring Option**

Risk Level 3 dischargers who are part of a qualified regional watershed-based monitoring program may be eligible for relief from the requirements in Sections I.5. The Regional Water Board may approve proposals to substitute an acceptable watershed-based monitoring program by determining if the watershed-based monitoring program will provide substantially similar monitoring information in evaluating discharger compliance with the requirements of this General Permit.

13. **Risk Level 3 – Particle Size Analysis for Project Risk Justification**

Risk Level 3 dischargers justifying an alternative project risk shall report a soil particle size analysis used to determine the RUSLE K-Factor. ASTM D-422 (Standard Test Method for Particle-Size Analysis of Soils), as revised, shall be used to determine the percentages of sand, very fine sand, silt, and clay on the site.

14. **Risk Level 3 – Records**

Risk Level 3 dischargers shall retain records of all storm water monitoring information and copies of all reports (including Annual Reports) for a period of at least three years. Risk Level 3 dischargers shall retain all records on-site while construction is ongoing. These records include:

a. The date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation.

b. The individual(s) who performed the facility inspections, sampling, visual observation (inspections), and or measurements.

c. The date and approximate time of analyses.

[7] For laboratory analysis, all sampling, sample preservation, and analyses must be conducted according to test procedures under 40 CFR Part 136. Field discharge samples shall be collected and analyzed according to the specifications of the manufacturer of the sampling devices employed.

d. The individual(s) who performed the analyses.

e. A summary of all analytical results from the last three years, the method detection limits and reporting units, the analytical techniques or methods used, and the chain of custody forms.

f. Rain gauge readings from site inspections.

g. Quality assurance/quality control records and results.

h. Non-storm water discharge inspections and visual observation (inspections) and storm water discharge visual observation records (see Sections I.3 and I.10 above).

i. Visual observation and sample collection exception records (see Section I.6 above).

j. The records of any corrective actions and follow-up activities that resulted from analytical results, visual observation (inspections), or inspections.

15. **Risk Level 3 – NAL Exceedance Report**

a. Risk Level 3 dischargers shall electronically submit all storm event sampling results to the State Water Board no later than 10 days after the conclusion of the storm event. The Regional Boards have the authority to require the submittal of an NAL Exceedance Report.

b. Risk Level 3 dischargers shall certify each NAL Exceedance Report in accordance with the Special Provisions for Construction Activity In this General Permit.

c. Risk Level 3 dischargers shall retain an electronic or paper copy of each NAL Exceedance Report for a minimum of three years after the date the annual report is filed.

d. Risk Level 3 dischargers shall include in the NAL Exceedance Report:

i. The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as “less than the method detection limit”).

ii. The date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation.

iii. A description of the current BMPs associated with the effluent sample that exceeded the NAL and the proposed corrective actions taken.

16. **Risk Level 3 – Bioassessment**

a. Risk Level 3 dischargers with a total project-related ground disturbance exceeding 30 acres shall:

i. Conduct bioassessment monitoring, as described in Appendix 3.

ii. Include the collection and reporting of specified in stream biological data and physical habitat.

iii. Use the bioassessment sample collection and Quality Assurance & Quality Control (QA/QC) protocols developed by the State of California's Surface Water Ambient Monitoring Program (SWAMP).[8]

b. Risk Level 3 dischargers qualifying for bioassessment, where construction commences out of an index period for the site location shall:

i. Receive Regional Board approval for the sampling exception.

ii. Conduct bioassessment monitoring, as described in Appendix 3.

iii. Include the collection and reporting of specified instream biological data and physical habitat.

iv. Use the bioassessment sample collection and Quality Assurance & Quality Control (QA/QC) protocols developed by the State of California's Surface Water Ambient Monitoring Program (SWAMP).

OR

v. Make a check payable to: Cal State Chico Foundation (SWAMP Bank Account) or San Jose State Foundation (SWAMP Bank Account) and include the WDID# on the check for the amount calculated for the exempted project.

[8] http://www.waterboards.ca.gov/water_issues/programs/swamp/.

vi. Send a copy of the check to the Regional Water Board office for the site's region.

vii. Invest $**7,500.00 X The number of samples required** into the SWAMP program as compensation (upon regional board approval).

Table 3 – Risk Level 3 Test Methods, Detection Limits, Reporting Units and Applicable NALs

Parameter	Test Method / Protocol	Discharge Type	Min. Detection Limit	Reporting Units	Numeric Action Level	Numeric Effluent Limitation	Receiving Water Monitoring Trigger
pH	Field test with calibrated portable instrument	Risk Level 3 Discharges	0.2	pH units	lower NAL = 6.5 upper NAL = 8.5	N/A	lower limit = 6.0 upper limit = 9.0
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	Risk Level 3 Discharges other than ATS	1	NTU	250 NTU	N/A	500 NTU
		For ATS discharges	1	NTU	N/A	10 NTU for Daily Weighted Average & 20 NTU for Any Single Sample	10 NTU for Daily Weighted Average & 20 NTU for Any Single Sample
SSC	ASTM Method D 3977-97[9]	Risk Level 3 (if Receiving Water Monitoring Trigger exceeded)	5	mg/L	N/A	N/A	N/A
Bioassessment	(STE) Level I of (SAFIT),[10] fixed-count of 600 org/sample	Risk Level 3 projects> 30 acres	N/A	N/A	N/A	N/A	N/A

[9] ASTM, 1999, Standard Test Method for Determining Sediment Concentration in Water Samples: American Society of Testing and Materials, D 3977-97, Vol. 11.02, pp. 389-394.

[10] The current SAFIT STEs (28 November 2006) list requirements for both the Level I and Level II taxonomic effort, and are located at: http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf. When new editions are published by SAFIT, they will supersede all previous editions. All editions will be posted at the State Water Board's SWAMP website.

ATTACHMENT F:
Active Treatment System (ATS) Requirements

Table 1 – Numeric Effluent Limitations, Numeric Action Levels, Test Methods, Detection Limits, and Reporting Units

Parameter	Test Method	Discharge Type	Min. Detection Limit	Units	Numeric Action Level	Numeric Effluent Limitation
Turbidity	EPA 0180.1 and/or field test with a calibrated portable instrument	For ATS discharges	1	NTU	N/A	10 NTU for Daily Flow-Weighted Average & 20 NTU for Any Single Sample

A. Dischargers choosing to implement an Active Treatment System (ATS) on their site shall comply with all of the requirements in this Attachment.

B. The discharger shall maintain a paper copy of each ATS specification onsite in compliance with the record retention requirements in the Special Provisions of this General Permit.

C. ATS Design, Operation and Submittals

1. The ATS shall be designed and approved by a Certified Professional in Erosion and Sediment Control (CPESC), a Certified Professional in Storm Water Quality (CPSWQ); a California registered civil engineer; or any other California registered engineer.

2. The discharger shall ensure that the ATS is designed in a manner to preclude the accidental discharge of settled floc[1] during floc pumping or related operations.

3. The discharger shall design outlets to dissipate energy from concentrated flows.

4. The discharger shall install and operate an ATS by assigning a lead person (or project manager) who has either a minimum of five years construction storm

[1] Floc is defined as a clump of solids formed by the chemical action in ATS systems.

water experience or who is a licensed contractors specifically holding a California Class A Contractors license.[2]

5. The discharger shall prepare an ATS Plan that combines the site-specific data and treatment system information required to safely and efficiently operate an ATS. The ATS Plan shall be electronically submitted to the State Water Board at least 14 days prior to the planned operation of the ATS and a paper copy shall be available onsite during ATS operation. At a minimum, the ATS Plan shall include:

   a. ATS Operation and Maintenance Manual for All Equipment.

   b. ATS Monitoring, Sampling & Reporting Plan, including Quality Assurance/Quality Control (QA/QC).

   c. ATS Health and Safety Plan.

   d. ATS Spill Prevention Plan.

6. The ATS shall be designed to capture and treat (within a 72-hour period) a volume equivalent to the runoff from a 10-year, 24-hour storm event using a watershed runoff coefficient of 1.0.

D. Treatment – Chemical Coagulation/Flocculation

1. Jar tests shall be conducted using water samples selected to represent typical site conditions and in accordance with ASTM D2035-08 (2003).

2. The discharger shall conduct, at minimum, six site-specific jar tests (per polymer with one test serving as a control) for each project to determine the proper polymer and dosage levels for their ATS.

3. Single field jar tests may also be conducted during a project if conditions warrant, for example if construction activities disturb changing types of soils, which consequently cause change in storm water and runoff characteristics.

E. Residual Chemical and Toxicity Requirements

1. The discharger shall utilize a residual chemical test method that has a method detection limit (MDL) of 10% or less than the maximum allowable threshold

[2] Business and Professions Code Division 3, Chapter 9, Article 4, Class A Contractor: A general engineering contractor is a contractor whose principal contracting business is in connection with fixed works requiring specialized engineering knowledge and skill. [http://www.cslb.ca.gov/General-Information/library/licensing-classifications.asp].

concentration[3] (MATC) for the specific coagulant in use and for the most sensitive species of the chemical used.

2. The discharger shall utilize a residual chemical test method that produces a result within one hour of sampling.

3. The discharger shall have a California State certified laboratory validate the selected residual chemical test. Specifically the lab will review the test protocol, test parameters, and the detection limit of the coagulant. The discharger shall electronically submit this documentation as part of the ATS Plan.

4. If the discharger cannot utilize a residual chemical test method that meets the requirements above, the discharger shall operate the ATS in Batch Treatment[4] mode.

5. A discharger planning to operate in Batch Treatment mode shall perform toxicity testing in accordance with the following:

   a. The discharger shall initiate acute toxicity testing on effluent samples representing effluent from each batch prior to discharge[5]. All bioassays shall be sent to a laboratory certified by the Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP). The required field of testing number for Whole Effluent Toxicity (WET) testing is E113.[6]

   b. Acute toxicity tests shall be conducted with the following species and protocols. The methods to be used in the acute toxicity testing shall be those outlined for a 96-hour acute test in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012" for Fathead minnow, *Pimephales promelas* (fathead minnow). Acute toxicity for *Oncorhynchus mykiss* (Rainbow Trout) may be used as a substitute for testing fathead minnows.

   c. All toxicity tests shall meet quality assurance criteria and test acceptability criteria in the most recent versions of the EPA test method for WET testing.

   d. The discharger shall electronically report all acute toxicity testing.

---

[3] The Maximum Allowable Threshold Concentration (MATC) is the allowable concentration of residual, or dissolved, coagulant/flocculant in effluent. The MATC shall be coagulant/flocculant-specific, and based on toxicity testing conducted by an independent, third-party laboratory. A typical MATC would be:
The MATC is equal to the geometric mean of the NOEC (No Observed Effect Concentration) and LOEC (Lowest Observed Effect Concentration) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant. The most sensitive species test shall be used to determine the MATC.
[4] Batch Treatment mode is defined as holding or recirculating the treated water in a holding basin or tank(s) until treatment is complete or the basin or storage tank(s) is full.
[5] This requirement only requires that the test be initiated prior to discharge.
[6] http://www.dhs.ca.gov/ps/ls/elap/pdf/FOT_Desc.pdf.

F. Filtration

1. The ATS shall include a filtration step between the coagulant treatment train and the effluent discharge. This is commonly provided by sand, bag, or cartridge filters, which are sized to capture suspended material that might pass through the clarifier tanks.

2. Differential pressure measurements shall be taken to monitor filter loading and confirm that the final filter stage is functioning properly.

G. Residuals Management

1. Sediment shall be removed from the storage or treatment cells as necessary to ensure that the cells maintain their required water storage (i.e., volume) capability.

2. Handling and disposal of all solids generated during ATS operations shall be done in accordance with all local, state, and federal laws and regulations.

H. ATS Instrumentation

1. The ATS shall be equipped with instrumentation that automatically measures and records effluent water quality data and flow rate.

2. The minimum data recorded shall be consistent with the Monitoring and Reporting requirements below, and shall include:

   a. Influent Turbidity

   b. Effluent Turbidity

   c. Influent pH

   d. Effluent pH

   e. Residual Chemical

   f. Effluent Flow rate

   g. Effluent Flow volume

3. Systems shall be equipped with a data recording system, such as data loggers or webserver-based systems, which records each measurement on a frequency no longer than once every 15 minutes.

4. Cumulative flow volume shall be recorded daily. The data recording system shall have the capacity to record a minimum of seven days continuous data.

5. Instrumentation systems shall be interfaced with system control to provide auto shutoff or recirculation in the event that effluent measurements exceed turbidity or pH.

6. The system shall also assure that upon system upset, power failure, or other catastrophic event, the ATS will default to a recirculation mode or safe shut down.

7. Instrumentation (flow meters, probes, valves, streaming current detectors, controlling computers, etc.) shall be installed and maintained per manufacturer's recommendations, which shall be included in the QA/QC plan.

8. The QA/QC plan shall also specify calibration procedures and frequencies, instrument method detection limit or sensitivity verification, laboratory duplicate procedures, and other pertinent procedures.

9. The instrumentation system shall include a method for controlling coagulant dose, to prevent potential overdosing. Available technologies include flow/turbidity proportional metering, periodic jar testing and metering pump adjustment, and ionic charge measurement controlling the metering pump.

I. ATS Effluent Discharge

1. ATS effluent shall comply with all provisions and prohibitions in this General Permit, specifically the NELs.

2. NELs for discharges from an ATS:

   a. Turbidity of all ATS discharges shall be less than 10 NTU for daily flow-weighted average of all samples and 20 NTU for any single sample.

   b. Residual Chemical shall be < 10% of MATC[7] for the most sensitive species of the chemical used.

[7] The Maximum Allowable Threshold Concentration (MATC) is the allowable concentration of residual, or dissolved, coagulant/flocculant in effluent. The MATC shall be coagulant/flocculant-specific, and based on toxicity testing conducted by an independent, third-party laboratory. The MATC is equal to the geometric mean of the NOEC (No Observed Effect Concentration) and LOEC (Lowest Observed Effect Concentration) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant. The most sensitive species test shall be used to determine the MATC.

3. If an analytical effluent sampling result exceeds the turbidity NEL (as listed in Table 1), the discharger is in violation of this General Permit and shall electronically file the results in violation within 24-hours of obtaining the results.

4. If ATS effluent is authorized to discharge into a sanitary sewer system, the discharger shall comply with any pre-treatment requirements applicable for that system. The discharger shall include any specific criteria required by the municipality in the ATS Plan.

5. Compliance Storm Event:

   Discharges of storm water from ATS shall comply with applicable NELs (above) unless the storm event causing the discharges is determined after the fact to be equal to or larger than the Compliance Storm Event (expressed in inches of rainfall). The Compliance Storm Event for ATS discharges is the 10 year, 24 hour storm, as determined using these maps:

   http://www.wrcc.dri.edu/pcpnfreq/nca10y24.gif
   http://www.wrcc.dri.edu/pcpnfreq/sca10y24.gif

   This exemption is dependent on the submission of rain gauge data verifying the storm event is equal to or larger than the Compliance Storm.

J. Operation and Maintenance Plan

1. Each Project shall have a site-specific Operation and Maintenance (O&M) Manual covering the procedures required to install, operate and maintain the ATS.[8]

2. The O&M Manual shall only be used in conjunction with appropriate project-specific design specifications that describe the system configuration and operating parameters.

3. The O&M Manual shall have operating manuals for specific pumps, generators, control systems,and other equipment.

K. Sampling and Reporting Quality Assurance/ Quality Check (QA/QC) Plan

4. A project-specific QA/QC Plan shall be developed for each project. The QA/QC Plan shall include at a minimum:

   a. Calibration – Calibration methods and frequencies for all system and field instruments shall be specified.

[8] The manual is typically in a modular format covering generalized procedures for each component that is utilized in a particular system.

b. Method Detection Limits (MDLs) – The methods for determining MDLs shall be specified for each residual coagulant measurement method. Acceptable minimum MDLs for each method, specific to individual coagulants, shall be specified.

c. Laboratory Duplicates – Requirements for monthly laboratory duplicates for residual coagulant analysis shall be specified.

L. Personnel Training

1. Operators shall have training specific to using an ATS and liquid coagulants for storm water discharges in California.

2. The training shall be in the form of a formal class with a certificate and requirements for testing and certificate renewal.

3. Training shall include a minimum of eight hours classroom and 32 hours field training. The course shall cover the following topics:

   a. Coagulation Basics –Chemistry and physical processes

   b. ATS System Design and Operating Principles

   c. ATS Control Systems

   d. Coagulant Selection – Jar testing, dose determination, etc.

   e. Aquatic Safety/Toxicity of Coagulants, proper handling and safety

   f. Monitoring, Sampling, and Analysis

   g. Reporting and Recordkeeping

   h. Emergency Response

M. Active Treatment System (ATS) Monitoring Requirements

Any discharger who deploys an ATS on their site shall conduct the following:

1. Visual Monitoring

   a. A designated responsible person shall be on site daily at all times during treatment operations.

b. Daily on-site visual monitoring of the system for proper performance shall be conducted and recorded in the project data log.

   i. The log shall include the name and phone number of the person responsible for system operation and monitoring.

   ii. The log shall include documentation of the responsible person's training.

2. Operational and Compliance Monitoring

   a. Flow shall be continuously monitored and recorded at not greater than 15-minute intervals for total volume treated and discharged.

   b. Influent and effluent pH must be continuously monitored and recorded at not greater than 15-minute intervals.

   c. Influent and effluent turbidity (expressed in NTU) must be continuously monitored and recorded at not greater than 15-minute intervals.

   d. The type and amount of chemical used for pH adjustment, if any, shall be monitored and recorded.

   e. Dose rate of chemical used in the ATS system (expressed in mg/L) shall be monitored and reported 15-minutes after startup and every 8 hours of operation.

   f. Laboratory duplicates – monthly laboratory duplicates for residual coagulant analysis must be performed and records shall be maintained onsite.

   g. Effluent shall be monitored and recorded for residual chemical/additive levels.

   h. If a residual chemical/additive test does not exist and the ATS is operating in a batch treatment mode of operation refer to the toxicity monitoring requirements below.

3. Toxicity Monitoring

   A discharger operating in batch treatment mode shall perform toxicity testing in accordance with the following:

   a. The discharger shall initiate acute toxicity testing on effluent samples representing effluent from each batch prior to discharge.[9] All bioassays shall be sent to a laboratory certified by the Department of Health Services (DHS)

[9] This requirement only requires that the test be initiated prior to discharge.

Environmental Laboratory Accreditation Program (ELAP). The required field of testing number for Whole Effluent Toxicity (WET) testing is E113.[10]

b. Acute toxicity tests shall be conducted with the following species and protocols. The methods to be used in the acute toxicity testing shall be those outlined for a 96-hour acute test in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012" for Fathead minnow, *Pimephales promelas or* Rainbow trout *Oncorhynchus mykiss* may be used as a substitute for fathead minnow.

c. All toxicity tests shall meet quality assurance criteria and test acceptability criteria in the most recent versions of the EPA test method for WET testing.[11]

4. Reporting and Recordkeeping

At a minimum, every 30 days a LRP representing the discharger shall access the State Water Boards Storm Water Mulit-Application and Report Tracking system (SMARTS) and electronically upload field data from the ATS. Records must be kept for three years after the project is completed .

5. Non-compliance Reporting

a. Any indications of toxicity or other violations of water quality objectives shall be reported to the appropriate regulatory agency as required by this General Permit.

b. Upon any measurements that exceed water quality standards, the system operator shall immediately notify his supervisor or other responsible parties, who shall notify the Regional Water Board.

c. If any monitoring data exceeds any applicable NEL in this General Permit, the discharger shall electronically submit a NEL Violation Report to the State Water Board within 24 hours after the NEL exceedance has been identified.

i. ATS dischargers shall certify each NEL Violation Report in accordance with the Special Provisions for Construction Activity in this General Permit.

ii. ATS dischargers shall retain an electronic or paper copy of each NEL Violation Report for a minimum of three years after the date the annual report is filed.

iii. ATS dischargers shall include in the NEL Violation Report:

[10] http://www.dhs.ca.gov/ps/ls/elap/pdf/FOT_Desc.pdf.
[11] http://www.epa.gov/waterscience/methods/wet/.

(1) The analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as “less than the method detection limit”);

(2) The date, place, time of sampling, visual observation (inspections), and/or measurements, including precipitation; and

(3) A description of the current onsite BMPs, and the proposed corrective actions taken to manage the NEL exceedance.

iv. Compliance Storm Exemption - In the event that an applicable NEL has been exceeded during a storm event equal to or larger than the Compliance Storm Event, ATS dischargers shall report the on-site rain gauge reading and nearby governmental rain gauge readings for verification.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Version 8/17/2011												
2		**Risk Determination Worksheet**											
3													
4			**Step 1**	Determine Sediment Risk via one of the options listed:									
5				1. GIS Map Method - EPA Rainfall Erosivity Calculator & GIS map									
6				2. Individual Method - EPA Rainfall Erosivity Calculator & Individual Data									
7			**Step 2**	Determine Receiving Water Risk via one of the options listed:									
8				1. GIS map of Sediment Sensitive Watersheds provided									
9				2. Site Specific Analysis (support documentation required)									
10			**Step 3**	Determine Combined Risk Level									
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

	A	B	C
1	**Sediment Risk Factor Worksheet**		**Entry**
2	**A) R Factor**		
3	Analyses of data indicated that when factors other than rainfall are held constant, soil loss is directly proportional to a rainfall factor composed of total storm kinetic energy (E) times the maximum 30-min intensity (I30) (Wischmeier and Smith, 1958). The numerical value of R is the average annual sum of EI30 for storm events during a rainfall record of at least 22 years. "Isoerodent" maps were developed based on R values calculated for more than 1000 locations in the Western U.S. Refer to the link below to determine the R factor for the project site.		
4	http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm		
5	**R Factor Value**		0
6	**B) K Factor (weighted average, by area, for all site soils)**		
7	The soil-erodibility factor K represents: (1) susceptibility of soil or surface material to erosion, (2) transportability of the sediment, and (3) the amount and rate of runoff given a particular rainfall input, as measured under a standard condition Fine-textured soils that are high in clay have low K values (about 0.05 to 0.15) because the particles are resistant to detachment. Coarse-textured soils, such as sandy soils, also have low K values (about 0.05 to 0.2) because of high infiltration resulting in low runoff even though these particles are easily detached. Medium-textured soils, such as a silt loam, have moderate K values (about 0.25 to 0.45) because they are moderately susceptible to particle detachment and they produce runoff at moderate rates. Soils having a high silt content are especially susceptible to erosion and have high K values, which can exceed 0.45 and can be as large as 0.65. Silt-size particles are easily detached and tend to crust, producing high rates and large volumes of runoff. Use Site-specific data must be submitted.		
8	Site-specific K factor guidance		
9	**K Factor Value**		0
10	**C) LS Factor (weighted average, by area, for all slopes)**		
11	The effect of topography on erosion is accounted for by the LS factor, which combines the effects of a hillslope-length factor, L, and a hillslope-gradient factor, S. Generally speaking, as hillslope length and/or hillslope gradient increase, soil loss increases. As hillslope length increases, total soil loss and soil loss per unit area increase due to the progressive accumulation of runoff in the downslope direction. As the hillslope gradient increases, the velocity and erosivity of runoff increases. Use the LS table located in separate tab of this spreadsheet to determine LS factors. Estimate the weighted LS for the site prior to construction.		
12	LS Table		
13	**LS Factor Value**		0
14			
15	**Watershed Erosion Estimate (=RxKxLS) in tons/acre**	0	
16	**Site Sediment Risk Factor**	**Low**	
17	Low Sediment Risk: < 15 tons/acre		
18	Medium Sediment Risk: >=15 and <75 tons/acre		
19	High Sediment Risk: >= 75 tons/acre		
20			
21			
22			
23	**GIS Map Method:**		
24	**1.** The R factor for the project is calculated using the online calculator at:		
25	http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm		
26			
27	**2**. The K and LS factors may be obtained by accessing the GIS maps located on the State Water Board FTP website at:		
28	ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/		
29			

Receiving Water (RW) Risk Factor Worksheet	Entry	Score
A. Watershed Characteristics	**yes/no**	
A.1. Does the disturbed area discharge (either directly or indirectly) to a **303(d)-listed waterbody impaired by sediment** (For help with impaired waterbodies please visit the link below) or has a **USEPA approved TMDL implementation plan for sediment**?:	**no**	**Low**
http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml		
OR		
A.2. Does the disturbed area discharge to a waterbody with designated beneficial uses of SPAWN & COLD & MIGRATORY? (For help please review the appropriate Regional Board Basin Plan)		
http://www.waterboards.ca.gov/waterboards_map.shtml		
Region 1 Basin Plan		
Region 2 Basin Plan		
Region 3 Basin Plan		
Region 4 Basin Plan		
Region 5 Basin Plan		
Region 6 Basin Plan		
Region 7 Basin Plan		
Region 8 Basin Plan		
Region 9 Basin Plan		

Combined Risk Level Matrix

Receiving Water Risk	Sediment Risk: Low	Sediment Risk: Medium	Sediment Risk: High
Low	Level 1	Level 2	
High	Level 2		Level 3

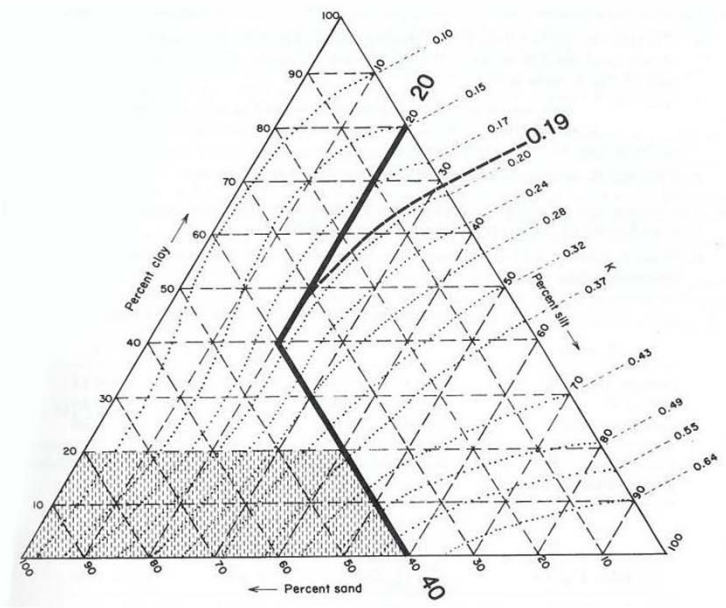
Project Sediment Risk: **Low**

Project RW Risk: **Low**

Project Combined Risk: **Level 1**

Soil Erodibility Factor (K)

The K factor can be determined by using the nomograph method, which requires that a particle size analysis (ASTM D-422) be done to determine the percentages of sand, very fine sand, silt and clay. Use the figure below to determine appropriate K value.



Erickson triangular nomograph used to estimate soil erodibility (K) factor.
The figure above is the USDA nomograph used to determine the K factor for a soil, based on its texture (% silt plus very fine sand, % sand, % organic matter, soil structure, and permeability). *Nomograph from Erickson 1977 as referenced in Goldman et. al., 1986.*

Sheet Flow Length (ft)	Average Watershed Slope (%)																		
	0.2	**0.5**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**8.0**	**10.0**	**12.0**	**14.0**	**16.0**	**20.0**	**25.0**	**30.0**	**40.0**	**50.0**	**60.0**
<3	0.05	0.07	0.09	0.13	0.17	0.20	0.23	0.26	0.32	0.35	0.36	0.38	0.39	0.41	0.45	0.48	0.53	0.58	0.63
6	0.05	0.07	0.09	0.13	0.17	0.20	0.23	0.26	0.32	0.37	0.41	0.45	0.49	0.56	0.64	0.72	0.85	0.97	1.07
9	0.05	0.07	0.09	0.13	0.17	0.20	0.23	0.26	0.32	0.38	0.45	0.51	0.56	0.67	0.80	0.91	1.13	1.31	1.47
12	0.05	0.07	0.09	0.13	0.17	0.20	0.23	0.26	0.32	0.39	0.47	0.55	0.62	0.76	0.93	1.08	1.37	1.62	1.84
15	0.05	0.07	0.09	0.13	0.17	0.20	0.23	0.26	0.32	0.40	0.49	0.58	0.67	0.84	1.04	1.24	1.59	1.91	2.19
25	0.05	0.07	0.10	0.16	0.21	0.26	0.31	0.36	0.45	0.57	0.71	0.85	0.98	1.24	1.56	1.86	2.41	2.91	3.36
50	0.05	0.08	0.13	0.21	0.30	0.38	0.46	0.54	0.70	0.91	1.15	1.40	1.64	2.10	2.67	3.22	4.24	5.16	5.97
75	0.05	0.08	0.14	0.25	0.36	0.47	0.58	0.69	0.91	1.20	1.54	1.87	2.21	2.86	3.67	4.44	5.89	7.20	8.37
100	0.05	0.09	0.15	0.28	0.41	0.55	0.68	0.82	1.10	1.46	1.88	2.31	2.73	3.57	4.59	5.58	7.44	9.13	10.63
150	0.05	0.09	0.17	0.33	0.50	0.68	0.86	1.05	1.43	1.92	2.51	3.09	3.68	4.85	6.30	7.70	10.35	12.75	14.89
200	0.06	0.10	0.18	0.37	0.57	0.79	1.02	1.25	1.72	2.34	3.07	3.81	4.56	6.04	7.88	9.67	13.07	16.16	18.92
250	0.06	0.10	0.19	0.40	0.64	0.89	1.16	1.43	1.99	2.72	3.60	4.48	5.37	7.16	9.38	11.55	15.67	19.42	22.78
300	0.06	0.10	0.20	0.43	0.69	0.98	1.28	1.60	2.24	3.09	4.09	5.11	6.15	8.23	10.81	13.35	18.17	22.57	26.51
400	0.06	0.11	0.22	0.48	0.80	1.14	1.51	1.90	2.70	3.75	5.01	6.30	7.60	10.24	13.53	16.77	22.95	28.60	33.67
600	0.06	0.12	0.24	0.56	0.96	1.42	1.91	2.43	3.52	4.95	6.67	8.45	10.26	13.94	18.57	23.14	31.89	39.95	47.18
800	0.06	0.12	0.26	0.63	1.10	1.65	2.25	2.89	4.24	6.03	8.17	10.40	12.69	17.35	23.24	29.07	40.29	50.63	59.93
1000	0.06	0.13	0.27	0.69	1.23	1.86	2.55	3.30	4.91	7.02	9.57	12.23	14.96	20.57	27.66	34.71	48.29	60.84	72.15

LS Factors for Construction Sites. *Table from Renard et. al., 1997.*

APPENDIX 2:
Post-Construction Water Balance Performance Standard Spreadsheet

The discharger shall submit with their Notice of Intent (NOI) the following information to demonstrate compliance with the New and Re-Development Water Balance Performance Standard.

Map Instructions

The discharger must submit a small-scale topographic map of the site to show the existing contour elevations, pre- and post-construction drainage divides, and the total length of stream in each watershed area. Recommended scales include 1 in. = 20 ft., 1 in. = 30 ft., 1 in. = 40 ft., or 1 in = 50 ft. The suggested contour interval is usually 1 to 5 feet, depending upon the slope of the terrain. The contour interval may be increased on steep slopes. Other contour intervals and scales may be appropriate given the magnitude of land disturbance.

Spreadsheet Instructions

The intent of the spreadsheet is to help dischargers calculate the project-related increase in runoff volume and select impervious area and runoff reduction credits to reduce the project-related increase in runoff volume to pre-project levels.

The discharger has the option of using the spreadsheet (**Appendix 2.1)** or a more sophisticated, watershed process-based model (e.g. Storm Water Management Model, Hydrological Simulation Program Fortran) to determine the project-related increase in runoff volume.

In* Appendix 4.1**, ***you must complete the worksheet for each land use/soil type combination for each project sub-watershed.

Steps 1 through 9 pertain specifically to the Runoff Volume Calculator:

Step 1: Enter the county where the project is located in cell H3.

Step 2: Enter the soil type in cell H6.

Step 3: Enter the existing pervious (dominant) land use type in cell H7.

Step 4: Enter the proposed pervious (dominant) land use type in cell H8.

Step 5: Enter the total project site area in cell H11 or J11.

Step 6: Enter the sub-watershed area in cell H12 or J12.

Step 7: Enter the existing rooftop area in cell H17 or J17, the existing non-rooftop impervious area in cell H18 or J18, the proposed rooftop area in cell H19 or J19, and the proposed non-rooftop impervious area in cell H20 or J20

Step 8: Work through each of the impervious area reduction credits and claim credits where applicable. Volume that cannot be addressed using non-structural practices must be captured in structural practices and approved by the Regional Water Board.

Step 9: Work through each of the impervious volume reduction credits and claim credits where applicable. Volume that cannot be addressed using non-structural practices must be captured in structural practices and approved by the Regional Water Board.

Non-structural Practices Available for Crediting

- ***Porous Pavement***
- ***Tree Planting***
- ***Downspout Disconnection***
- ***Impervious Area Disconnection***
- ***Green Roof***
- ***Stream Buffer***
- ***Vegetated Swales***
- ***Rain Barrels and Cisterns***
- ***Landscaping Soil Quality***

Post-Construction Water Balance Calculator

User may make changes from any cell that is orange or brown in color (similar to the cells to the immediate right). Cells in green are calculated for you.

(Step 1a) If you know the 85th percentile storm event for your location enter it in the box below

(Step 1b) If you can not answer 1a then select the county where the project is located (click on the cell to the right for drop-down): This will determine the average 85th percentile 24 hr. storm event for your site, which will appear under precipitation to left.

SACRAMENTO

(Step 1c) If you would like a more percise value select the location closest to your site. If you do not recgonize any of these locations, leave this drop-down menu at location. The average value for the County will be used.

SACRAMENTO FAA ARPT

Project Information		***Runoff Calculations***		
Project Name:	***Optional***	(Step 2) Indicate the Soil Type (dropdown menu to right):	***Group C Soils***	**Low infiltration. Sandy clay loam. Infiltration rate 0.05 to 0.15 inch/hr when wet.**
Waste Discharge Identification (WDID):	***Optional***	(Step 3) Indicate the existing **dominant** non-built land Use Type (dropdown menu to right):	***Wood & Grass: <50% ground cover***	
Date:	***Optional***	(Step 4) Indicate the proposed **dominant** non-built land Use Type (dropdown menu to right):	***Lawn, Grass, or Pasture covering more than 75% of the open space***	
Sub Drainage Area Name (from map):	***Optional***		**Complete Either**	

Runoff Curve Numbers			**Sq Ft**	**Acres**	**Acres**
Existing Pervious Runoff Curve Number	**82**	*(Step 5) Total Project Site Area:*		**5.00**	**5.00**
Proposed Development Pervious Runoff Curve Number	**74**	*(Step 6) Sub-watershed Area:*		**5.00**	**5.00**
Design Storm		*Percent of total project :*	**100%**		
Based on the County you indicated above, we have included the 85 percentile average 24 hr event - P85 (in)^ for your area.	**0.62** **in**				
The Amount of rainfall needed for runoff to occur (Existing runoff curve number -P from existing RCN (in)^)	**0.44** **In**	***(Step 7) Sub-watershed Conditions***	**Complete Either**		**Calculated Acres**
P used for calculations (in) (the greater of the above two criteria)	**0.62** **In**	Sub-watershed Area (acres)	**Sq Ft**	**Acres**	**5.00**
^Available at www.cabmphandbooks.com		Existing Rooftop Impervious Coverage		**0**	**0.00**
		Existing Non-Rooftop Impervious Coverage		**0**	**0.00**
		Proposed Rooftop Impervious Coverage		**0**	**0.00**
		Proposed Non-Rooftop Impervious Coverage		**0**	**0.00**
		Credits	**Acres**		**Square Feet**
		Porous Pavement	**0.00**		**0**
		Tree Planting	**0.00**		**0**
Pre-Project Runoff Volume (cu ft)	**247** **Cu.Ft.**	Downspout Disconnection	**0.00**		**0**
Project-Related Runoff Volume Increase w/o credits (cu ft)	**0** **Cu.Ft.**	Impervious Area Disconnection	**0.00**		**0**
		Green Roof	**0.00**		**0**
		Stream Buffer	**0.00**		**0**
Project-Related Volume Increase with Credits (cu ft)	**0** **Cu.Ft.**	Vegetated Swales	**0.00**		**0**
		Subtotal	**0.00**		**0**
		Subtotal Runoff Volume Reduction Credit	**0 Cu. Ft.**		
You have achieved your minimum requirements		***(Step 9) Impervious Volume Reduction Credits***	**Volume (cubic feet)**		
		Rain Barrels/Cisterns	**0 Cu. Ft.**		
		Soil Quality	**0 Cu. Ft.**		
		Subtotal Runoff Volume Reduction	**0 Cu. Ft.**		
		Total Runoff Volume Reduction Credit	**0 Cu. Ft.**		

Porous Pavement Credit Worksheet

Please fill out a porous pavement credit worksheet for each project sub-watershed.

For the PROPOSED Development:

Proposed Porous Pavement	Runoff Reduction*	Fill in either Acres or SqFt In SqFt.	In Acres	Equivalent Acres
Area of **Brick without Grout** on less than 12 inches of base with at least 20% void space over soil	0.45			0.00
Area of **Brick without Grout** on more than 12 inches of base with at least 20% void space over soil	0.90			0.00
Area of **Cobbles** less than 12 inches deep and over soil	0.30			0.00
Area of **Cobbles** less than 12 inches deep and over soil	0.60			0.00
Area of **Reinforced Grass Pavement** on less than 12 inches of base with at least 20% void space over soil	0.45			0.00
Area of **Reinforced Grass Pavement** on at least 12 inches of base with at least 20% void space over soil	0.90			0.00
Area of **Porous Gravel Pavement** on less than 12 inches of base with at least 20% void space over soil	0.38			0.00
Area of **Porous Gravel Pavement** on at least 12 inches of base with at least 20% void space over soil	0.75			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with less than 4 inches of gravel base (washed stone)	0.40			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 4 to 8 inches of gravel base (washed stone)	0.60			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 8 to 12 inches of gravel base (washed stone)	0.80			0.00
Area of **Poured Porous Concrete or Asphalt Pavement** with 12 or more inches of gravel base (washed stone)	1.00			0.00

*=1-Rv**

Return to Calculator

**Using Site Design Techniques to meet Development Standards for Stormwater Quality (BASMAA 2003)

**NCDENR Stormwater BMP Manual (2007)

Tree Planting Credit Worksheet

Please fill out a tree canopy credit worksheet for each project sub-watershed.

Tree Canopy Credit Criteria	Number of Trees Planted	Credit (acres)
Number of proposed evergreen trees to be planted (credit = number of trees x 0.005)*	0	0.00
Number of proposed deciduous trees to be planted (credit = number of trees x 0.0025)*		0.00
	Square feet Under Canopy	
Square feet under an existing tree canopy, that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is LESS than 12 in diameter.		0.00
Square feet under an existing tree canopy that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is 12 in diameter or GREATER.		0.00
Please describe below how the project will ensure that these trees will be maintained.		

0

Return to Calculator

* credit amount based on credits from Stormwater Quality Design Manual for the Sacramento and South Placer Regions

Downspout Disconnection Credit Worksheet

Please fill out a downspout disconnection credit worksheet for each project subwatershed. If you answer yes to all questions, all rooftop area draining to each downspout will be subtracted from your proposed rooftop impervious coverage.

Downspout Disconnection Credit Criteria					
Do downspouts and any extensions extend at least six feet from a basement and two feet from a crawl space or concrete slab?				○ Yes	◉ No
Is the area of rooftop connecting to each disconnected downspout 600 square feet or less?				○ Yes	◉ No
Is the roof runoff from the design storm event fully contained in a raised bed or planter box or does it drain as sheet flow to a landscaped area large enough to contain the roof runoff from the design storm event?				○ Yes	◉ No
The Stream Buffer and/or Vegetated Swale credits **will not** be taken in this sub-watershed area?				○ Yes	◉ No
Percentage of existing	0.00	Acres	of rooftop surface has disconnected downspouts		
Percentage of the proposed	0.00	Acres	of rooftop surface has disconnected downspouts	50	
				Return to Calculator	

Impervious Area Disconnection Credit Worksheet

Please fill out an impervious area disconnection credit worksheet for each project sub-watershed. If you answer yes to all questions, all non-rooftop impervious surface area will be subtracted from your proposed non-rooftop impervious coverage.

Non-Rooftop Disconnection Credit Criteria	Response
Is the maximum contributing impervious flow path length less than 75 feet or, if equal or greater than 75 feet, is a storage device (e.g. French drain, bioretention area, gravel trench) implemented to achieve the required disconnection length?	◉ Yes ○ No
Is the impervious area to any one discharge location less than 5,000 square feet?	◉ Yes ○ No
The Stream Buffer credit **will not** be taken in this sub-watershed area?	◉ Yes ○ No

Percentage of existing	0.00	Acres non-rooftop surface area disconnected	
Percentage of the proposed	0.00	Acres non-rooftop surface area disconnected	70

Return to Calculator

Green Roof Credit Worksheet

Please fill out a greenroof credit worksheet for each project sub-watershed. If you answer yes to all questions, 70% of the greenroof area will be subtracted from your proposed rooftop impervious coverage.

Green Roof Credit Criteria	Response
Is the roof slope less than 15% or does it have a grid to hold the substrate in place until it forms a thick vegetation mat?	◉ Yes ○ No
Has a professional engineer assessed the necessary load reserves and designed a roof structure to meet state and local codes?	◉ Yes ○ No
Is the irrigation needed for plant establishment and/or to sustain the green roof during extended dry periods, is the source from stored, recycled, reclaimed, or reused water?	◉ Yes ○ No
Percentage of existing 0.00 Acres rooftop surface area in greenroof	
Percentage of the proposed 0.00 Acres rooftop surface area in greenroof	

Return to Calculator

Stream Buffer Credit Worksheet

Please fill out a stream buffer credit worksheet for each project sub-watershed. If you answer yes to all questions, you may subtract all impervious surface draining to each stream buffer that has not been addressed using the Downspout and/or Impervious Area Disconnection credits.

Stream Buffer Credit Criteria				Response
Does runoff enter the floodprone width* or within 500 feet (whichever is larger) of a stream channel as sheet flow**?				○ Yes ◉ No
Is the contributing overland slope 5% or less, or if greater than 5%, is a level spreader used?				○ Yes ◉ No
Is the buffer area protected from vehicle or other traffic barriers to reduce compaction?				○ Yes ◉ No
Will the stream buffer be maintained in an ungraded and uncompacted condition and will the vegetation be maintained in a natural condition?				○ Yes ◉ No
Percentage of existing	0.00	Acres	impervious surface area draining into a stream buffer:	
Percentage of the proposed	0.00	Acres	impervious surface area that will drain into a stream buffer:	
Please describe below how the project will ensure that the buffer areas will remain in ungraded and uncompacted condition and that the vegetation will be maintained in a natural condition.				

Return to Calculator

* floodprone width is the width at twice the bankfull depth.
** the maximum contributing length shall be 75 feet for impervious area

Vegetated Swale Credit Worksheet

Please fill out a vegetated swale worksheet for each project subwatershed. If you answer yes to all questions, you may subtract all impervious surface draining to each stream buffer that has not been addressed using the Downspout Disconnection credit.

Vegetated Swale Credit Criteria

Have all vegetated swales been designed in accordance with Treatment Control BMP 30 (TC-30 - Vegetated Swale) from the California Stormwater BMP Handbook, New Development and Redevelopment (available at www.cabmphandbooks.com)?	○ Yes ◉ No
Is the maximum flow velocity for runoff from the design storm event less than or equal to 1.0 foot per second?	○ Yes ◉ No

Percentage of existing	0.00	Acres of impervious area draining to a vegetated swale	
Percentage of the proposed	0.00	Acres of impervious area draining to a vegetated swale	

Return to Calculator

Rain Barrel/Cistern Credit Worksheet

Please fill out a rain barrel/cistern worksheet for each project sub-watershed.

Rain Barrel/Cistern Credit Criteria	Response
Total number of rain barrel(s)/cisterns	
Average capacity of rain barrel(s)/cistern(s) (in gallons)	
Total capacity rain barrel(s)/cistern(s) (in cu ft) [1]	0

[1] accounts for 10% loss

Return to Calculator

Please fill out a soil quality worksheet for each project sub-watershed.

	Response
Will the landscaped area be lined with an impervious membrane?	
Will the soils used for landscaping meet the ideal bulk densities listed in Table 1 below? [1]	○ Yes ◉ No
If you answered yes to the question above, and you know the area-weighted bulk density within the top 12 inches for soils used for landscaping (in g/cm^3)* , fill in the cell to the right and skip to cell G11. If not select from the drop-down menu in G10.	1.3
If you answered yes to the question above, but you do not know the exact bulk density, which of the soil types in the drop down menu to the right best describes the top 12 inches for soils used for landscaping (in g/cm^3).	Sandy loams, loams
What is the average depth of your landscaped soil media meeting the above criteria (inches)?	12
What is the total area of the landscaped areas meeting the above criteria (in acres)?	2.97

Return to Calculator

Table 1

Sands, loamy sands	<1.6
Sandy loams, loams	<1.4
Sandy clay loams, loams, clay loams	<1.4
Silts, silt loams	<1.3
Silt loams, silty clay loams	<1.1
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.1
Clays (>45% clay)	<1.1

Porosity (%) 50.94%

Mineral grains in many soils are mainly quartz and feldspar, so 2.65 a good average for particle density. To determine percent porosity, use the formula: Porosity (%) = (1-Bulk Density/2.65) X 100

[1] USDA NRCS. "Soil Quality Urban Technical Note No.2-Urban Soil Compaction". March 2000. http://soils.usda.gov/sqi/management/files/sq_utn_2.pdf

* To determine how to calculate density see: http://www.globe.gov/tctg/bulkden.pdf?sectionID=94

APPENDIX 3
Bioassessment Monitoring Guidelines

Bioassessment monitoring is required for projects that meet all of the following criteria:

1. The project is rated Risk Level 3 or LUP Type 3
2. The project directly discharges runoff to a freshwater wadeable stream (or streams) that is either: (a) listed by the State Water Board or USEPA as impaired due to sediment, and/or (b) tributary to any downstream water body that is listed for sediment; and/or have the beneficial use SPAWN & COLD & MIGRATORY
3. Total project-related ground disturbance exceeds 30 acres.

For all such projects, the discharger shall conduct bioassessment monitoring, as described in this section, to assess the effect of the project on the biological integrity of receiving waters.
Bioassessment shall include:

1. The collection and reporting of specified instream biological data
2. The collection and reporting of specified instream physical habitat data

<u>Bioassessment Exception</u>
If a site qualifies for bioassessment, but construction commences out of an index period for the site location, the discharger shall:

1. Receive Regional Water Board approval for the sampling exception
2. Make a check payable to: Cal State Chico Foundation (SWAMP Bank Account) or San Jose State Foundation (SWAMP Bank Account) and include the WDID# on the check for the amount calculated for the exempted project.
3. Send a copy of the check to the Regional Water Board office for the site's region
4. Invest **7,500.00 X The number of samples required** into the SWAMP program as compensation (upon Regional Water Board approval).
5. Conduct bioassessment monitoring, as described in Appendix 4
6. Include the collection and reporting of specified instream biological data and physical habitat
7. Use the bioassessment sample collection and Quality Assurance & Quality Control (QA/QC) protocols developed by the State of California's Surface Water Ambient Monitoring Program (SWAMP)

<u>Site Locations and Frequency</u>
Macroinvertebrate samples shall be collected both before ground disturbance is initiated and after the project is completed. The "after" sample(s) shall be collected after at least one winter season resulting in surface runoff has transpired after project-related ground disturbance has ceased. "Before" and "after" samples shall be collected both upstream and downstream of the project's

discharge. Upstream samples should be taken immediately before the sites outfall and downstream samples should be taken immediately after the outfall (when safe to collect the samples). Samples should be collected for each freshwater wadeable stream that is listed as impaired due to sediment, or tributary to a water body that is listed for sediment. Habitat assessment data shall be collected concurrently with all required macroinvertebrate samples.

Index Period (Timing of Sample Collection)
Macroinvertebrate sampling shall be conducted during the time of year (i.e., the "index period") most appropriate for bioassessment sampling, depending on ecoregion. This map is posted on the State Water Board's Website: http://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.shtml

Field Methods for Macroinvertebrate Collections
In collecting macroinvertebrate samples, the discharger shall use the "Reachwide Benthos (Multi-habitat) Procedure" specified in *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California* (Ode 2007).[1]

Physical - Habitat Assessment Methods
The discharger shall conduct, concurrently with all required macroinvertebrate collections, the "Full" suite of physical habitat characterization measurements as specified in *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California* (Ode 2007), and as summarized in the Surface Water Ambient Monitoring Program's *Stream Habitat Characterization Form — Full Version*.

Laboratory Methods
Macroinvertebrates shall be identified and classified according to the Standard Taxonomic Effort (STE) Level I of the Southwestern Association of Freshwater Invertebrate Taxonomists (SAFIT),[2] and using a fixed-count of 600 organisms per sample.

Quality Assurance
The discharger or its consultant(s) shall have and follow a quality assurance (QA) plan that covers the required bioassessment monitoring. The QA plan shall include, or be supplemented to include, a specific requirement for external QA checks (i.e., verification of taxonomic identifications and correction of data where

---

[1] This document is available on the Internet at: ~~http://www.swrcb.ca.gov/swamp/docs/phab_sopr6.pdf~~. http://swamp.mpsl.mlml.calstate.edu/wp-content/uploads/2009/04/swamp_sop_bioassessment_collection_020107.pdf.

[2] The current SAFIT STEs (28 November 2006) list requirements for both the Level I and Level II taxonomic effort, and are located at: ~~http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf~~ http://www.safit.org/Docs/ste_list.pdf. When new editions are published by SAFIT, they will supersede all previous editions. All editions will be posted at the State Water Board's SWAMP website.

errors are identified). External QA checks shall be performed on one of the discharger's macroinvertebrate samples collected per calendar year, or ten percent of the samples per year (whichever is greater). QA samples shall be randomly selected. The external QA checks shall be paid for by the discharger, and performed by the California Department of Fish and Game's Aquatic Bioassessment Laboratory. An alternate laboratory with equivalent or better expertise and performance may be used if approved in writing by State Water Board staff.

Sample Preservation and Archiving

The original sample material shall be stored in 70 percent ethanol and retained by the discharger until: 1) all QA analyses specified herein and in the relevant QA plan are completed; and 2) any data corrections and/or re-analyses recommended by the external QA laboratory have been implemented. The remaining subsampled material shall be stored in 70 percent ethanol and retained until completeness checks have been performed according to the relevant QA plan. The identified organisms shall be stored in 70 percent ethanol, in separate glass vials for each final ID taxon. (For example, a sample with 45 identified taxa would be archived in a minimum of 45 vials, each containing all individuals of the identified taxon.) Each of the vials containing identified organisms shall be labeled with taxonomic information (i.e., taxon name, organism count) and collection information (i.e., site name/site code, waterbody name, date collected, method of collection). The identified organisms shall be archived (i.e., retained) by the discharger for a period of not less than three years from the date that all QA steps are completed, and shall be checked at least once per year and "topped off" with ethanol to prevent desiccation. The identified organisms shall be relinquished to the State Water Board upon request by any State Water Board staff.

Data Submittal

The macroinvertebrate results (i.e., taxonomic identifications consistent with the specified SAFIT STEs, and number of organisms within each taxa) shall be submitted to the State Water Board in electronic format. The State Water Board's Surface Water Ambient Monitoring Program (SWAMP) is currently developing standardized formats for reporting bioassessment data. All bioassessment data collected after those formats become available shall be submitted using the SWAMP formats. Until those formats are available, the biological data shall be submitted in MS-Excel (or equivalent) format.[3]

The physical/habitat data shall be reported using the standard format titled *SWAMP Stream Habitat Characterization Form — Full Version*.[4]

[3] Any version of Excel, 2000 or later, may be used.
[4] Available at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/fieldforms_fullversion052908.pdf

Invasive Species Prevention

In conducting the required bioassessment monitoring, the discharger and its consultants shall take precautions to prevent the introduction or spread of aquatic invasive species. At minimum, the discharger and its consultants shall follow the recommendations of the California Department of Fish and Game to minimize the introduction or spread of the New Zealand mudsnail.[5]

[5] Instructions for controlling the spread of NZ mudsnails, including decontamination methods, can be found at: http://www.dfg.ca.gov/invasives/mudsnail/
More information on AIS More information on AIS
http://www.waterboards.ca.gov/water_issues/programs/swamp/ais/

Appendix 4 Non Sediment TMDLs

Region 1 Lost River-DIN and CBOD

Region 1 Source: Cal Trans Construction TMDL Completion Date: 12 30 2008 TMDL Type: River, Lake Watershed Area= 2996 mi^2	**Pollutant Stressors/WLA**	
	Dissolved inorganic nitrogen (DIN) (metric tons/yr)	**Carbonaceous biochemical oxygen demand (CBOD) (metric tons/yr)**
Lost River from the Oregon border to Tule Lake	.1	.2
Tule Lake Refuge	.1	.2
Lower Klamath Refuge	.1	.2

Region 2 San Francisco Bay-Mercury

Region 2 Source:Non-Urban Stormwater Runoff TMDL Type: Bay	**Name**	**Pollutant Stressor/WLA**	**TMDL Completion Date**
	San Francisco Bay	Mercury 25 kg/year	08 09 2006

Region 4 Ballona Creek-Metals and Selenium

Region 4 Source: NPDES General Construction TMDL Completion Date: 12 22 2005 TMDL Type: Creek	**Pollutant Stressors/WLA**							
	Copper (Cu)		**Lead (Pb)**		**Selenium (Se)**		**Zinc (Zn)**	
	g/day	g/day/acre	g/day	g/day/acre	g/day	g/day/acre	g/day	g/day/acre
Ballona Creek	4.94E-07 x Daily storm volume (L)	2.20E-10 x Daily storm volume (L)	1.62E-06 x Daily storm volume (L)	7.20E-10 x Daily storm volume (L)	1.37E-07 x Daily storm volume (L)	6.10E-11 x Daily storm volume (L)	3.27E-06 x Daily storm volume (L)	1.45E-09 x Daily storm volume (L)

General Construction Storm Water Permits:
Waste load allocations will be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board.

- Dry-weather Implementation Non-storm water flows authorized by the General Permit for Storm Water Discharges Associated with Construction Activity (Water Quality Order No. 99-08 DWQ), or any successor order, are exempt from the dry-weather waste load allocation equal to zero as long as they comply with the provisions of sections C.3 and A.9 of the Order No. 99-08 DWQ, which state that these authorized non-storm discharges shall be:
  (1) infeasible to eliminate
  (2) comply with BMPs as described in the Storm Water Pollution Prevention Plan prepared by the permittee, and
  (3) not cause or contribute to a violation of water quality standards, or comparable provisions in any successor order.
  Unauthorized non-storm water flows are already prohibited by Order No. 99-08 DWQ.
- Wet-weather Implementation Within seven years of the effective date of the TMDL, the construction industry will submit the results of BMP effectiveness studies to determine BMPs that will achieve compliance with the final waste load allocations assigned to construction storm water permittees.
- Regional Board staff will bring the recommended BMPs before the Regional Board for consideration within eight years of the effective date of the TMDL.
- General construction storm water permittees will be considered in compliance with final waste load allocations if they implement these Regional Board approved BMPs. All permittees must implement the approved BMPs within nine years of the effective date of the TMDL. If no effectiveness studies are conducted and no BMPs are approved by the Regional Board within eight years of the effective date of the TMDL, each general construction storm water permit holder will be subject to site-specific BMPs and monitoring requirements to demonstrate compliance with final waste load allocations.

Region 4 Calleaguas Creek-OC Pesticides, PCBs, and Siltation

Interim Requirements

Region 4 Calleaguas Creek Source: Minor NPDES point sources/WDRs TMDL Completion Date: 3 14 2006 TMDL Type:Creek	**Pollutant Stressor**	**WLA Daily Max (µg/L)**	**WLA Monthly Ave (µg/L)**
	Chlordane	1.2	0.59
	4,4-DDD	1.7	0.84
	4,4-DDE	1.2	0.59
	4,4-DDT	1.2	0.59
	Dieldrin	0.28	0.14
	PCB's	0.34	0.17
	Toxaphene	0.33	0.16

Final WLA (ng/g)							
Region 4 Calleaguas Creek Source: Stormwater Permittees TMDL Completion Date: 3 14 2006 TMDL Type:Creek	Chlordane	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	PCB's	Toxaphene
Mugu Lagoon*	3.3	2.0	2.2	0.3	4.3	180.0	360.0
Callegaus Creek	3.3	2.0	1.4	0.3	0.2	120.0	0.6
Revolon Slough (SW)*	0.9	2.0	1.4	0.3	0.1	130.0	1.0
Arroyo Las posas(SW)*	3.3	2.0	1.4	0.3	0.2	120.0	0.6
Arroyo Simi	3.3	2.0	1.4	0.3	0.2	120.0	0.6
Conejo Creek	3.3	2.0	1.4	0.3	0.2	120.0	0.6
Interim Requirements (ng/g)							
Mugu Lagoon*	25.0	69.0	300.0	39.0	19.0	180.	22900.0
Callegaus Creek	17.0	66.0	470.0	110.0	3.0	3800.0	260.0
Revolon Slough (SW)*	48.0	400.0	1600.0	690.0	5.7	7600.0	790.0
Arroyo Las posas(SW)*	3.3	290.0	950.0	670.0	1.1	25700.0	230.0
Arroyo Simi	3.3	14.0	170.0	25.0	1.1	25700.0	230.0
Conejo Creek	3.4	5.3	20.0	2.0	3.0	3800.0	260.0

*(SW)=Subwatershed
*Mugu Lagoon includes Duck pond/Agricultural Drain/Mugu/Oxnard Drain #2
Compliance with sediment based WLAs is measured as an instream annual average at the base of each subwatershed where the discharges are located.

Region 4 Calleguas Creek-Salts

Final Dry Weather Pollutant WLA (mg/L)					
Region 4 Calleaguas Creek Source Permitted Stormwater Dischargers TMDL Completion Date: 12 2 2008 TMDL Type:Creek	**Critical Condition Flow Rate (mgd)**	**Chloride (lb/day)**	**TDS (lb/day)**	**Sulfate (lb/day)**	**Boron (lb/day)**
Simi	1.39	1738.0	9849.0	2897.0	12.0
Las Posas	0.13	157.0	887.0	261.0	N/A
Conejo	1.26	1576.0	8931.0	2627.0	N/A

Camarillo	0.06	72.0	406.0	119.0	N/A
Pleasant Valley (Calleguas)	0.12	150.0	850.0	250.0	N/A
Pleasant Valley (Revolon)	0.25	314.0	1778.0	523.0	2.0

Dry Weather Interim Pollutant WLA (mg/L)				
	Chloride (mg/L)	**TDS (mg/L)**	**Sulfate (mg/L)**	**Boron (mg/L)**
Simi	230.0	1720.0	1289.0	1.3
Las Posas	230.0	1720.0	1289.0	1.3
Conejo	230.0	1720.0	1289.0	1.3
Camarillo	230.0	1720.0	1289.0	1.3
Pleasant Valley (Calleguas)	230.0	1720.0	1289.0	1.3
Pleasant Valley (Revolon)	230.0	1720.0	1289.0	1.3

- General Construction permittees are assigned a dry weather wasteload allocation equal to the average dry weather critical condition flow rate multiplied by the numeric target for each constituent. Waste load allocations apply in the receiving water at the base of each subwatershed. Dry weather allocations apply when instream flow rates are below the 86th percentile flow and there has been no measurable precipitation in the previous 24 hours.
- Because wet weather flows transport a large mass of salts at low concentrations, these dischargers meet water quality objectives during wet weather.
- Interim limits are assigned for dry weather discharges from areas covered by NPDES stormwater permits to allow time to implement appropriate actions. The interim limits are assigned as concentration based receiving water limits set to the 95th percentile of the discharger data as a monthly average limit except for chloride. The 95th percentile for chloride was 267 mg/L which is higher than the recommended criteria set forth in the Basin Plan for protection of sensitive beneficial uses including aquatic life. Therefore, the interim limit for chloride for Permitted Stormwater Dischargers is set equal to 230 mg/L to ensure protection of sensitive beneficial uses in the Calleguas Creek watershed.

Region 4 San Gabriel River and Tributaries-Metals and Selenium

Region 4 San Gabriel River and Tributaries Source: Construction Stormwater Dischargers TMDL Completion Date: 3 2007 TMDL Type: Creek	**Pollutant Stressor**	**Wet weather Allocations**	**Dry Weather Allocations**	**% of Watershed**

San Gabriel Reach 2	Lead (Pb)	0.7% * 166 µg/l * Daily Storm Vol	N/A	0.7%
San Gabriel Reach 2	Lead (Pb) Mass based	0.8 kg/d	N/A	0.7%
Coyote Creek	Copper (Cu)	0.285 kg/d	0	5.0%
Coyote Creek	Lead (Pb)	1.70 kg/d	N/A	5.0%
Coyote Creek	Zinc (Zn)	2.4 kg/d	N/A	5.0%
San Jose Creek Reach 1 and 2	Selenium	5 µg/L	5 µg/L	5.0%

Wet-weather allocations for lead in San Gabriel River Reach 2. Concentration-based allocations apply to non-stormwater NPDES discharges. Stormwater allocations are expressed as a percent of load duration curve. Mass-based values presented in table are based on a flow of 260 cfs (daily storm volume = 6.4 $x10^8$ liters).

There are 1555 acres of water in the entire watershed, 37.4 acres of water in the Reach 1 subwatershed (2.4%), and 269 acres in the Coyote Creek subwatershed (17%).

General Construction Storm Water Permits

Waste load allocations for the general construction storm water permits may be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board. An estimate of direct atmospheric deposition is developed based on the percent area of surface water in the watershed. Approximately 0.4% of the watershed area draining to San Gabriel River Reach 2 is comprised of water and approximately 0.2% of the watershed area draining to Coyote Creek is comprised of water.

Region 4 The Harbor Beaches of Ventura County-Bacteria

The TMDL has a multi-part numeric target based on the bacteriological water quality objectives for marine water to protect the water contact recreation use. These targets are the most appropriate indicators of public health risk in recreational waters. Bacteriological objectives are set forth in Chapter 3 of the Basin Plan. The objectives are based on four bacteria indicators and include both geometric mean limits and single sample limits. The Basin Plan objectives that serve as the numeric targets for this TMDL are:

The General NPDES Construction permit is seen as a minor contributor and is given no allocation

General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR permittees in the Channel Islands Harbor subwatershed are assigned WLAs of zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean. Any future enrollees under a general NPDES permit, individual NPDES permit, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR will also be subject to a WLA of zero (0) days of allowable exceedances.

Region 4 Resolution No. 03-009 Los Angeles River and Tributaries-Nutrients

Minor Point Sources
Waste loads are allocated to minor point sources enrolled under NPDES or WDR permits including but not limited to Tapia WRP, Whittier Narrows WRP, Los Angeles Zoo WRP, industrial and construction stormwater, and municipal storm water and urban runoff from municipal separate storm sewer systems (MS4s)

Region 4 Minor Point Sources for NPDES/WDR Permits TMDL Completion Date: 7 10 2003 TMDL Type: River	Pollutant Stressor/WLA				
	Total Ammonia (NH_3)		**Nitrate-nitrogen (NO_3-N)**	**Nitrite-nitrogen (NO_2-N)**	**NO_3-N + NO_3-N**
	1 Hr Ave mg/l	30 Day Ave mg/l	30 Day Ave mg/l		30 Day Ave mg/l
LA River Above Los Angeles-Glendale WRP (LAG)	4.7	1.6	8.0	1.0	8.0
LA River Below LAG	8.7	2.4	8.0	1.0	8.0
Los Angeles Tributaries	10.1	2.3	8.0	1.0	8.0

Malibu Creek Attachment A to Resolution No. 2004-019R-Bacteria

12 13 2004 The WLAs for permittees under the NPDES General Stormwater Construction Permit are zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean.

Region 4 Marina del Rey Harbor, Mothers' Beach and Back Basins

Attachment A to Resolution No. 2003-012-Bacteria

8 7 2003 As discussed in "Source Analysis", discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria. Therefore, the WLAs for these discharges are zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean. Any future enrollees under a general NPDES permit, general industrial storm water permit or general construction storm water permit within the MdR Watershed will also be subject to a WLA of zero days of allowable exceedances.

Region 4 San Gabriel River and Tributaries-Metals and Selenium

Dry Weather Selenium WLA
A zero WLA is assigned to the industrial and construction stormwater permits during dry weather. Non-storm water discharges are already prohibited or restricted by existing general permits.

Region 4 General Construction Permittees TMDL Completion Date: 7 13 2006 TMDL Type: River	**Total Recoverable Metals (kg/day)**		
	Copper (Cu) Kg/day	**Lead (Pb) Kg/day**	**Zinc (Zn) Kg/day**
San Gabriel River Reach 2 and upstream reaches/tributaries	**XXXX**	Daily storm volume x 1.24 µg/L	**XXXX**
Coyote Creek and Tributaries	Daily storm volume x 0.7 µg/L	Daily storm volume x 4.3 µg/L	Daily storm volume x 6.2 µg/L

Each enrollee under the general construction stormwater permit receives a WLA on a per acre basis

Region 4 General Construction Permittees TMDL Completion Date: 7 13 2006 TMDL Type: River	**Total Recoverable Metals (kg/day/acre)**		
	Copper (Cu) Kg/acre/day	**Lead (Pb) Kg/acre/day**	**Zinc (Zn) Kg/acre/day**
San Gabriel River Reach 2 and upstream reaches/tributaries	**XXXX**	Daily storm volume x 0.56 µg/L	**XXXX**

Coyote Creek and Tributaries	Daily storm volume x 0.12 µg/L	Daily storm volume x 0.70 µg/L	Daily storm volume x 1.01 µg/L

For the general industrial and construction storm water permits, the daily storm volume is measured at USGS station 11085000 for discharges to Reach 2 and above and at LACDPW flow gauge station F354-R for discharges to Coyote Creek.

General construction storm water permits
WLAs will be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board.
Dry-weather implementation
Non-storm water flows authorized by the General Permit for Storm Water Discharges Associated with Construction Activity (NPDES Permit No. CAS000002), or any successor permit, are exempt from the dry-weather WLA equal to zero as long as they comply with the provisions of sections C.3.and A.9 of the Order No. 99-08 DWQ, which state that these authorized non-storm discharges shall be (1) infeasible to eliminate (2) comply with BMPs as described in the Storm Water Pollution Prevention Plan prepared by the permittee, and (3) not cause or contribute to a violation of water quality standards, or comparable provisions in any successor order. Unauthorized non-storm water flows are already prohibited by Permit No. CAS000002.

Upon permit issuance, renewal, or re-opener
Non-storm water flows not authorized by Order No. 99-08 DWQ, or any successor order, shall achieve dry-weather WLAs. WLAs shall be expressed as NPDES water quality-based effluent limitations specified in accordance with federal regulations and state policy on water quality control. Effluent limitations may be expressed as permit conditions, such as the installation, maintenance, and monitoring of Regional Board-approved BMPs.

Six years from the effective date of the TMDL
The construction industry will submit the results of wet-weather BMP effectiveness studies to the Los Angeles Regional Board for consideration. In the event that no effectiveness studies are conducted and no BMPs are approved, permittees shall be subject to site-specific BMPs and monitoring to demonstrate BMP effectiveness.

Seven years from the effective date of the TMDL
The Los Angeles Regional Board will consider results of the wet weather BMP effectiveness studies and consider approval of BMPs.

Eight years from the effective date of the TMDL
All general construction storm water permittees shall implement Regional Board-approved BMPs.

Total Maximum Daily Loads (TMDLs) for San Diego Creek,
Upper and Lower Newport Bay, Orange County, California

Region 8 NPDES Construction Permit TMDL Completion Date: 1 24 1995 TMDL Type: River. Cr, Bay	Organochlorine Compounds							
	Total DDT		**Chlordane**		**Total PCBs**		**Toxaphene**	
	g/day	g/yr	g/day	g/yr	g/day	g/yr	g/day	g/yr
San Diego Creek	.27	99.8	**.18***	**64.3***	**.09***	**31.5***	.004	1.5
Upper Newport Bay	.11	40.3	.06	23.4	.06	23.2	**X**	**X**
Lower Newport Bay	.04	14.9	.02	8.6	.17	60.7	**X**	**X**

*Red= Informational WLA only, not for enforcement purposes

Organochlorine Compounds TMDLs Implementation Tasks and Schedule

Regional Board staff shall develop a SWPPP Improvement Program that identifies the Regional Board's expectations with respect to the content of SWPPPs, including documentation regarding the selection and implementation of BMPs, and a sampling and analysis plan. The Improvement Program shall include specific guidance regarding the development and implementation of monitoring plans, including the constituents to be monitored, sampling frequency and analytical protocols. The SWPPP Improvement Program shall be completed by (*the date of OAL approval of this BPA*). ***No later than two months*** from completion of the Improvement Program, Board staff shall assure that the requirements of the Program are communicated to interested parties, including dischargers with existing authorizations under the General Construction Permit. Existing, authorized dischargers shall revise their project SWPPPs as needed to address the Program requirements as soon as possible but ***no later than (three months of completion of the SWPPP Improvement Program)***. Applicable SWPPPs that do not adequately address the Program requirements shall be considered inadequate and enforcement by the Regional Board shall proceed accordingly. The Caltrans and Orange County MS4 permits shall be revised as needed to assure that the permittees communicate the Regional Board's SWPPP expectations, based on the SWPPP Improvement Program, with the Standard Conditions of Approval.

Appendix 4 Sediment TMDLs

Implemented Sediment TMDLs in California. Construction was listed as a source in all fo these TMDLs in relation to road construction. Although construction was mentioned as a source, it was not given a specific allocation amount. The closest allocation amount would be for the road activity management WLA. **Implementation Phase** – Adoption process by the Regional Board, the State Water Resources Control Board, the Office of Administrative Law, and the US Environmental Protection Agency completed and TMDL being implemented.

A. Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres**	**WLA** tons mi^2 yr
1 R1.epa.albionfinaltmdl	R	Albion River	Sedimentation	Road Construction	2001	43 acres	See A (table 6)

B Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres**	**WLA** tons mi^2 yr
1 R1.epa.EelR-middle.mainSed.temp	R	Middle Main Eel River and Tributaries (from Dos Rios to the South Fork)	Sedimentation	Road Construction	2005-2006	521 mi^2	100

C Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres**	**WLA** tons mi^2 yr
1 R1.epa.EelRsouth.sed.temp	R	South Fork Eel River	Sedimentation	Road Construction	12 1999	See chart	473

D Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres**	**WLA** tons mi^2 yr
1 R1.epa.bigfinaltmdl	R	Big River	Sedimentation	Road Construction	12 2001	181 mi^2 watershed drainage	TMDL = loading capacity = nonpoint sources + background =

							393 t mi2 yr

E Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres	WLA tons mi^2 yr
1 R1.epa.EelR-lower.Sed.temp-121807-signed	R	Lower Eel River	Sedimentation	Road Construction	12 2007	300 square-mile watershed	898

F Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres	WLA tons mi^2 yr
1 R1.epa.EelR-middle.Sed.temp-	R	Middle Fork Eel River	Sedimentation	Road Construction	12 2003	753 mi^2 (approx. 482,000 acres)	82

G Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres Mi^2	WLA tons mi^2 yr
1 R1.epa.EelRnorth-Sed.temp.final-121807-signed	R	North Fork Eel River	Sedimentation	Road Construction	12 30 2002	289 (180,020 acres)	20

H Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres Mi^2	WLA tons mi^2 yr
1 R1.epa.EelR-upper.mainSed.temp-	R	Upper Main Eel River and Tributaries (including Tomki Creek, Outlet Creek and Lake Pillsbury)	Sedimentation	Road Construction	12 29 2004	688 (approx. 440,384 acres)	14

I Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres	WLA tons mi^2 yr
1 R1.epa.gualalafinaltmdl	R	Gualala River	Sedimentation	Road Construction	Not sure	300 (191,145 acres)	7

J Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres mi^2	WLA tons mi^2 yr
1 R1.epa.Mad-sed.turbidity	R	Mad River	Sedimentation	Road Construction	12 21 2007	480	174

K Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres mi^2	WLA tons mi^2 yr
1 R1.epa.mattole.sediment	R	Mattole River	Sedimentation	Road Construction	12 30 2003	296	27 or 520+27 = 547

L Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres mi^2	WLA tons mi^2 yr
1 R1.epa.navarro.sed.temp	R	Navarro River	Sedimentation	Road Construction	Not sure	315 (201,600 acres).	50

M Region	Type	Name	Pollutant Stressor	Potential Sources	TMDL Completion Date	Watershed Acres mi^2	WLA tons mi^2 yr
1 R1.epa.noyo.sediment	R	Noyo River	Sedimentation	Road Construction	12 16 1999	113 (72,323 acres)	68 (three areas measured) Table 16 in the TMDL

N Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA** tons mi^2 yr
1 R1.epa.RedwoodCk.sed	Cr	Redwood Creek	Sedimentation	Road Construction	12 30 1998	278	1900 Total allocation

O Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA – Roads** tons mi^2 yr
1 R1.epa.tenmile.sed	R	Ten Mile River	Sedimentation	Road Construction	2000	120	9

P Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA management** tons mi^2 yr
1 R1.epa.trinity.sed	R	Trinity River	Sedimentation	Road Construction	12 20 2001	2000 of 3000 covered in this TMDL	See rows below
1	Cr	Horse Linto Creek	Sedimentation	Road Construction	12 20 2001	64	528
1	Cr	Mill creek and Tish Tang	Sedimentation	Road Construction	12 20 2001	39	210
1	Cr	Willow Creek	Sedimentation	Road Construction	12 20 2001	43	94
1	Cr	Campbell Creek and Supply Creek	Sedimentation	Road Construction	12 20 2001	11	1961
1	Cr	Lower Mainstem and Coon Creek	Sedimentation	Road Construction	12 20 2001	32	63
1	R	Reference	Sedimentation	Road	12 20 2001	434	24

		Subwatershed [1]		Construction			
1	Cr	Canyon Creek	Sedimentation	Road Construction	12 20 2001	64	326
1	R	Upper Tributaries[2]	Sedimentation	Road Construction	12 20 2001	72	67
1	R	Middle Tributaries[3]	Sedimentation	Road Construction	12 20 2001	54	53
1	R	Lower Tributaries[4]	Sedimentation	Road Construction	12 20 2001	96	55
1	Cr	Weaver and Rush Creeks	Sedimentation	Road Construction	12 20 2001	72	169
1	Cr	Deadwood Creek Hoadley Gulch Poker Bar	Sedimentation	Road Construction	12 20 2001	47	68
1	L	Lewiston Lake	Sedimentation	Road Construction	12 20 2001	25	49
1	Cr	Grassvalley Creek	Sedimentation	Road Construction	12 20 2001	37	44
1	Cr	Indian Creek	Sedimentation	Road Construction	12 20 2001	34	81
1	Cr	Reading and Browns Creek	Sedimentation	Road Construction	12 20 2001	104	66
1	Cr	Reference Subwatersheds[5]	Sedimentation	Road Construction	12 20 2001	235	281
1	L, Cr	Westside tributaries[6]	Sedimentation	Road Construction	12 20 2001	93	105
1	R, Cr, G	Upper trinity[7]	Sedimentation	Road Construction	12 20 2001	161	690
1	R, Cr, G	East Fork Tributaries[8]	Sedimentation	Road Construction	12 20 2001	115	65

1
2
3
4
5
6
7
8

1	R, L	Eastside Tributaries[9]	Sedimentation	Road Construction	12 20 2001	89	60

1 New River, Big French, Manzanita, North Fork, East Fork, North Fork
2 Dutch, Soldier, Oregon gulch, Conner Creek
3 Big Bar, Prairie Creek, Little French Creek
4 Swede, Italian, Canadian, Cedar Flat, Mill, McDonald, Hennessy, Quimby, Hawkins, Sharber
5 Stuarts Fork, Swift Creek, Coffee Creek
6 Stuart Arm, Stoney Creek, Mule Creek, East Fork, Stuart Fork, West Side Trinity Lake, Hatchet Creek, Buckeye Creek,
7 Upper Trinity River, Tangle Blue, Sunflower, Graves, Bear Upper Trinity Mainstream, Ramshorn Creek, Ripple Creek, Minnehaha Creek, Snowslide Gulch, Scorpion Creek
8 East Fork Trinity, Cedar Creek, Squirrel Gulch
9 East Side Tributaries, Trinity Lake

Q Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA** tons mi^2 yr
1 R1.epa.trinity.so.sed	R, Cr	South Fork Trinity River and Hayfork Creek	Sedimentation	Road Construction	12 1998	Not given, 19 miles long	33 (road total)

R Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA** tons mi^2 yr
1 R1.epa.vanduzen.sed	R, Cr	Van Duzen River and Yager Creek	Sedimentation	Various	12 16 1999	429	1353 total allocation
1		Upper Basin	Sedimentation	Road Construction			7
1		Middle Basin	Sedimentation	Road Construction			22
1		Lower Basin	Sedimentation	Road Construction			20

S Region	**Type**	**Name**	**Pollutant Stressor**	**Potential**	**TMDL**	**Watershed**	**WLA** tons mi^2

[9] 2009-0009-DWQ as amended by 2010-0014-DWQ & 2012-0006-DWQ

				Sources	**Completion Date**	**Acres** mi^2	yr
6 R6.blackwood.sed	Cr	Blackwood Creek (Placer County)	Bedded Sediment	Various	9 2007	11	17272 total

T Region	**Type**	**Name**	**Pollutant Stressor**	**Potential Sources**	**TMDL Completion Date**	**Watershed Acres** mi^2	**WLA** tons mi^2 yr
6 R6.SquawCk.sed	R	Squaw Creek (Placer County)	Sedimentation /controllable sources	Various – basin plan amendment	4 13 2006	8.2	10,900

Adopted TMDLs for Construction Sediment Sources

Region	Type	Name	Pollutant Stressor	Potential Sources	**TMDL Completion Date**	**Watershed Area** mi^2	Waste load Allocation tons mi^2 yr
8	R	Newport Bay San Diego Creek Watershed	Sedimentation	Construction Land Development	1999	2.24 (1432 acres)	125,000 tons per Year (no more than 13,000 tons per year from construction sites)

APPENDIX 5:
Glossary

Active Areas of Construction
All areas subject to land surface disturbance activities related to the project including, but not limited to, project staging areas, immediate access areas and storage areas. All previously active areas are still considered active areas until final stabilization is complete. [The construction activity Phases used in this General Permit are the Preliminary Phase, Grading and Land Development Phase, Streets and Utilities Phase, and the Vertical Construction Phase.]

Active Treatment System (ATS)
A treatment system that employs chemical coagulation, chemical flocculation, or electrocoagulation to aid in the reduction of turbidity caused by fine suspended sediment.

Acute Toxicity Test
A chemical stimulus severe enough to rapidly induce a negative effect; in aquatic toxicity tests, an effect observed within 96 hours or less is considered acute.

Air Deposition
Airborne particulates from construction activities.

Approved Signatory
A person who has been authorized by the Legally Responsible Person to sign, certify, and electronically submit Permit Registration Documents, Notices of Termination, and any other documents, reports, or information required by the General Permit, the State or Regional Water Board, or U.S. EPA. The Approved Signatory must be one of the following:

1. For a corporation or limited liability company: a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (a) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation or limited liability company; or (b) the manager of the facility if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

2. For a partnership or sole proprietorship: a general partner or the proprietor, respectively;

3. For a municipality, State, Federal, or other public agency: a principal executive officer, ranking elected official, city manager, council president, or any other authorized public employee with managerial responsibility over the

construction or land disturbance project (including, but not limited to, project manager, project superintendent, or resident engineer);

4. For the military: any military officer or Department of Defense civilian, acting in an equivalent capacity to a military officer, who has been designated;

5. For a public university: an authorized university official;

6. For an individual: the individual, because the individual acts as both the Legally Responsible Person and the Approved Signatory; or

7. For any type of entity not listed above (e.g. trusts, estates, receivers): an authorized person with managerial authority over the construction or land disturbance project.

Beneficial Uses
As defined in the California Water Code, beneficial uses of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

Best Available Technology Economically Achievable (BAT)
As defined by USEPA, BAT is a technology-based standard established by the Clean Water Act (CWA) as the most appropriate means available on a national basis for controlling the direct discharge of toxic and nonconventional pollutants to navigable waters. The BAT effluent limitations guidelines, in general, represent the best existing performance of treatment technologies that are economically achievable within an industrial point source category or subcategory.

Best Conventional Pollutant Control Technology (BCT)
As defined by USEPA, BCT is a technology-based standard for the discharge from existing industrial point sources of conventional pollutants including biochemical oxygen demand (BOD), total suspended sediment (TSS), fecal coliform, pH, oil and grease.

Best Professional Judgment (BPJ)
The method used by permit writers to develop technology-based NPDES permit conditions on a case-by-case basis using all reasonably available and relevant data.

Best Management Practices (BMPs)
BMPs are scheduling of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants. BMPs also include treatment requirements, operating procedures,

and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Chain of Custody (COC)
Form used to track sample handling as samples progress from sample collection to the analytical laboratory. The COC is then used to track the resulting analytical data from the laboratory to the client. COC forms can be obtained from an analytical laboratory upon request.

Coagulation
The clumping of particles in a discharge to settle out impurities, often induced by chemicals such as lime, alum, and iron salts.

Common Plan of Development
Generally a contiguous area where multiple, distinct construction activities may be taking place at different times under one plan. A plan is generally defined as any piece of documentation or physical demarcation that indicates that construction activities may occur on a common plot. Such documentation could consist of a tract map, parcel map, demolition plans, grading plans or contract documents. Any of these documents could delineate the boundaries of a common plan area. However, broad planning documents, such as land use master plans, conceptual master plans, or broad-based CEQA or NEPA documents that identify potential projects for an agency or facility are not considered common plans of development.

Daily Average Discharge
The discharge of a pollutant measured during any 24-hour period that reasonably represents a calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged during the day. For pollutants with limitations expressed in other units of measurement (e.g., concentration) the daily discharge is calculated as the average measurement of the pollutant throughout the day (40 CFR 122.2). In the case of pH, the pH must first be converted from a log scale.

Debris
Litter, rubble, discarded refuse, and remains of destroyed inorganic anthropogenic waste.

Direct Discharge
A discharge that is routed directly to waters of the United States by means of a pipe, channel, or ditch (including a municipal storm sewer system), or through surface runoff.

Discharger
The Legally Responsible Person (see definition) or entity subject to this General Permit.

Dose Rate (for ATS)
In exposure assessment, dose (e.g. of a chemical) per time unit (e.g. mg/day), sometimes also called dosage.

Drainage Area
The area of land that drains water, sediment, pollutants, and dissolved materials to a common outlet.

Effluent
Any discharge of water by a discharger either to the receiving water or beyond the property boundary controlled by the discharger.

Effluent Limitation
Any numeric or narrative restriction imposed on quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into waters of the United States, the waters of the contiguous zone, or the ocean.

Erosion
The process, by which soil particles are detached and transported by the actions of wind, water, or gravity.

Erosion Control BMPs
Vegetation, such as grasses and wildflowers, and other materials, such as straw, fiber, stabilizing emulsion, protective blankets, etc., placed to stabilize areas of disturbed soils, reduce loss of soil due to the action of water or wind, and prevent water pollution.

Field Measurements
Testing procedures performed in the field with portable field-testing kits or meters.

Final Stabilization
All soil disturbing activities at each individual parcel within the site have been completed in a manner consistent with the requirements in this General Permit.

First Order Stream
Stream with no tributaries.

Flocculants
Substances that interact with suspended particles and bind them together to form flocs.

Good Housekeeping BMPs
BMPs designed to reduce or eliminate the addition of pollutants to construction site runoff through analysis of pollutant sources, implementation of proper handling/disposal practices, employee education, and other actions.

Grading Phase (part of the Grading and Land Development Phase)
Includes reconfiguring the topography and slope including; alluvium removals; canyon cleanouts; rock undercuts; keyway excavations; land form grading; and stockpiling of select material for capping operations.

Hydromodification
Hydromodification is the alteration of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources. Hydromodification can cause excessive erosion and/or sedimentation rates, causing excessive turbidity, channel aggradation and/or degradation.

Identified Organisms
Organisms within a sub-sample that is specifically identified and counted.

Inactive Areas of Construction
Areas of construction activity that are not active and those that have been active and are not scheduled to be re-disturbed for at least 14 days.

Index Period
The period of time during which bioassessment samples must be collected to produce results suitable for assessing the biological integrity of streams and rivers. Instream communities naturally vary over the course of a year,and sampling during the index period ensures that samples are collected during a time frame when communities are stable so that year-to-year consistency is obtained. The index period approach provides a cost-effective alternative to year-round sampling. Furthermore, sampling within the appropriate index period will yield results that are comparable to the assessment thresholds or criteria for a given region, which are established for the same index period. Because index periods differ for different parts of the state, it is essential to know the index period for your area.

K Factor
The soil erodibility factor used in the Revised Universal Soil Loss Equation (RUSLE). It represents the combination of detachability of the soil, runoff potential of the soil, and the transportability of the sediment eroded from the soil.

Legally Responsible Person
The Legally Responsible Person (LRP) will typically be the project proponent. The categories of persons or entities that are eligible to serve as the LRP are set forth below. For any construction or land disturbance project where multiple persons or entities are eligible to serve as the LRP, those persons or entities

shall select a single LRP. In exceptional circumstances, a person or entity that qualifies as the LRP may provide written authorization to another person or entity to serve as the LRP. In such a circumstance, the person or entity that provides the authorization retains all responsibility for compliance with the General Permit. Except as provided in category 2(d), a contractor who does not satisfy the requirements of any of the categories below is not qualified to be an LRP.

The following persons or entities may serve as an LRP:

1. A person, company, agency, or other entity that possesses a real property interest (including, but not limited to, fee simple ownership, easement, leasehold, or other rights of way) in the land upon which the construction or land disturbance activities will occur for the regulated site.

2. In addition to the above, the following persons or entities may also serve as an LRP:

    a. For linear underground/overhead projects, the utility company, municipality, or other public or private company or agency that owns or operates the LUP;

    b. For land controlled by an estate or similar entity, the person who has day-to-day control over the land (including, but not limited to, a bankruptcy trustee, receiver, or conservator);

    c. For pollution investigation and remediation projects, any potentially responsible party that has received permission to conduct the project from the holder of a real property interest in the land; or

    d. For U.S. Army Corp of Engineers projects, the U.S. Army Corps of Engineers may provide written authorization to its bonded contractor to serve as the LRP, provided, however, that the U.S. Army Corps of Engineers is also responsible for compliance with the general permit, as authorized by the Clean Water Act or the Federal Facilities Compliance Act.

Likely Precipitation Event
Any weather pattern that is forecasted to have a 50% or greater chance of producing precipitation in the project area. The discharger shall obtain likely precipitation forecast information from the National Weather Service Forecast Office (e.g., by entering the zip code of the project's location at http://www.srh.noaa.gov/forecast).

Maximum Allowable Threshold Concentration (MATC)
The allowable concentration of residual, or dissolved, coagulant/flocculant in effluent. The MATC shall be coagulant/flocculant-specific, and based on toxicity

testing conducted by an independent, third-party laboratory. A typical MATC would be:

The MATC is equal to the geometric mean of the NOEC (No Observed Effect Concentration) and LOEC (Lowest Observed Effect Concentration) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant. The most sensitive species test shall be used to determine the MATC.

Natural Channel Evolution
The physical trend in channel adjustments following a disturbance that causes the river to have more energy and degrade or aggrade more sediment. Channels have been observed to pass through 5 to 9 evolution types. Once they pass though the suite of evolution stages, they will rest in a new state of equilibrium.

Non-Storm Water Discharges
Discharges are discharges that do not originate from precipitation events. They can include, but are not limited to, discharges of process water, air conditioner condensate, non-contact cooling water, vehicle wash water, sanitary wastes, concrete washout water, paint wash water, irrigation water, or pipe testing water.

Non-Visible Pollutants
Pollutants associated with a specific site or activity that can have a negative impact on water quality, but cannot be seen though observation (ex: chlorine). Such pollutants being discharged are not authorized.

Numeric Action Level (NAL)
Level is used as a warning to evaluate if best management practices are effective and take necessary corrective actions. Not an effluent limit.

Original Sample Material
The material (i.e., macroinvertebrates, organic material, gravel, etc.) remaining after the subsample has been removed for identification.

pH
Unit universally used to express the intensity of the acid or alkaline condition of a water sample. The pH of natural waters tends to range between 6 and 9, with neutral being 7. Extremes of pH can have deleterious effects on aquatic systems.

Post-Construction BMPs
Structural and non-structural controls which detain, retain, or filter the release of pollutants to receiving waters after final stabilization is attained.

Preliminary Phase (Pre-Construction Phase - Part of the Grading and Land Development Phase)
Construction stage including rough grading and/or disking, clearing and grubbing operations, or any soil disturbance prior to mass grading.

Project

Qualified SWPPP Developer
Individual who is authorized to develop and revise SWPPPs.

Qualified SWPPP Practitioner
Individual assigned responsibility for non-storm water and storm water visual observations, sampling and analysis, and responsibility to ensure full compliance with the permit and implementation of all elements of the SWPPP, including the preparation of the annual compliance evaluation and the elimination of all unauthorized discharges.

Qualifying Rain Event
Any event that produces 0.5 inches or more precipitation with a 48 hour or greater period between rain events.

R Factor
Erosivity factor used in the Revised Universal Soil Loss Equation (RUSLE). The R factor represents the erosivity of the climate at a particular location. An average annual value of R is determined from historical weather records using erosivity values determined for individual storms. The erosivity of an individual storm is computed as the product of the storm's total energy, which is closely related to storm amount, and the storm's maximum 30-minute intensity.

Rain Event Action Plan (REAP)
Written document, specific for each rain event, that when implemented is designed to protect all exposed portions of the site within 48 hours of any likely precipitation event.

Remaining Sub sampled Material
The material (e.g., organic material, gravel, etc.) that remains after the organisms to be identified have been removed from the subsample for identification. (Generally, no macroinvertebrates are present in the remaining subsampled material, but the sample needs to be checked and verified using a complete Quality Assurance (QA) plan)

Routine Maintenance
Activities intended to maintain the original line and grade, hydraulic capacity, or original purpose of a facility.

Runoff Control BMPs
Measures used to divert runon from offsite and runoff within the site.

Run-on
Discharges that originate offsite and flow onto the property of a separate project site.

Revised Universal Soil Loss Equation (RUSLE)
Empirical model that calculates average annual soil loss as a function of rainfall and runoff erosivity, soil erodibility, topography, erosion controls, and sediment controls.

Sampling and Analysis Plan
Document that describes how the samples will be collected, under what conditions, where and when the samples will be collected, what the sample will be tested for, what test methods and detection limits will be used, and what methods/procedures will be maintained to ensure the integrity of the sample during collection, storage, shipping and testing (i.e., quality assurance/quality control protocols).

Sediment
Solid particulate matter, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sedimentation
Process of deposition of suspended matter carried by water, wastewater, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material.

Sediment Control BMPs
Practices that trap soil particles after they have been eroded by rain, flowing water, or wind. They include those practices that intercept and slow or detain the flow of storm water to allow sediment to settle and be trapped (e.g., silt fence, sediment basin, fiber rolls, etc.).

Settleable Solids (SS)
Solid material that can be settled within a water column during a specified time frame. It is typically tested by placing a water sample into an Imhoff settling cone and then allowing the solids to settle by gravity for a given length of time. Results are reported either as a volume (mL/L) or a mass (mg/L) concentration.

Sheet Flow
Flow of water that occurs overland in areas where there are no defined channels where the water spreads out over a large area at a uniform depth.

Site

Soil Amendment
Any material that is added to the soil to change its chemical properties, engineering properties, or erosion resistance that could become mobilized by storm water.

Streets and Utilities Phase
Construction stage including excavation and street paving, lot grading, curbs, gutters and sidewalks, public utilities, public water facilities including fire hydrants, public sanitary sewer systems, storm sewer system and/or other drainage improvements.

Structural Controls
Any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution

Suspended Sediment Concentration (SSC)
The measure of the concentration of suspended solid material in a water sample by measuring the dry weight of all of the solid material from a known volume of a collected water sample. Results are reported in mg/L.

Total Suspended Solids (TSS)
The measure of the suspended solids in a water sample includes inorganic substances, such as soil particles and organic substances, such as algae, aquatic plant/animal waste, particles related to industrial/sewage waste, etc. The TSS test measures the concentration of suspended solids in water by measuring the dry weight of a solid material contained in a known volume of a sub-sample of a collected water sample. Results are reported in mg/L.

Toxicity
The adverse response(s) of organisms to chemicals or physical agents ranging from mortality to physiological responses such as impaired reproduction or growth anomalies.

Turbidity
The cloudiness of water quantified by the degree to which light traveling through a water column is scattered by the suspended organic and inorganic particles it contains. The turbidity test is reported in Nephelometric Turbidity Units (NTU) or Jackson Turbidity Units (JTU).

Vertical Construction Phase
The Build out of structures from foundations to roofing, including rough landscaping.

Waters of the United States
Generally refers to surface waters, as defined by the federal Environmental Protection Agency in 40 C.F.R. § 122.2.[1]

Water Quality Objectives (WQO)
Water quality objectives are defined in the California Water Code as limits or levels of water quality constituents or characteristics, which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area.

[1] The application of the definition of "waters of the United States" may be difficult to determine; there are currently several judicial decisions that create some confusion. If a landowner is unsure whether the discharge must be covered by this General Permit, the landowner may wish to seek legal advice.

APPENDIX 6:
Acronym List

ASBS	Areas of Special Biological Significance
ASTM	American Society of Testing and Materials; Standard Test Method for Particle-Size Analysis of Soils
ATS	Active Treatment System
BASMAA	Bay Area Storm water Management Agencies Association
BAT	Best Available Technology Economically Achievable
BCT	Best Conventional Pollutant Control Technology
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
BPJ	Best Professional Judgment
CAFO	Confined Animal Feeding Operation
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CGP	NPDES General Permit for Storm Water Discharges Associated with Construction Activities
CIWQS	California Integrated Water Quality System
CKD	Cement Kiln Dust
COC	Chain of Custody
CPESC	Certified Professional in Erosion and Sediment Control
CPSWQ	Certified Professional in Storm Water Quality
CSMP	Construction Site Monitoring Program
CTB	Cement Treated Base
CTR	California Toxics Rule
CWA	Clean Water Act
CWC	California Water Code
CWP	Center for Watershed Protection
DADMAC	Diallyldimethyl-ammonium chloride
DDNR	Delaware Department of Natural Resources
DFG	Department of Fish and Game
DHS	Department of Health Services
DWQ	Division of Water Quality
EC	Electrical Conductivity
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
ESA	Environmentally Sensitive Area
ESC	Erosion and Sediment Control
HSPF	Hydrologic Simulation Program Fortran
JTU	Jackson Turbidity Units
LID	Low Impact Development
LOEC	Lowest Observed Effect Concentration
LRP	Legally Responsible Person
LUP	Linear Underground/Overhead Projects

MATC	Maximum Allowable Threshold Concentration
MDL	Method Detection Limits
MRR	Monitoring and Reporting Requirements
MS4	Municipal Separate Storm Sewer System
MUSLE	Modified Universal Soil Loss Equation
NAL	Numeric Action Level
NEL	Numeric Effluent Limitation
NICET	National Institute for Certification in Engineering Technologies
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effect Concentration
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTR	National Toxics Rule
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
PAC	Polyaluminum chloride
PAM	Polyacrylamide
PASS	Polyaluminum chloride Silica/sulfate
POC	Pollutants of Concern
PoP	Probability of Precipitation
POTW	Publicly Owned Treatment Works
PRDs	Permit Registration Documents
PWS	Planning Watershed
QAMP	Quality Assurance Management Plan
QA/QC	Quality Assurance/Quality Control
REAP	Rain Event Action Plan
Regional Board	Regional Water Quality Control Board
ROWD	Report of Waste Discharge
RUSLE	Revised Universal Soil Loss Equation
RW	Receiving Water
SMARTS	Storm water Multi Application Reporting and Tracking System
SS	Settleable Solids
SSC	Suspended Sediment Concentration
SUSMP	Standard Urban Storm Water Mitigation Plan
SW	Storm Water
SWARM	Storm Water Annual Report Module
SWAMP	Surface Water Ambient Monitoring Program
SWMM	Storm Water Management Model
SWMP	Storm Water Management Program
SWPPP	Storm Water Pollution Prevention Plan
TC	Treatment Control
TDS	Total Dissolved Solids

TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACOE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WDID	Waste Discharge Identification Number
WDR	Waste Discharge Requirements
WLA	Waste Load Allocation
WET	Whole Effluent Toxicity
WRCC	Western Regional Climate Center
WQBEL	Water Quality Based Effluent Limitation
WQO	Water Quality Objective
WQS	Water Quality Standard

APPENDIX 7:
State and Regional Water Resources Control Board Contacts

NORTH COAST REGION (1)
5550 Skylane Blvd, Ste. A
Santa Rose, CA 95403
(707) 576-2220 FAX: (707)523-0135

SAN FRANCISCO BAY REGION (2)
1515 Clay Street, Ste. 1400
Oakland, CA 94612
(510) 622-2300 FAX: (510) 622-2640

CENTRAL COAST REGION (3)
895 Aerovista Place, Ste 101
San Luis Obispo, CA 93401
(805) 549-3147 FAX: (805) 543-0397

LOS ANGELES REGION (4)
320 W. 4th Street, Ste. 200
Los Angeles, CA 90013
(213) 576-6600 FAX: (213) 576-6640

LAHONTAN REGION (6 SLT)
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150
(530) 542-5400 FAX: (530) 544-2271

VICTORVILLE OFFICE (6V)
14440 Civic Drive, Ste. 200
Victorville, CA 92392-2383
(760) 241-6583 FAX: (760) 241-7308

CENTRAL VALLEY REGION (5S)
11020 Sun Center Dr., #200
Rancho Cordova, CA 95670-6114
(916) 464-3291 FAX: (916) 464-4645

FRESNO BRANCH OFFICE (5F)
1685 E St.
Fresno, CA 93706
(559) 445-5116 FAX: (559) 445-5910

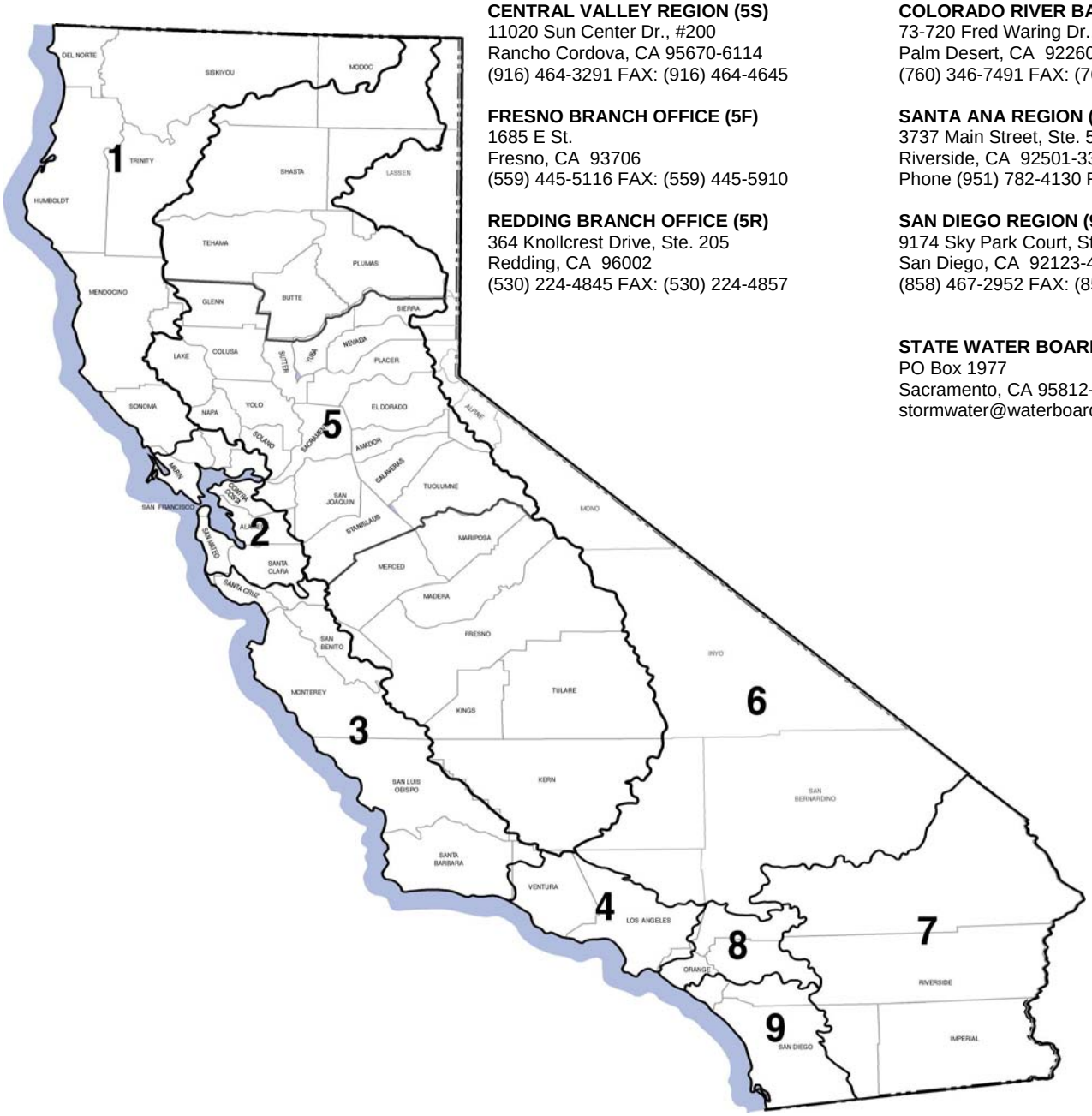
REDDING BRANCH OFFICE (5R)
364 Knollcrest Drive, Ste. 205
Redding, CA 96002
(530) 224-4845 FAX: (530) 224-4857

COLORADO RIVER BASIN REGION (7)
73-720 Fred Waring Dr., Ste. 100
Palm Desert, CA 92260
(760) 346-7491 FAX: (760) 341-6820

SANTA ANA REGION (8)
3737 Main Street, Ste. 500
Riverside, CA 92501-3339
Phone (951) 782-4130 FAX: (951) 781-6288

SAN DIEGO REGION (9)
9174 Sky Park Court, Ste. 100
San Diego, CA 92123-4340
(858) 467-2952 FAX: (858) 571-6972

STATE WATER BOARD
PO Box 1977
Sacramento, CA 95812-1977
stormwater@waterboards.ca.gov



APPENDIX B
SITE MAPS

FIGURES

1 AOI 14 Site Location

2 AOI 14 Site Map

3 Site Characterization Proposed Investigation Area Grids

4 Site Features and Proposed Layout of Best Management Practices

5 Proposed Final Grading Plan

6 Wetland and Waters of the U.S. and Burrowing Owl Preserves

7 Areas of Potentially Occurring Federally Listed Species—Western Snowy Plover and California Least Tern

8 Areas of Potentially Occurring Federally Listed Species—California Clapper Rail and Salt Marsh Harvest Mouse

AOI 14

NASA Ames

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWPPP	Stormwater Polution Prevention Plan

TETRA TECH

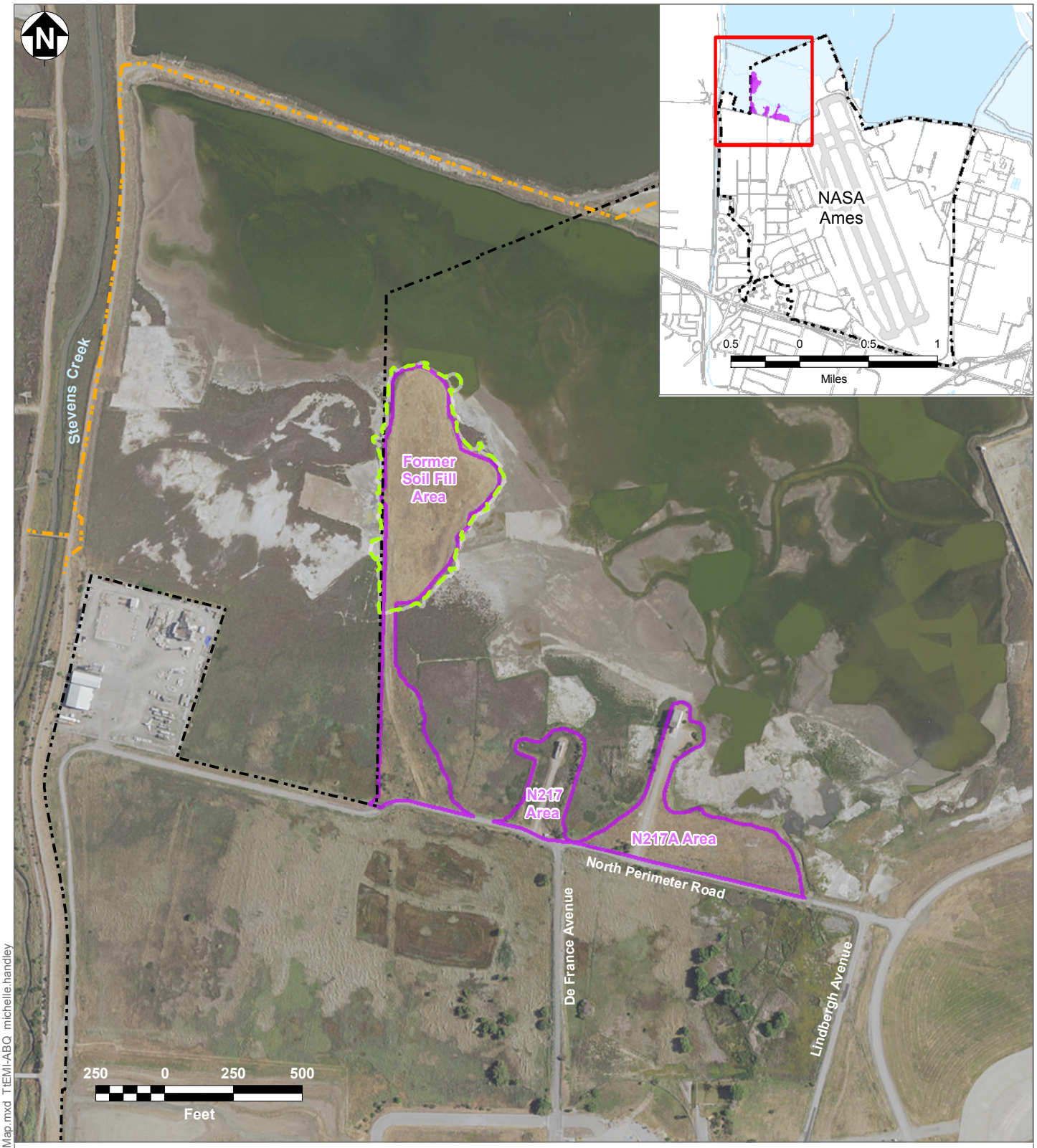
NASA Ames Research Center
Moffett Field, California

Figure 1

AOI 14 Site Location

SWPPP for AOI 14 Removal Action

2017-01-09 C:\NASA\Projects\SWPPP\01_Site_Location.mxd TtEMI michelle.handley



Removal Action Boundary

AOI 14

NASA Ames

Bay Trail

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWPPP	Storm Water Pollution Prevention Plan
SWRP	Storm Water Retention Pond

TETRA TECH

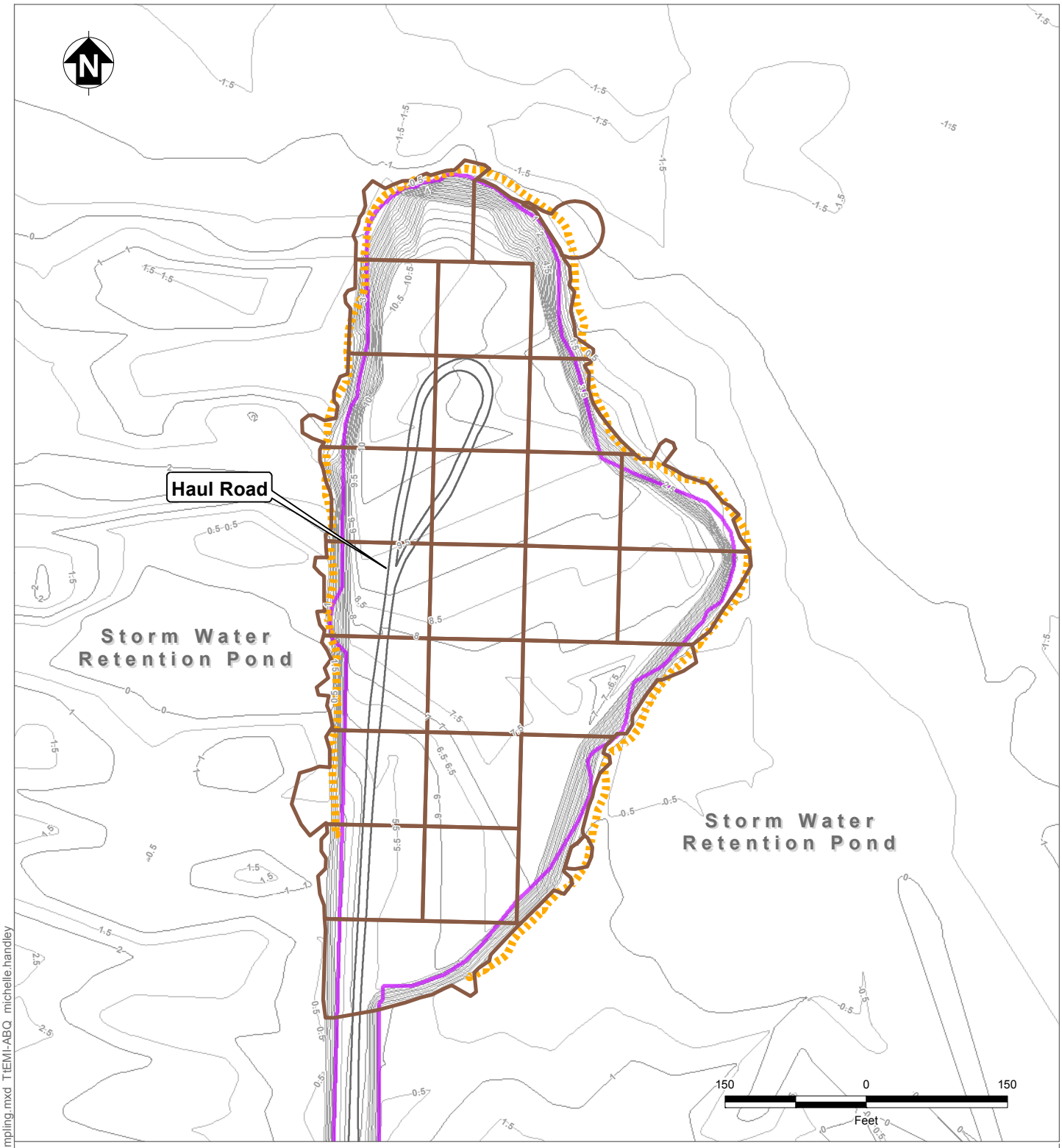
NASA Ames Research Center
Moffett Field, California

Figure 2

AOI 14 Site Map

SWPPP for AOI 14 Removal Action

1/27/2017 C:\NASA\Projects\SWPPP\02_SiteMap.mxd TtEMI-ABQ michelle.handley



Investigation Area Grid

Existing Silt Fence

Access Road

AOI 14

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWPPP	Storm Water Pollution Prevention Plan

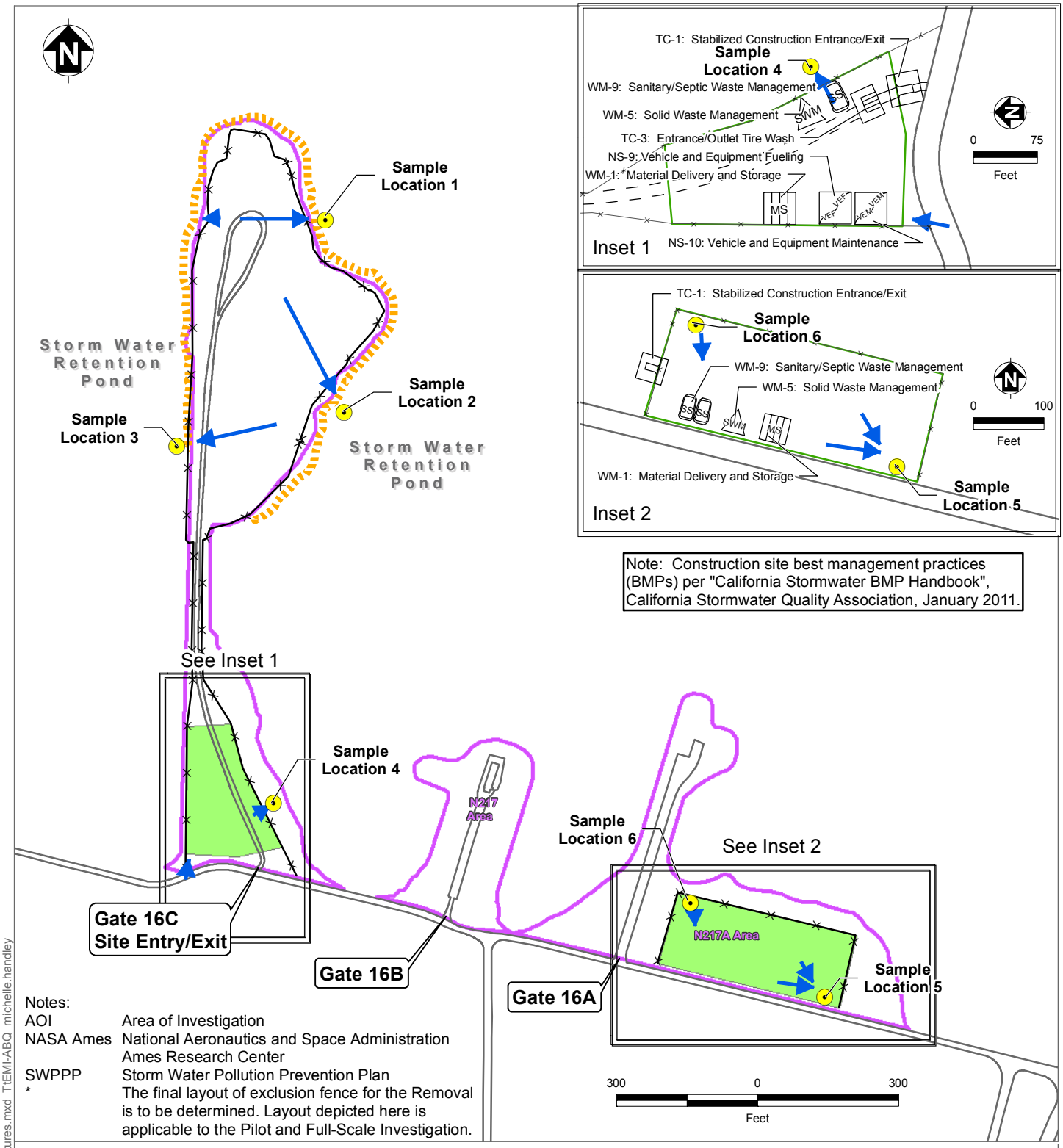
TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 3
Site Characterization
Proposed Investigation Area Grids

SWPPP for AOI 14 Removal Action

1/26/2017 C:\NASA\Projects\SWPPP\03_ICAM_Sampling.mxd TtEMI-ABQ michelle.handley



Note: Construction site best management practices (BMPs) per "California Stormwater BMP Handbook", California Stormwater Quality Association, January 2011.

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWPPP	Storm Water Pollution Prevention Plan
*	The final layout of exclusion fence for the Removal is to be determined. Layout depicted here is applicable to the Pilot and Full-Scale Investigation.

Stormwater Flow Direction

Exclusion Fence *

Existing Silt Fence

Access Road

AOI 14

Contractor Staging/Laydown Area

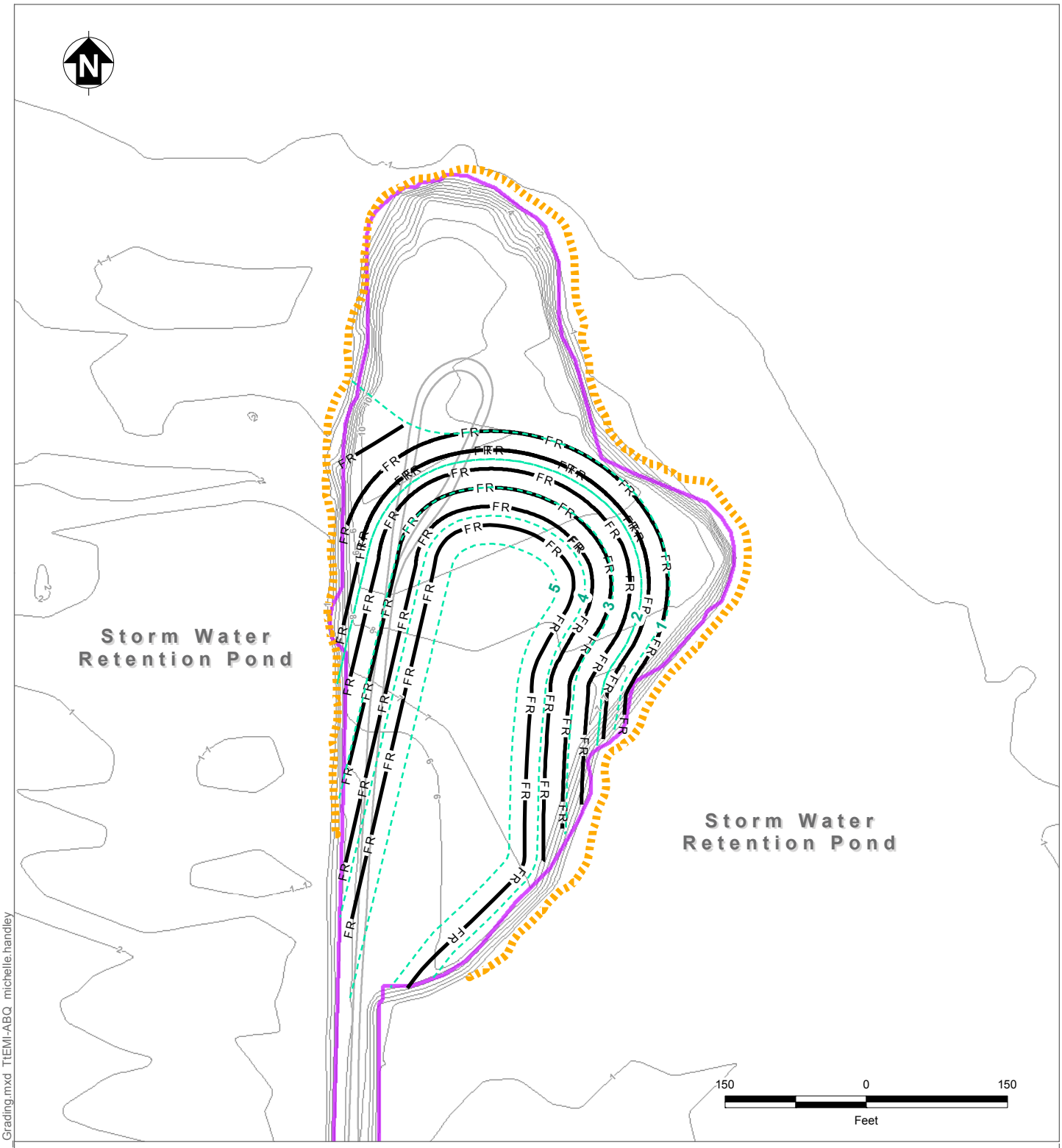
TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 4
Site Features and Proposed Layout of Best Management Practices

SWPPP for AOI 14 Removal Action

2/17/2017 C:\NASA\Projects\SWPPP\04_Site_Features.mxd TtEMI-ABQ michelle.handley



Proposed 1-foot Contour

FR Fiber Roll

Existing Silt Fence

Access Road

AOI 14

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWPPP	Storm Water Pollution Prevention Plan

TETRA TECH

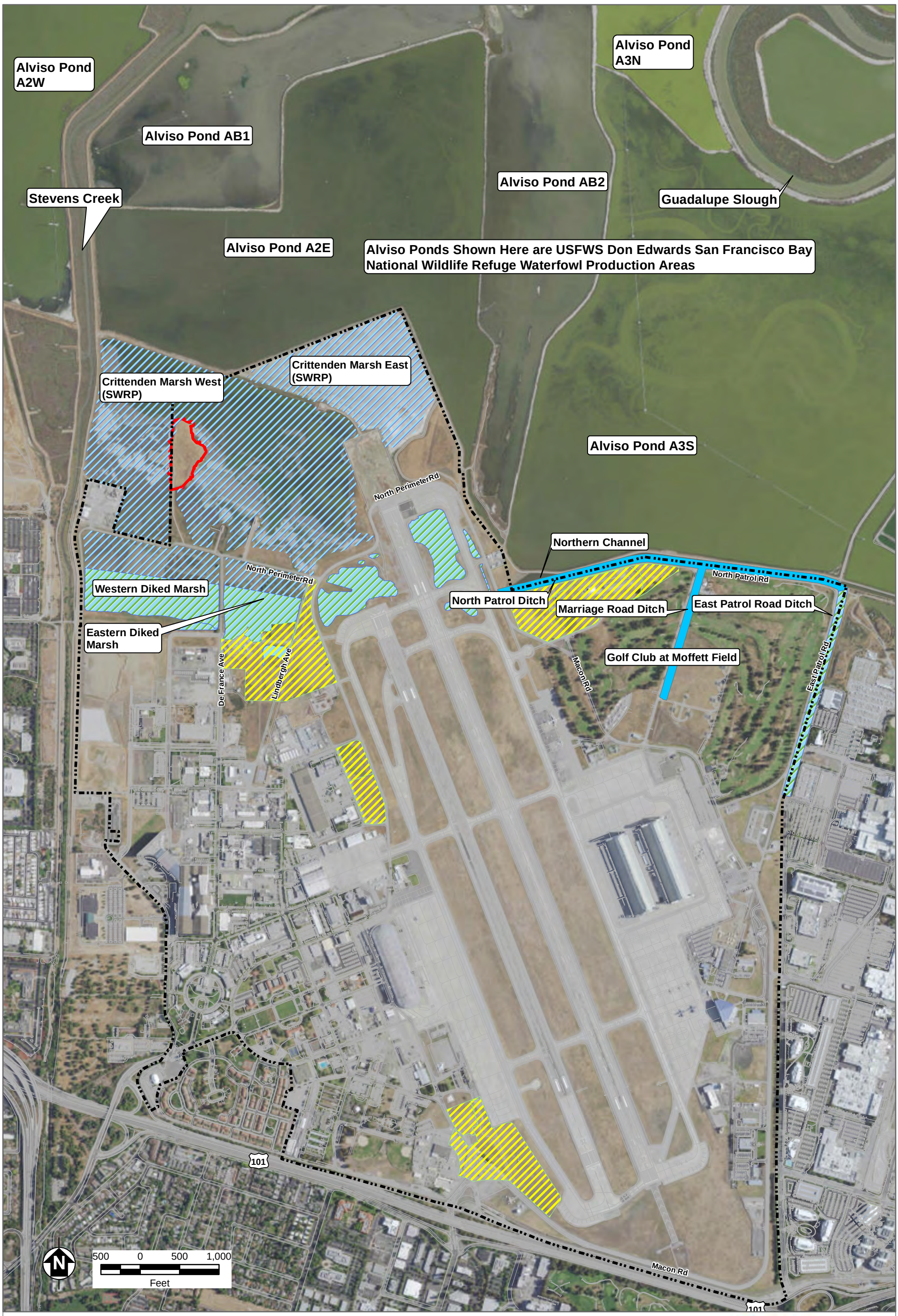
NASA Ames Research Center
Moffett Field, California

Figure 5

Proposed Final Grading Plan

SWPPP for AOI 14 Removal Action

1/26/2017 C:\NASA\Projects\SWPPP\05_Proposed_Grading.mxd TtEMI-ABQ michelle.handley



NASA Ames

Removal Action Boundary

Burrowing Owl Preserve

Waters of the U.S. (2009)

Wetlands (2009)

Wetlands and Waters of the U.S. (1989)

Note: (Year) denotes verification of delineation by U.S. Army Corps of Engineers (USACE)

IR = Installation Restoration; SWRP = Storm water retention pond

SWPPP = Storm Water Pollution Prevention Plan

Sources: NASA Ames GIS, NASA Ames Development Plan Enivronmental Impact Statement (Design, Community and Environment 2002), and NASA Ames Environmental Resources Document (ERT 2015)

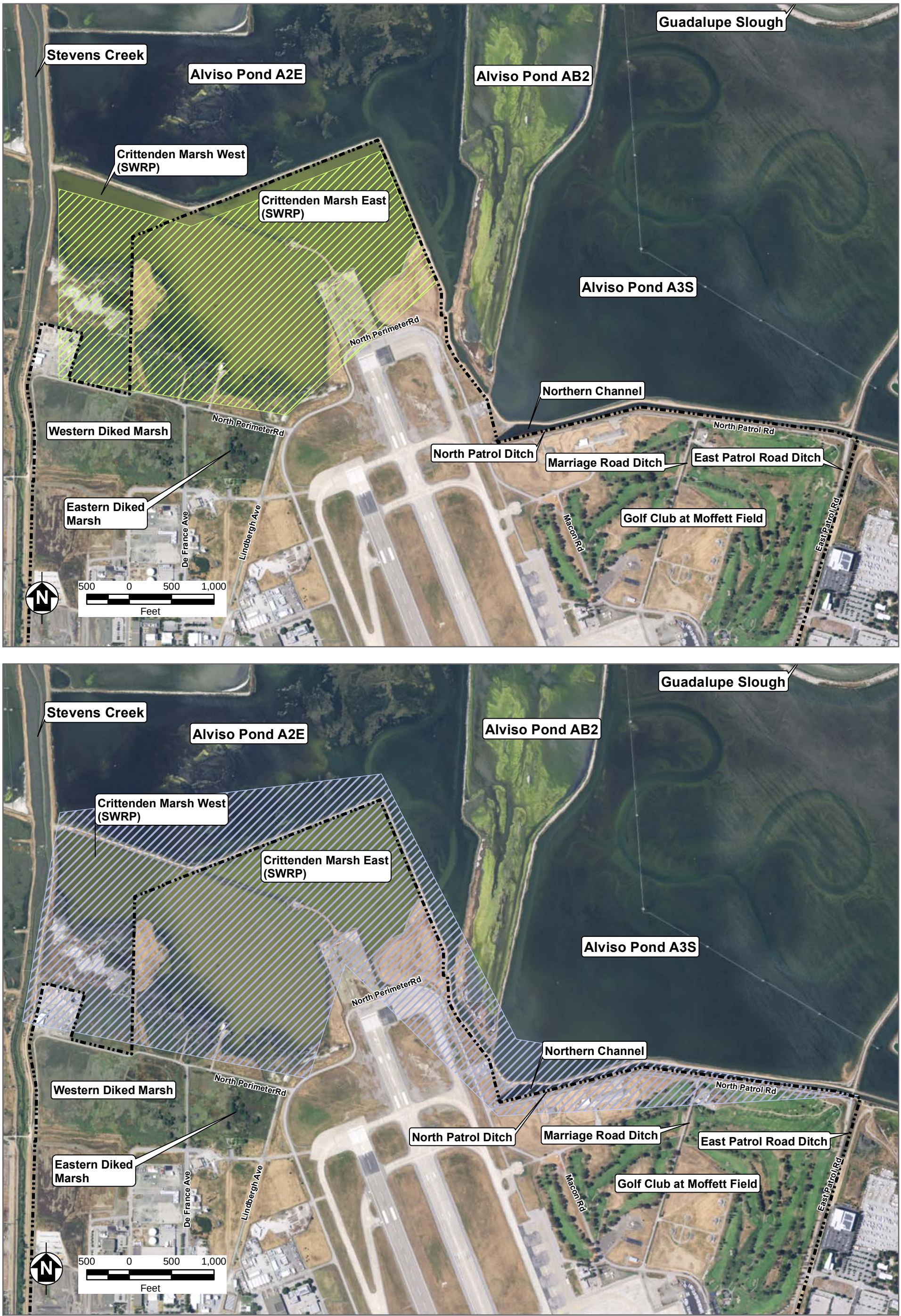
TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 6
Wetlands and Waters of the U.S. and Burrowing Owl Preserves

SWPPP for AOI 14 Removal Action

1/27/2017 H:\Tetra tech\NASA\NASA_GIS\SWPPP figs\06_SWPPP_Wetlands11X17.mxd TtEMI-BLDR angela.lortie



NASA Ames

Federally Listed Species Area of Potential Occurrence

Western Snowy Plover

California Least Tern

Note: IR = Installation Restoration; SWRP = Storm water retention pond
SWPPP = Storm Water Pollution Prevention Plan

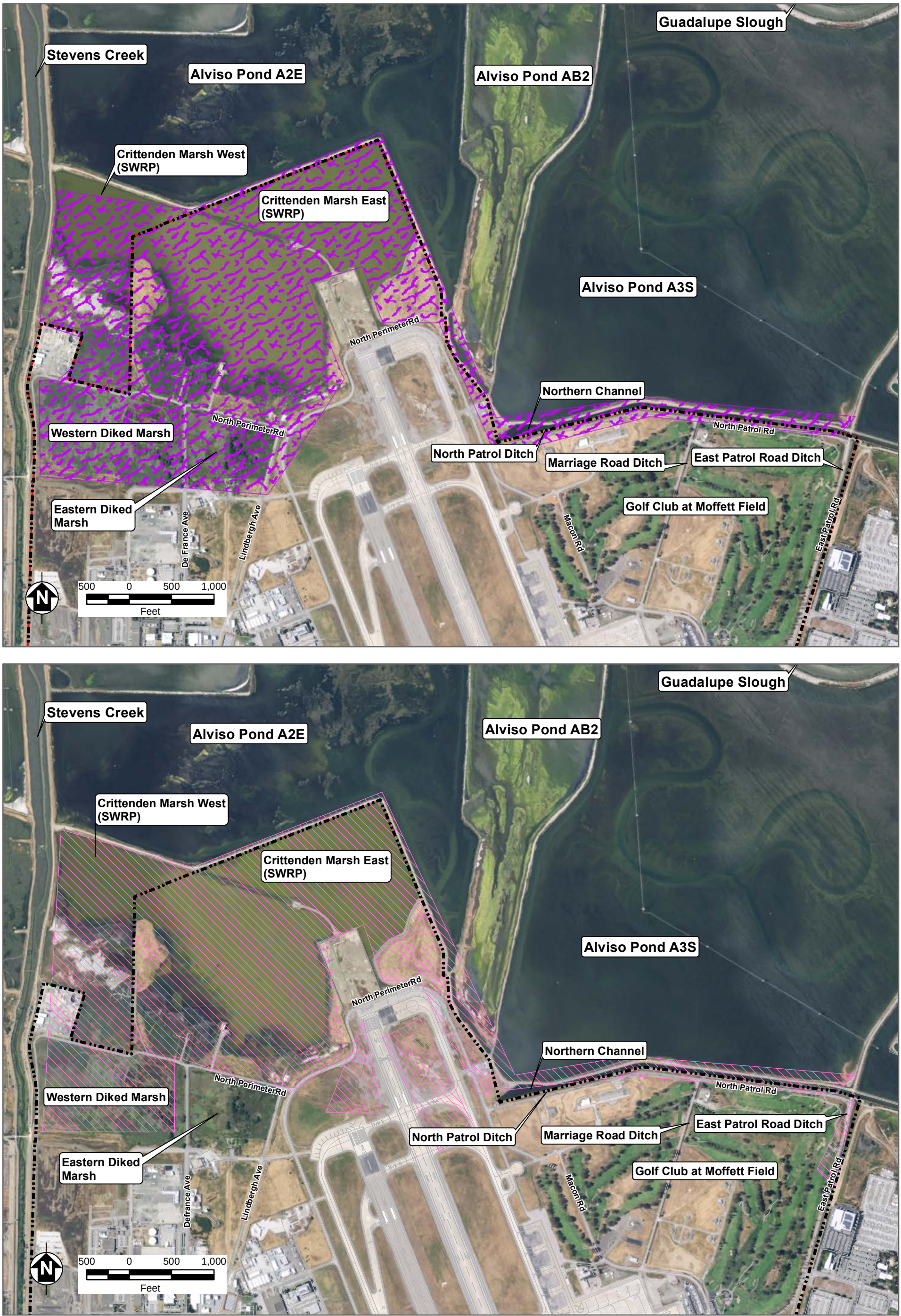
Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 7
Areas of Potentially Occurring Federally Listed Species – Western Snowy Plover and California Least Tern
SWPPP for AOI 14 Removal Action

11/29/2017 H:\Tetra tech\NASA\NASA_GIS\SWPPP figs\07_SWPPP_Species11X17.mxd TtEMI-BLDR angela.lortie



NASA Ames

Federally Listed Species Area of Potential Occurrence

California (Ridgway's) Clapper Rail

Salt Marsh Harvest Mouse

Note: IR = Installation Restoration; SWRP = Storm water retention pond

SWPPP = Storm Water Pollution Prevention Plan

Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 8
Areas of Potentially Occurring Federally Listed Species – California Clapper Rail and Salt Marsh Harvest Mouse
SWPPP for AOI 14 Removal Action

11/29/2017 H:\Tetra tech\NASA\NASA_GIS\SWPPP figs\08_SWPPP_Species11X17_Mouse_CCR.mxd TtEMI-BLDR angela.lortie

APPENDIX C
RISK LEVEL DETERMINATION

	A	B	C	D	E	F	G
1	Version 8/17/2011						
2		**Risk Determination Worksheet**					
3							
4			**Step 1**	Determine Sediment Risk via one of the options listed:			
5				1. GIS Map Method - EPA Rainfall Erosivity Calculator & GIS map			
6				2. Individual Method - EPA Rainfall Erosivity Calculator & Individual Data			
7			**Step 2**	Determine Receiving Water Risk via one of the options listed:			
8				1. GIS map of Sediment Sensitive Watersheds provided			
9				2. Site Specific Analysis (support documentation required)			
10			**Step 3**	Determine Combined Risk Level			

Selected this option

Selected this option - see support documentation

	A	B	C
1	**Sediment Risk Factor Worksheet**		**Entry**
2	**A) R Factor**		
3	Analyses of data indicated that when factors other than rainfall are held constant, soil loss is directly proportional to a rainfall factor composed of total storm kinetic energy (E) times the maximum 30-min intensity (I30) (Wischmeier and Smith, 1958). The numerical value of R is the average annual sum of EI30 for storm events during a rainfall record of at least 22 years. "Isoerodent" maps were developed based on R values calculated for more than 1000 locations in the Western U.S. Refer to the link below to determine the R factor for the project site.		
4	http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm		
5	From EPA Rainfall Erosivity Calculator See document 01	**R Factor Value**	42.2
6	**.**		
7	The soil-erodibility factor K represents: (1) susceptibility of soil o erosion, (2) transportability of the sediment, and (3) the amount and rate of runoff given a particular rainfall input, as measured under a standard condition. Fine-textured soils that are high in clay have low K values (about 0.05 to 0.15) because the particles are resistant to detachment. Coarse-textured soils, such as sandy soils, also have low K values (about 0.05 to 0.2) because of high infiltration resulting in low runoff even though these particles are easily detached. Medium-textured soils, such as a silt loam, have moderate K values (about 0.25 to 0.45) because they are moderately susceptible to particle detachment and they produce runoff at moderate rates. Soils having a high silt content are especially susceptible to erosion and have high K values, which can exceed 0.45 and can be as large as 0.65. Silt-size particles are easily detached and tend to crust, producing high rates and large volumes of runoff. Use Site-specific data must be submitted.		
8	Site-specific K factor guidance		
9	From GIS map See document 02	**K Factor Value**	0.24
10	**C) LS Factor (weighted average, by area, for all slopes)**		
11	The effect of topography on erosion is accounted for by the LS factor, which combines the effects of a hillslope-length factor, L, and a hillslope-gradient factor, S. Generally speaking, as hillslope length and/or hillslope gradient increase, soil loss increases. As hillslope length increases, total soil loss and soil loss per unit area increase due to the progressive accumulation of runoff in the downslope direction. As the hillslope gradient increases, the velocity and erosivity of runoff increases. Use the LS table located in separate tab of this spreadsheet to determine LS factors. Estimate the weighted LS for the site prior to construction.		
12	LS Table		
13	From GIS map See document 03	**LS Factor Value**	0.2
14			
15	**Watershed Erosion Estimate (=RxKxLS) in tons/acre**		2.0256
16	**Site Sediment Risk Factor**		**Low**
17	Low Sediment Risk: < 15 tons/acre		
18	Medium Sediment Risk: >=15 and <75 tons/acre		
19	High Sediment Risk: >= 75 tons/acre		
20			

Receiving Water (RW) Risk Factor Worksheet	Entry	Score
A. Watershed Characteristics	**yes/no**	
A.1. Does the disturbed area discharge (either directly or indirectly) to a **303(d)-listed waterbody impaired by sediment** (For help with impaired waterbodies please visit the link below) or has a **USEPA approved TMDL implementation plan for** http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml	no	Low
OR		
A.2. Does the disturbed area discharge to a waterbody with designated beneficial uses of SPAWN & COLD & MIGRATORY? (For help please review the appropriate Regional Board Basin Plan) http://www.waterboards.ca.gov/waterboards_map.shtml		

Jagel Slough is not 303(d) listed.
San Francisco Bay is not 303(d) listed for sediment.
See document 04

Region 1 Basin Plan

Region 2 Basin Plan

Region 3 Basin Plan

Region 4 Basin Plan

Region 5 Basin Plan

Region 6 Basin Plan

Region 7 Basin Plan

Region 8 Basin Plan

Region 9 Basin Plan

The guidance states that the Basin Plan should be used to determine beneficial uses.
Document 05 is the Basin Plan's table of beneficial uses for water bodies in this region.

Jagel Slough has no designated beneficial uses.
South San Francisco Bay does not have COLD beneficial use.
(Additionally for reference, adjacent sloughs do not have COLD or SPWN beneficial uses.)

Combined Risk Level Matrix

Receiving Water Risk	Sediment Risk: Low	Sediment Risk: Medium	Sediment Risk: High
Low	Level 1	Level 2	
High	Level 2		Level 3

Project Sediment Risk: Low

Project RW Risk: Low

Project Combined Risk: Level 1

We've made some changes to EPA.gov. If the information you are looking for is not here, you may be able to find it on the EPA Web Archive or the January 19, 2017 Web Snapshot.

United States Environmental Protection Agency

Rainfall Erosivity Factor Calculator for Small Construction Sites

EPA's stormwater regulations allow NPDES permitting authorities to waive NPDES permitting requirements for stormwater discharges from small construction sites if:

- the construction site disturbs less than five acres, and
- the rainfall erosivity factor ("R" in the revised universal soil loss equation, or RUSLE) value is less than five during the period of construction activity.

If your small construction project is located in an area where EPA is the permitting authority and your R factor is less than five, you qualify for a low erosivity waiver (LEW) from NPDES stormwater permitting. LEW certifications are submitted through the electronic Notice of Intent (eNOI) system. Several states that are authorized to implement the NPDES permitting program also accept LEWs. Check with your state NPDES permitting authority for more information.

- List of states, Indian country, and territories where EPA's 2012 Construction General Permit (CGP) and Multi-Sector General Permit (MSGP) Apply
- EPA's CGP eNOI System

The period during which small construction sites qualify for the waiver generally occurs during a relatively short time in arid and semi-arid areas. If your small construction project does not qualify for a waiver, then NPDES stormwater permit coverage is required.

To use the Rainfall Erosivity Factor Calculator to determine your eligibility for the LEW, you will need your project's location (either latitude/longitude or address) and the estimated start and end dates of construction. The period of construction activity begins at initial earth disturbance and ends with final stabilization.

- Construction Rainfall Erosivity Waiver Fact Sheet
- Appendix C of the 2017 CGP – Small Construction Waivers and Instructions

For questions or comments, email EPA's CGP staff at cgp@epa.gov.

Facility Information

- Start Date: 12/14/2017
- End Date: 12/26/2018
- Latitude: 37.4307
- Longitude: -122.0636

Erosivity Index Calculator Results

An erosivity index value Of **42.20** has been determined for the construction period of **12/14/2017 - 12/26/2018**.

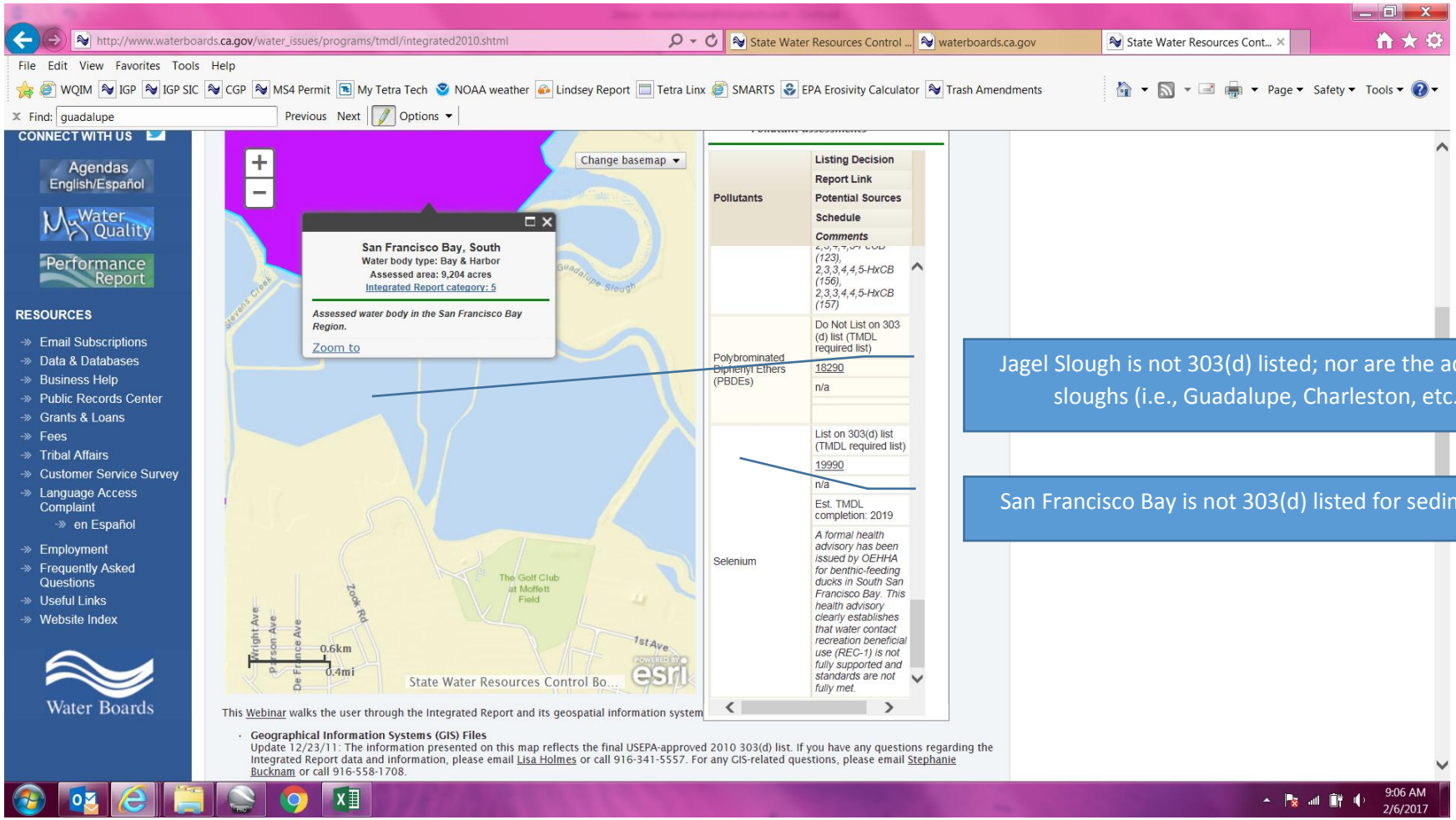
A rainfall erosivity factor of 5.0 or greater has been calculated for your site and period of construction. **You do NOT qualify for a waiver from NPDES permitting requirements**.

Start Over

LAST UPDATED ON JULY 26, 2017

Untitled Map
Write a description for your map.
Legend
37.430733, -122.063691
Site Location
0.24
K Factor, from SWRCB GIS layer
Google earth
© 2016 Google
N
2000 ft

Untitled Map
Write a description for your map.
Legend
37.430733, -122.063691
Site Location
0.2
LS Factor, based on SWRCB GIS layer
Google earth
© 2016 Google
N
2000 ft



Jagel Slough is not 303(d) listed; nor are the adjacent sloughs (i.e., Guadalupe, Charleston, etc.).

San Francisco Bay is not 303(d) listed for sediment.

Table 2-1: Existing and Potential Beneficial Uses of Water Bodies in the San Francisco Bay Region

MARIN COASTAL BASIN

	← Human Consumptive Uses →						← Aquatic Life Uses →									Wildlife Use	Recreational Uses		
COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
MARIN COUNTY																			
Pacific Ocean (Marin)					E		E	E			E	E	E	E		E	E	E	E
Abbotts Lagoon											E					E	E	E	
Drakes Estero							E	E			E	E	E	E		E	E	E	
East Schooner Creek								E	E			E	E	E	E	E	E	E	
Home Ranch Creek									E			E	E	E	E	E	E	E	
Limantour Estero							E	E			E	E	E	E		E	E	E	
Glenbrook Creek									E			E	E		E	E	E	E	
Muddy Hollow Creek									E			E	E	E	E	E	E	E	
Santa Maria Creek (Marin)									E			E	E	E	E	E	E	E	
Coast Creek								E	E			E	E	E	E	E	E	E	
Alamere Creek									E							E	E	E	
Wildcat Lake															E	E	E	E	
Crystal Lake									E					E	E	E	E	E	
Bass Lake							E								E	E	E	E	
Pelican Lake															E	E	E	E	
Arroyo Hondo (Marin)		E							E						E	E	E	E	
Bolinas Lagoon							E	E			E	E	E	E		E	E	E	E
Pine Gulch Creek		E							E			E	E	E	E	E	E	E	
Copper Mine Gulch Creek									E			E	E	E	E	E	E	E	
Wilkins Gulch Creek									E			E	E		E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

MARIN COASTAL BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
MARIN COUNTY, continued																			
Pike County Gulch Creek									E						E	E	E	E	
Morses Gulch Creek									E			E	E	E	E	E	E	E	
McKinnan Gulch Creek									E			E	E	E	E	E	E	E	
Stinson Gulch Creek		E							E			E	E	E	E	E	E	E	
Easkoot Creek									E			E	E	E	E	E	E	E	
Webb Creek		E							E				E		E	E	E	E	
Lone Tree Creek															E	E	E	E	
Redwood Creek (Marin)	E	E	E					E	E			E	E	E	E	E	E	E	
Green Gulch Creek									E			E	E	E	E	E	E	E	
Tennessee Valley Creek															E	E	E	E	
Rodeo Lagoon							E		E		E		E			E	E	E	
Rodeo Creek									E				E	E	E	E	E	E	
Tomales Bay							E	E			E	E	E	E		E	E	E	E
Millerton Gulch									E				E		E	E	E	E	
Grand Canyon Creek															E	E	E	E	
Tomasini Canyon Creek									E			E	E	E	E	E	E	E	
Walker Creek							E		E			E	E	E	E	E	E	E	
Chileno Creek									E			E	E		E	E	E	E	
Laguna Lake															E	E	E*	E	
Frink Canyon Creek									E			E	E		E	E	E	E	
Verde Canyon Creek									E			E	E		E	E	E	E	
Salmon Creek (Marin)									E			E	E		E	E	E	E	
Soulajule Reservoir		E	E				E								E	E	E*	E	
Arroyo Sausal			E						E				E		E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
MARIN COUNTY, continued																			
Lagunitas Creek	E	E	E						E			E	E	E	E	E	E	E	
Haggerty Gulch Creek			E						E			E	E	E	E	E	E	E	
Bear Valley Creek			E						E			E	E	E	E	E	E	E	
Olema Creek			E						E			E	E	E	E	E	E	E	
Nicasio Creek		E	E						E			E		E	E	E	E	E	
Nicasio Reservoir		E	E				E		P					E	E	E	E*	E	
Halleck Creek			E						E						E	E	E	E	
Devils Gulch Creek									E			E	E	E	E	E	E	E	
San Geronimo Creek									E			E	E	E	E	E	E	E	
Woodacre Creek									E			E	E		E	E	E	E	
Kent Lake		E					E		E					E	E	E	E*	E	
Big Carson Creek			E						E							E	E	E	
Alpine Lake		E					E		E					E	E	E	E*	E	
Cataract Creek			E						E							E	E	E	
Bon Tempe Lake		E							E					E	E	E	E*	E	
Lake Lagunitas		E					E		E					E	E	E	E*	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SAN MATEO COASTAL BASIN

	Human Consumptive Uses						Aquatic Life Uses									Wildlife Use	Recreational Uses		
COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SAN FRANCISCO COUNTY																			
Pacific Ocean (San Mateo, San Francisco Counties)					E		E	E			E	E	E	E		E	E[1]	E	E
Lake Merced		P					E		E					E	E	E	E	E	
SAN MATEO COUNTY																			
Milagra Creek												E	E		E	E	E	E	
Calera Creek (San Mateo)													E		E	E	E	E	
San Pedro Creek		E							E			E	E	E	E	E	E	E	
San Vicente Creek	E	E							E			E	E	E	E	E	E	E	
Denniston Creek	E	E							E			E	E	E	E	E	E	E	
Arroyo de en Medio									E						E	E	E	E	
Frenchmans Creek	E								E			E	E	E	E	E	E	E	
Pilarcitos Creek	E	E							E			E	E	E	E	E	E	E	
Arroyo Leon Creek									E						E	E	E	E	
Mills Creek (San Mateo)									E				E		E	E	E	E	
Apanolio Creek									E				E	E	E	E	E	E	
Corinda Los Trancos Creek									E				E		E	E	E	E	
Pilarcitos Reservoir		E							E				E	E	E	E	E*	E	
Purisima Creek	E								E			E	E	E		E	E	E	
Lobitos Creek	E								E			E	E	E		E	E	E	
Tunitas Creek	E	E							E			E	E	E	E	E	E	E	
San Gregorio Creek	E								E			E	E	E	E	E	E	E	
Clear Creek									E						E	E	E	E	
El Corte de Madera Creek									E			P	E	P	E	E	E	E	
Bogess Creek									E			E	E	E	E	E	E	E	
Harrington Creek									E			E	E	E	E	E	E	E	
La Honda Creek									E			E	E	E	E	E	E	E	

[1] REC-1 applies within a zone bounded by the shoreline and a distance of 1000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline. This distance is consistent with the applicability of water-contact standards in the Water Quality Plan for the Ocean Waters of California.

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SAN MATEO COUNTY, continued																			
Woodruff Creek									E						E	E	E	E	
Woodhams Creek									E						E	E	E	E	
Mindego Creek									E				E	E	E	E	E	E	
Alpine Creek									E			E	E	E	E	E	E	E	
Pomponio Creek	E								E			E	E	E	E	E	E	E	
Pomponio Reservoir									E						E	E	E	E	
Pescadero Creek	E	E							E			E	E	E	E	E	E	E	
Honsinger Creek									E				E		E	E	E	E	
McCormick Creek									E			E	E	E	E	E	E	E	
Hoffman Creek									E				E			E	E	E	
Jones Gulch Creek									E						E	E	E	E	
Tarwater Creek									E			E	E	E	E	E	E	E	
Peters Creek									E				E	E	E	E	E	E	
Lambert Creek									E				E	E	E	E	E	E	
Fall Creek									E						E	E	E	E	
Slate Creek									E				E	E	E	E	E	E	
Oil Creek									E			E	E	E	E	E	E	E	
Little Boulder Creek									E				E		E	E	E	E	
Waterman Creek									E				E	E	E	E	E	E	
Butano Creek									E			E	E		E	E	E	E	
Little Butano Creek									E				E	E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

CENTRAL BASIN

	Human Consumptive Uses						Aquatic Life Uses									Wildlife Use	Recreational Uses		
COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SAN FRANCISCO COUNTY																			
Golden Gate Channel							E				E	E	E	E		E	E	E	E
San Francisco Bay Central					E	E	E	E		E		E	E	E		E	E	E	E
Crissy Field Lagoon										E						E	E	E	
Golden Gate Park Lakes															E	E		E	
Lobos Creek		E												E	E	E	E	E	
Mountain Lake															E	E	E	E	
MARIN COUNTY																			
San Rafael Creek									E						E	E	E	E	E
Corte Madera Creek							E		E			E	E	E	E	E	E	E	E
Larkspur Creek									E				E	E	E	E	E	E	
Tamalpais Creek									E			E	E	E	E	E	E	E	
Ross Creek (Marin)									E			E	E	E	E	E	E	E	
Phoenix Lake		E					E		E				E	E	E	E	E*	E	
Phoenix Creek			E						E						E	E	E	E	
Bill Williams Creek			E						E					E	E	E	E	E	
Sleepy Hollow Creek									E			E	E	E	E	E	E	E	
San Anselmo Creek									E			E	E	E	E	E	E	E	
Fairfax Creek									E					E	E	E	E	E	
Cascade Creek									E			E	E	E		E	E	E	
Richardson Bay					E		E	E		E		E	E	E		E	E	E	E
Arroyo Corte Madera del Presidio								E	E			E	E	E	E	E	E	E	
Warner Creek (Mill Valley, Marin)									E			E	E	E	E	E	E	E	
Old Mill Creek									E			E	E	E	E	E	E	E	
Willow Reed Creek									E				E	E	E	E	E	E	
Coyote Creek (Marin)									E						E	E	E	E	
Nyhan Creek									E						E	E	E	E	
ALAMEDA COUNTY																			
Berkeley Aquatic Park Lagoon										E		E		P		E	E	E	
Lake Temescal							E		E					E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

CENTRAL BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
ALAMEDA COUNTY, continued																			
Temescal Creek									E						E	E	E	E	
Claremont Creek															E	E	E	E	
Strawberry Creek															E	E	E	E	
Codornices Creek									E			E	E	E	E	E	E	E	
Village Creek															E	E	E	E	
Capistrano Creek															E	E	E	E	
CONTRA COSTA COUNTY																			
Cerrito Creek															E	E	E	E	
Baxter Creek															E	E	E	E	
Richmond Inner Harbor							E			E						E	E	E	E

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SOUTH BAY BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
	Human Consumptive Uses							Aquatic Life Uses								Wildlife Use	Recreational Uses		
SAN FRANCISCO COUNTY																			
San Francisco Bay Lower					E		E	E		E		E	E	E		E	E	E	E
Mission Creek (San Francisco)							E			E						E	E	E	E
Central Basin							E			E						E	E	E	E
Islais Creek, tidal							E			E						E	E	E	E
India Basin							E			E						E	E	E	E
South Basin							E			E						E	E	E	E
Yosemite Creek							E			E						E	E	E	
SAN MATEO COUNTY																			
Brisbane Lagoon										E						E	E	E	
Guadalupe Canyon Creek															E	E	E	E	
Colma Creek															E	E	E	E	
San Bruno Creek															E	E	E	E	
Mills Creek															E	E	E	E	
Easton Creek															E	E	E	E	
Burlingame Lagoon										E						E	E	E	
Anza Lagoon										E						E	E	E	
Sanchez Creek															E	E	E	E	
Cherry Canyon Creek															E	E	E	E	
San Mateo Creek			E						E			E	E	E	E	E	E	E	
Polhemus Creek									E						E	E	E	E	
Lower Crystal Springs Reservoir		E							E				E	E	E	E	E*	E	
Upper Crystal Springs Reservoir		E							E				E	E	E	E	E*	E	
San Andreas Creek			E						E						E	E	E	E	
San Andreas Reservoir		E							E				E	E	E	E	E*	E	
Marina Lagoon										E						E	E	E	
Seal Slough										E			E			E	E	E	
Leslie Creek															E	E	E	E	
Borel Creek															E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SOUTH BAY BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SAN MATEO COUNTY, continued																			
O'Neill Slough										E						E	E	E	
Foster City Lagoon										E						E	E	E	
Belmont Slough										E			E	E		E	E	E	
Belmont Creek															E	E	E	E	
Laurel Creek (San Mateo)															E	E	E	E	
Bay Slough (San Mateo)										E			E			E	E	E	
Steinberger Slough										E			E			E	E	E	
Corkscrew Slough										E			E			E	E	E	
Smith Slough (San Mateo)										E			E			E	E	E	
Pulgas Creek															E	E	E	E	
Cordilleras Creek															E	E	E	E	
Redwood Slough										E			E			E	E	E	E
Redwood Creek (San Mateo)															E	E	E	E	
Arroyo Ojo de Agua															E	E	E	E	
Westpoint Slough										E			E			E	E	E	
Atherton Creek															E	E	E	E	
Ravenswood Slough										E			E			E	E	E	
ALAMEDA COUNTY																			
Oakland Inner Harbor										E						E	E	E	E
Merritt Channel							E			E						E	E	E	
Lake Merritt							E	E		E				E	E	E	E	E	
Glen Echo Creek															E	E	E	E	
Sausal Creek (Alameda)									E				E	E	E	E	E	E	
Peralta Creek															E	E	E	E	
Lion Creek									E						E	E	E	E	
Arroyo Viejo									E						E	E	E	E	
Rifle Range Creek															E	E	E	E	
San Leandro Bay							E			E		E	E			E	E	E	E
Lower San Leandro Creek			E						E			E	E	E	E	E	E	E	
Lake Chabot (Alameda)		E					E		E					E	E	E	E*	E	
Grass Valley Creek			E						E						E	E	E	E	
Upper San Leandro Creek			E						E			P		P	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SOUTH BAY BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
ALAMEDA COUNTY, continued																			
Upper San Leandro Reservoir		E							E					E	E	E	E*	P	
Kaiser Creek			E						E					E	E	E	E	E	
Buckhorn Creek			E						E					E	E	E	E	E	
Redwood Creek (Alameda)			E						E					E	E	E	E	E	
Moraga Creek (in Contra Costa Co.)			E						E					E	E	E	E	E	
Estudillo Canal															E	E	E	E	
San Lorenzo Creek		E	E	E					E			E		E	E	E	E	E	
Don Castro Reservoir							E		E					E	E	E	E	E	
Castro Valley Creek									E				E		E	E	E	E	
Crow Creek									E			E	E	E	E	E	E	E	
Cull Creek									E				E	E	E	E	E	E	
Cull Canyon Reservoir							E		E					E	E	E	E	E	
Bolinas Creek									E						E	E	E	E	
Norris Creek									E						E	E	E	E	
Palomares Creek									E			E		E	E	E	E	E	
Eden Canyon Creek									E						E	E	E	E	
Hollis Creek									E				E		E	E	E	E	
Sulphur Creek (west Alameda)															E	E	E	E	
Mount Eden Creek										E						E	E	E	
Old Alameda Creek										E						E	E	E	
Ward Creek															E	E	E	E	
Zeile Creek															E	E	E	E	
Alameda Creek Quarry Ponds				E			E		E						E	E	E	E	
Coyote Hills Slough										E		E	E	E		E	E	E	
Alameda Creek	E			E			E		E			E	E	E	E	E	E	E	
Crandall Creek															E	E	E	E	
Dry Creek (Alameda, low in watershed)													E		E	E	E	E	
Stonybrook Creek									E			E	E	E	E	E	E	E	
Sinbad Creek									E			E	E	E	E	E	E	E	
San Antonio Creek (Alameda)			E						E				E	E	E	E	E*	E	
San Antonio Reservoir		E							E				E	E	E	E	E*	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SOUTH BAY BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
ALAMEDA COUNTY, continued																			
Indian Creek (central Alameda)			E						E				E	E	E	E	E*	E	
La Costa Creek			E						E				E	E	E	E	E	E	
Arroyo de la Laguna				E					E			E		E	E	E	E	E	
Vallecitos Creek															E	E	E	E	
Happy Valley Creek															E	E	E	E	
Sycamore Creek															E	E	E	E	
Arroyo del Valle		E		E					E			P	E	E	E	E	E	E	
Shadow Cliffs Reservoir				E			E		E					E	E	E	E	E	
Del Valle Reservoir		E					E		E					E	E	E	E	E	
Arroyo Mocho				E					E			E		E	E	E	E	E	
Tassajara Creek				E					P			E	E	E	E	E	E	E	
Arroyo las Positas				E					E			E	E	E	E	E	E	E	
Cottonwood Creek													E		E	E	E	E	
Collier Canyon Creek													E		E	E	E	E	
Cayetano Creek													E		E	E	E	E	
Arroyo Seco (Alameda)				E					E			E	E	E	E	E	E	E	
Altamont Creek				E					E				E		E	E	E	E	
Alamo Canal				E					P			E		E	E	E	E	E	
Alamo Creek				E					P			E	E	E	E	E	E	E	
Dublin Creek															E	E	E	E	
Martin Canyon Creek															E	E	E	E	
South San Ramon Creek															E	E	E	E	
SANTA CLARA COUNTY																			
Tributary to Alameda Creek:																			
Calaveras Creek			E						E				E	E	E	E	E	E	
Calaveras Reservoir		E							E				E	E	E	E	E*	E	
Arroyo Hondo		E	E						E				E	E	E	E	E	E	
Isabel Creek		E	E						E					E	E	E	E	E	
Smith Creek		E	E						E					E	E	E	E	E	
Sulphur Creek (Santa Clara)		E	E						E					E	E	E	E	E	
Colorado Creek *Trib. to Arroyo del Val*			E						E						E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SANTA CLARA BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
	Human Consumptive Uses						Aquatic Life Uses									Wildlife Use	Recreational Uses		
San Francisco Bay South					E		E	E		E		E	E	E		E	E	E	E
ALAMEDA & SANTA CLARA COUNTIES																			
Newark Slough										E			E			E	E	E	
Plummer Creek (Zone 5 Line F-1)										E			E			E	E	E	
Mowry Slough										E			E			E	E	E	
Coyote Slough										E			E			E	E	E	
Mud Slough										E			E			E	E	E	
Laguna Creek (Arroyo la Laguna, or Zone 6 Line E)															E	E	E	E	
Mission Creek (Zone 6 Line L)															E	E	E	E	
Lake Elizabeth									E					E	E	E	E*	E	
Sabrecat Creek (Zone 6 Line K)															E	E	E	E	
Canada del Aliso (Zone 6 Line J)															E	E	E	E	
Agua Caliente Creek (Alameda) (Zone 6 Line F)															E	E	E	E	
Agua Fria Creek (Zone 6 Line D)															E	E	E	E	
Stivers Lagoon (Fremont Lagoon)			E												E	E	E	E	
Mallard (Artesian) Slough										E			E			E	E	E	
Scott Creek (Zone 6 Line A)															E	E	E	E	
Toroges Creek (Zone 6 Line C)													E		E	E	E	E	
SAN MATEO AND SANTA CLARA COUNTIES																			
San Francisquito Creek									E			E		E	E	E	E	E	
Lake Lagunita													E		E	E	E	E	
Los Trancos Creek									E			E	E	E	E	E	E	E	
Felt Lake	E													E	E	E	E	E	
Bear Creek (San Mateo)									E			E	E	E	E	E	E	E	
Bear Gulch Creek (San Mateo)		E							E			E	E	E	E	E	E	E	
West Union Creek									E			E	E	E	E	E	E	E	
Searsville Lake	E								E					E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SANTA CLARA BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SAN MATEO AND SANTA CLARA COUNTIES, continued																			
Alambique Creek									E						E	E	E	E	
Sausal Creek (San Mateo)									E						E	E	E	E	
SANTA CLARA COUNTY ONLY																			
Palo Alto Harbor & Baylands										E		E	E			E	E	E	
Mayfield Slough										E		E	E			E	E	E	
Matadero Creek									E			E	E	E	E	E	E	E	
Deer Creek (Santa Clara)									E				E		E	E	E	E	
Arastradero Creek									E				E		E	E	E	E	
Charleston Slough										E		E	E			E	E	E	
Barron Creek															E	E	E	E	
Adobe Creek (Santa Clara)									E						E	E	E	E	
Mountain View Slough										E			E			E	E	E	
Permanente Creek				E					E				E	E	E	E	E	E	
Hale Creek									E						E	E	E	E	
Stevens Creek			E	E					E			E	E	E	E	E	E	E	
Stevens Creek Reservoir		E		E			E		E			E		E	E	E	E	E	
Swiss Creek			E						E						E	E	E	E	
Guadalupe Slough										E			E			E	E	E	
Moffett Channel										E						E	E	E	
Calabazas Creek	E			E					E						E	E	E	E	
San Tomas Aquino Creek									E				E		E	E	E	E	
Saratoga Creek	E		E	E					E						E	E	E	E	
Bonjetti Creek									E						E	E	E	E	
McElroy Creek									E						E	E	E	E	
Alviso Slough										E		E	E			E	E	E	
Guadalupe River				E					E			E	E	E	E	E	E	E	
Los Gatos Creek		E	E	E					E			P	E	P	E	E	E	P	
Campbell Percolation Pond				E			E		E					E	E	E	E	E	
Vasona Reservoir		E		E			E		E					E	E	E	E	E	
Lexington Reservoir		E		E			E		E					E	E	E	E	E	
Soda Springs Creek			E						E						E	E	E	E	

Near Jagel Slough

Adjacent to Jagel Slough

Near Jagel Slough

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SANTA CLARA BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SANTA CLARA COUNTY ONLY, continued																			
Lake Elsman		E							E						E	E	E*	E	
Austrian Gulch Creek			E						E					E	E	E	E	E	
Ross Creek				E											E	E	E	E	
Canoas Creek															E	E	E	E	
Guadalupe Creek			E	E					E			E	E	E	E	E	E	E	
Los Capitancillos Percolation Ponds				E											E	E	E	E	
Guadalupe Percolation Ponds				E											E	E	E	E	
Pheasant Creek			E						E					E	E	E	E	E	
Guadalupe Reservoir		E		E					E					E	E	E	E	E	
Los Capitancillos Creek			E	E					E						E	E	E	E	
Rincon Creek			E	E					E			E	E		E	E	E	E	
Alamitos Creek			E	E					E			E	E	E	E	E	E	E	
Arroyo Calero			E						E			E	E	E	E	E	E	E	
Calero Reservoir		E		E										E	E	E	E*	E	
Almaden Reservoir		E		E					E				E	E	E	E	E*	E	
Herbert Creek			E						E						E	E	E	E	
Barrett Canyon Creek			E						E						E	E	E	E	
Coyote Creek (nontidal)				E			E		E			E	E	E	E	E	E	E	
Upper Penitencia Creek			E	E					E			E	E	E	E	E	E	E	
Arroyo Aguague Creek									E			E	E	E	E	E	E	E	
Halls Valley Lake (Grant Lake)							E							E	E	E	E	E	
Cherry Flat Reservoir	E	E												E	E	E	E*	E	
Lower Silver Creek															E	E	E	E	
Babb Creek															E	E	E	E	
South Babb Creek															E	E	E	E	
Flint Creek															E	E	E	E	
Thompson Creek															E	E	E	E	
Quimby Creek															E	E	E	E	
Yerba Buena Creek															E	E	E	E	
Upper Silver Creek													E		E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SANTA CLARA BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SANTA CLARA COUNTY ONLY, continued																			
Cottonwood Lake							E		E					E	E	E	E	E	
Fisher Creek															E	E	E	E	
Anderson Reservoir		E		E			E		E					E	E	E	E*	E	
San Felipe Creek			E						E					E	E	E	E	E	
Las Animas Creek			E						E						E	E	E	E	
Packwood Creek			E						E					E	E	E	E	E	
Hoover Creek			E						E					E	E	E	E	E	
Otis Canyon Creek			E						E						E	E	E	E	
Coyote Reservoir	E	E					E		E					E	E	E	E*	E	
Canada de los Osos Creek			E												E	E	E	E	
Soda Springs Canyon Creek									E						E	E	E	E	
Lower Penitencia Creek															E	E	E	E	
Berryessa Creek															E	E	E	E	
Calera Creek (Santa Clara)															E	E	E	E	
Tularcitos Creek															E	E	E	E	
Arroyo de los Coches													E		E	E	E	E	
Sandy Wool Lake							E		E					E	E	E	E*	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SAN PABLO BASIN

	Human Consumptive Uses						Aquatic Life Uses									Wildlife Use	Recreational Uses		
COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
San Pablo Bay					E		E	E		E		E	E	E		E	E	E	E
SOLANO COUNTY																			
Mare Island Strait							E			E		E	E			E	E	E	E
White Slough							E			E		E	E	E		E	E	E	
South Slough							E			E		E	E			E	E	E	
Dutchman Slough							E			E		E	E			E	E	E	
Lake Chabot (Solano)	E	E							E					E	E	E	E	E	
Rindler Creek			E												E	E	E	E	
Blue Rock Springs Creek			E												E	E	E	E	
Lake Dalwigk															E	E	E	E	
CONTRA COSTA COUNTY																			
Rodeo Creek									E					E	E	E	E	E	
Refugio Creek															E	E	E	E	
Pinole Creek									E			E	E	E	E	E	E	E	
Garrity Creek															E	E	E	E	
Rheem Creek															E	E	E	E	
San Pablo Creek			E						E			E	E	E	E	E	E*	E	
San Pablo Reservoir		E					E		E					E	E	E	E*	E	
Lauterwasser Creek			E												E	E	E	E	
Briones Reservoir		E							E					E	E	E	E*	P	
Bear Creek (Contra Costa)			E										E		E	E	E	E	
Wildcat Creek			E						E			E	E	E	E	E	E	E	
Jewel Lake									E						E	E	E	E	
Lake Anza			E				E		E						E	E	E	E	
MARIN COUNTY																			
Black John Slough										E		E	E			E	E	E	
Rush Creek										E			E			E	E	E	
Bahia Lagoon										E						E	E	E	
Novato Creek		E					E		E			E	E	E	E	E	E	E	
Stafford Lake		E					E		E					E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SAN PABLO BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
MARIN COUNTY, continued																			
Bowman Canyon Creek									E			E	E	E	E	E	E	E	
Warner Creek (Novato)									E			E	E		E	E	E	E	
Arroyo Avichi									E				E		E	E	E	E	
Pacheco Pond							E		E			P	E	P	E	E	E	E	
Arroyo San Jose									E				E		E	E	E	E	
Miller Creek									E			E	E	E	E	E	E	E	
Gallinas Creek									E				E		E	E	E	E	
SONOMA COUNTY																			
Petaluma River									E	E		E	E	E	E	E	E	E	E
San Antonio Creek									E			P		P	E	E	E	E	
Adobe Creek (Sonoma)									E			E	E	E	E	E	E	E	
Lynch Creek									E			E	E	E	E	E	E	E	
Willow Creek (Willow Canyon Creek)									E			E	E	E	E	E	E	E	
Lichau Creek									E			E		E	E	E	E	E	
Tolay Creek													E		E	E	E	E	
Second Napa Slough							E			E		E	E			E	E	E	
Third Napa Slough							E			E			E			E	E	E	
Steamboat Slough							E			E			E			E	E	E	
Hudeman Slough							E			E		E	E			E	E	E	
Rainbow Slough							E			E			E			E	E	E	
Sonoma Creek							E		E			E	E	E	E	E	E	E	
Fowler Creek									E			E	E		E	E	E	E	
Felder Creek									E						E	E	E	E	
Carriger Creek									E			E	E	E	E	E	E	E	
Rodgers Creek									E				E	E	E	E	E	E	
Schell Creek									E			E	E		E	E	E	E	
Arroyo Seco Creek (Sonoma)									E			E	E	E	E	E	E	E	
Nathanson Creek									E			E	E	E	E	E	E	E	
Agua Caliente Creek (Sonoma)									E			E	E	E	E	E	E	E	
Hooker Creek									E			E	E	E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SAN PABLO BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SONOMA COUNTY, continued																			
Mill Creek (Sonoma)									E			E	E	E	E	E	E	E	
Calabazas Creek (Sonoma)									E			E	E	E	E	E	E	E	
Stuart Creek									E			E	E	E	E	E	E	E	
Graham Creek									E			E	E	E	E	E	E	E	
Yulupa Creek									E			E	E	E	E	E	E	E	
Bear Creek (Sonoma)									E			E	E	E	E	E	E	E	
NAPA COUNTY																			
Napa Slough							E			E		E	E			E	E	E	
China Slough							E			E		E	E			E	E	E	
Napa River – tidal							E			E		E	E			E	E	E	E
American Canyon Creek															E	E	E	E	
Mud Slough (Napa)							E			E		E	E			E	E	E	
Devils Slough							E			E		E	E			E	E	E	
Huichica Creek									E			E	E	E	E	E	E	E	
Carneros Creek									E			E	E	E	E	E	E	E	
Fagan Creek															E	E	E	E	
Suscol Creek									E			E	E	E	E	E	E	E	
Bedford Slough (Napa)										E						E	E	E	
Lake Marie	E	E							P					E	P	E	E	E	
Tulucay Creek									E			E	E	E	E	E	E	E	
Spencer Creek									E			E	E	E	E	E	E	E	
Murphy Creek									E			E	E	E	E	E	E	E	
Napa River – nontidal	E	E		E			E		E			E	E	E	E	E	E	E	E
Napa Creek									E			E	E	E	E	E	E	E	
Browns Valley Creek									E			E	E	E	E	E	E	E	
Redwood Creek (Napa)									E			E	E	E	E	E	E	E	
Pickle Canyon Creek									E			E	E	E	E	E	E	E	
Milliken Creek			E						E			E	E	E	E	E	E	E	
Milliken Reservoir		E							E					E	E	E	E*	E	
Sarco Creek									E			E	E	E	E	E	E	E	
Salvador Creek									E				E	E	E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
NAPA COUNTY, continued																			
Soda Creek									E			E	E	E	E	E	E	E	
Dry Creek (Napa)	E	E							E			E	E	E	E	E	E	E	
Segassia Canyon Creek									E			E	E	E	E	E	E	E	
Montgomery Creek									E			E	E	E	E	E	E	E	
Hopper Creek									E						E	E	E	E	
Conn Creek		E	E						E			E	E	E	E	E	E	E	
Rector Creek			E						E			E	E	E	E	E	E	E	
Rector Reservoir		E							E					E	E	E	E*	E	
Lake Hennessey		E					E		E					E	E	E	E	E	
Chiles Creek		E	E						E					E	E	E	E	E	
Moore Creek			E						E						E	E	E	E	
Sage Creek		E	E						E					E	E	E	E	E	
Angwin Lakes		E													E	E	E	E	
Bale Slough									E			E	E	E	E	E	E	E	
Bear Canyon Creek									E				E		E	E	E	E	
Sulphur Creek (Napa)									E			E	E	E	E	E	E	E	
Heath Canyon Creek									E			E	E	E	E	E	E	E	
Iron Mine Creek									E			E	E	E	E	E	E	E	
York Creek									E			E	E	E		E	E	E	
Bell Canyon Creek									E			E	E	E	E	E	E	E	
Bell Canyon Reservoir		E													E	E	E	E	
Mill Creek (Napa)									E			E	E	E	E	E	E	E	
Ritchey Creek (Ritchie Creek)									E			E	E	E	E	E	E	E	
Selby Creek									E			E	E	E	E	E	E	E	
Dutch Henry Creek									E			E	E	E	E	E	E	E	
Diamond Mountain Creek									E					E	E	E	E	E	
Cyrus Creek									E			E	E	E	E	E	E	E	
Garnett Creek									E			E	E	E	E	E	E	E	
Jericho Canyon Creek									E				E	E	E	E	E	E	
Kimball Canyon Creek		E							E				E		E	E	E	E	
Kimball Reservoir		E													E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

SUISUN BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
	Human Consumptive Uses							Aquatic Life Uses								Wildlife Use	Recreational Uses		
Carquinez Strait					E		E			E		E	E	E		E	E	E	E
Suisun Bay					E	E	E			E		E	E	E		E	E	E	E
Sacramento-San Joaquin Delta	E	E		E	E	E	E			E		E	E	E		E	E	E	E
SOLANO COUNTY																			
Grizzly Bay							E			E		E	E			E	E	E	
Honker Bay							E			E		E	E			E	E	E	
Sulphur Springs Creek			E												E	E	E	E	
Lake Herman		E			E				E					E	E	E	E*	E	
Goodyear Slough							E			E		E	E			E	E	E	
Cordelia Slough							E			E		E	E			E	E	E	
Green Valley Creek			E						E			E	E	E	E	E	E	E	
Dan Wilson Creek									E						E	E	E	E	
Wild Horse Creek			E						E						E	E	E	E	
Lake Frey		E							E					E	E	E	E*	E	
Lake Madigan	E	E							E					E	E	E	E*	E	
Suisun Slough							E			E		E	E	E	E	E	E	E	E
Suisun Creek			E						E			E	E	E	E	E	E	E	
Suisun Reservoir			E						E						E	E	E	E	
Wooden Valley Creek									E			E	E	E	E	E	E	E	
Lake Curry		E												E	E	E	E	E	
Sheldrake Slough							E			E			E			E	E	E	
Boynton Slough							E			E			E			E	E	E	
Peytonia Slough							E			E			E			E	E	E	
Ledgewood Creek			E						E			E		E	E	E	E	E	
Gordon Valley Creek									E						E	E	E	E	
Laurel Creek (Solano)			E						E			E		E	E	E	E	E	
Hill Slough							E			E			E			E	E	E	
Cutoff Slough							E			E		E	E			E	E	E	
Spring Branch															E	E	E	E	

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

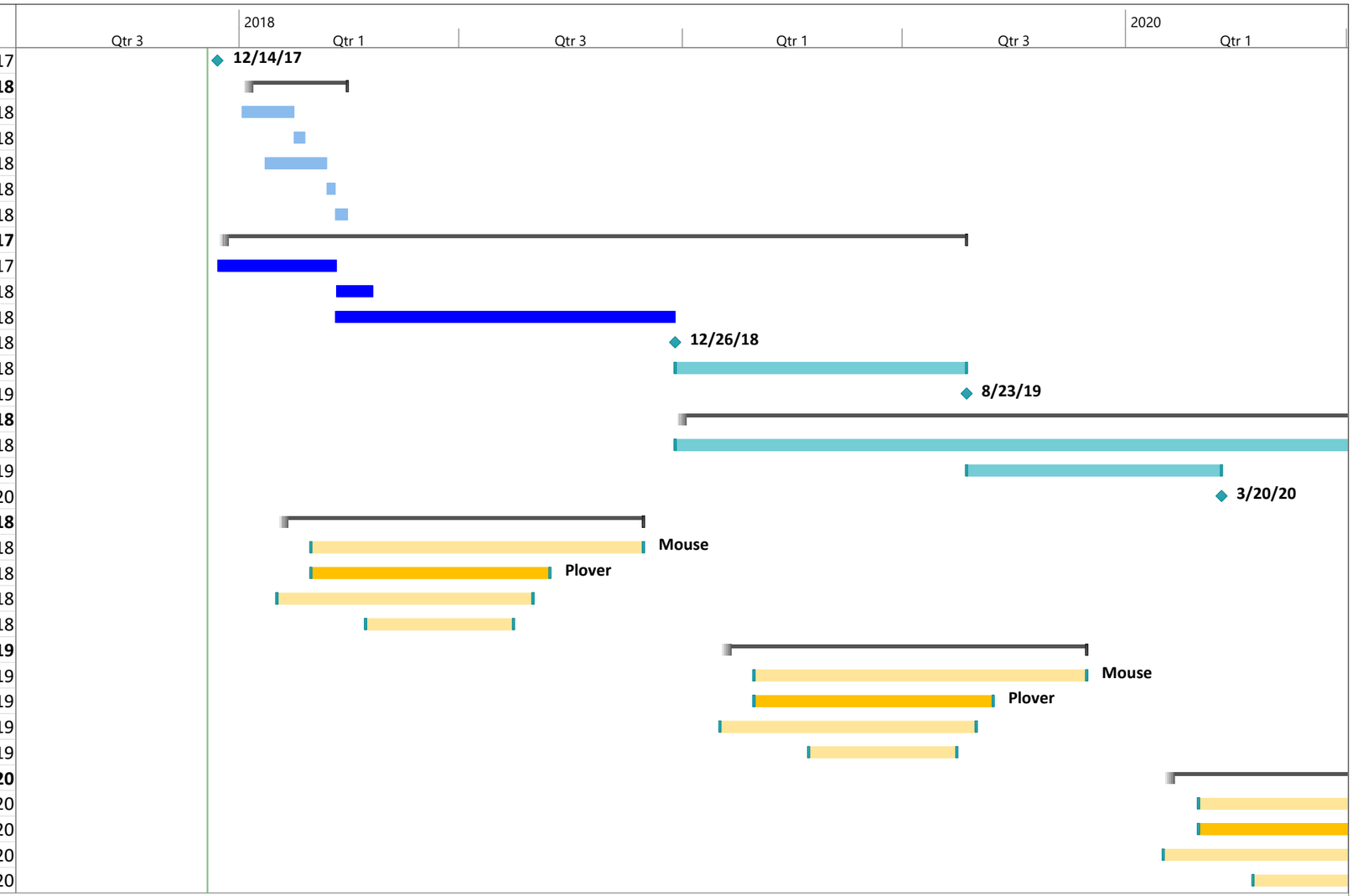
SUISUN BASIN

COUNTY Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
SOLANO COUNTY, continued																			
Volanti Slough							E			E			E			E	E	E	
Montezuma Slough							E			E		E	E	E	E	E	E	E	E
Nurse Slough							E			E		E	E			E	E	E	
Denverton Slough							E			E		E	E			E	E	E	
Denverton Creek													E	E	E	E	E	E	
CONTRA COSTA COUNTY																			
Alhambra Creek									E			E	E		E	E	E	E	
Franklin Creek									E			E	E	E	E	E	E	E	
Arroyo del Hambre									E						E	E	E	E	
Peyton Slough					E		E			E		E	E			E	E	E	
Pacheco Creek															E	E	E	E	
Walnut Creek									E			E	E	E	E	E	E	E	
Grayson Creek									E			E	E		E	E	E	E	
Pine Creek									E			E	E	E	E	E	E	E	
Galindo Creek									E						E	E	E	E	
San Ramon Creek															E	E	E	E	
Bollinger Canyon Creek									E					E	E	E	E	E	
Las Trampas Creek									E				E		E	E	E	E	
Tice Creek													E		E	E	E	E	
Lafayette Creek									E						E	E	E	E	
Lafayette Reservoir		E					E		E					E	E	E	E*	E	
Hastings Slough										E			E			E	E	E	
Mt. Diablo Creek									E			E	E	E	E	E	E	E	
Mitchell Creek									E			E	E	E	E	E	E	E	
Donner Creek									E					E	E	E	E	E	
Mallard Slough (Contra Costa)							E			E		E	E			E	E	E	
Kirker Creek													E		E	E	E	E	
New York Slough							E			E		E	E			E	E	E	E

E: Existing beneficial use E*: Water quality objectives apply; water contact recreation is prohibited or limited to protect public health P: Potential beneficial use

APPENDIX D
CONSTRUCTION SCHEDULE

ID	Task Name	Duration	Start
1	Final RAWP	0 days	12/14/17
2	**Site Characterization**	**63 days**	**1/3/18**
3	Pilot-Scale Sampling/Analysis/95UCL Calculations	31 days	1/3/18
4	Agency/NASA Meeting (95UCL Calculations)	7 days	2/15/18
5	Full-Scale Sampling/Analysis/Volume Calculations	37 days	1/22/18
6	Agency/NASA Meeting (Volume Calculations)	5 days	3/14/18
7	Final Data Report/ Grading Plan	8 days	3/21/18
8	**Removal Action**	**441 days**	**12/14/17**
9	Mobilization	70 days	12/14/17
10	Submittals/Moblization	30 edays	3/21/18
11	Excavation, Off-Site Disposal, Regrading, Vegetatic	10 mons	3/21/18
12	End	0 days	12/26/18
13	RACR (Removal Action Completion Report)	240 edays	12/26/18
14	RACR Complete	0 days	8/23/19
15	**Restoration Monitoring**	**1305 days**	**12/26/18**
16	Restoration Monitoring	1305 days	12/26/18
17	Long-term Management Plan (LTMP)	210 edays	8/22/19
18	LTMP Complete	0 days	3/20/20
19	**Breeding Season 2018**	**216 days**	**2/1/18**
20	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/18
21	Western Snowy Plover Breeding Season	197 edays	3/1/18
22	California Clapper Rail	211 edays	2/1/18
23	California Least Tern	122 edays	4/15/18
24	**Breeding Season 2019**	**216 days**	**2/1/19**
25	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/19
26	Western Snowy Plover Breeding Season	197 edays	3/1/19
27	California Clapper Rail	211 edays	2/1/19
28	California Least Tern	122 edays	4/15/19
29	**Breeding Season 2020**	**215 days**	**2/1/20**
30	Salt Marsh Harvest Mouse Breeding Season	274 edays	3/1/20
31	Western Snowy Plover Breeding Season	197 edays	3/1/20
32	California Clapper Rail	152 days	2/1/20
33	California Least Tern	122 edays	4/15/20



Project: AOI 14 RAWP_Appendix A
Date: 12/14/17

Task		Project Summary		Manual Task		Start-only		Deadline	
Split		Inactive Task		Duration-only		Finish-only		Progress	
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			

APPENDIX E
CONSTRUCTION ACTIVITIES, MATERIALS USED, AND ASSOCIATED POLLUTANTS

Table E.1 Construction Activities and Associated Pollutants

Phase	Activity	Associated Materials or Pollutants	Pollutant Category[1]
Grading and Land Development	Excavation, grading	Sediment	Sediment
	Contaminated soil removal, stockpiling	Metals, PCBs	Metals, Synthetic Organics
	Vehicle and equipment use	Vehicle maintenance and fueling	Oil and Grease, Synthetic Organics, Metals
	Portable toilets	Wash water, septic waste	Bacteria and Viruses
Streets and Utilities Phase	N/A	N/A	N/A
Vertical Construction Phase	N/A	N/A	N/A
Landscaping and Site Stabilization Phase	Final grading, soil roughneing, hydroseeding	Sediment	Sediment
	Vehicle and equipment use	Vehicle maintenance and fueling	Oil and Grease, Synthetic Organics, Metals
	Portable toilets	Wash water, septic waste	Bacteria and Viruses

[1] Categories per CASQA BMP Handbook (i.e., Sediment, Nutrients, Bacteria and Viruses, Oil and Grease, Metals, Synthetic Organics, Pesticides, Gross Pollutants, and Vector Production)

APPENDIX F
CASQA STORMWATER BMP HANDBOOK PORTAL: CONSTRUCTION FACT SHEETS

Section 3
Erosion and Sediment Control BMPs

3.1 Erosion Control

Erosion control is any source control practice that protects the soil surface and prevents soil particles from being detached by rainfall, flowing water, or wind. Erosion control consists of using project scheduling and planning to reduce soil or vegetation disturbance (particularly during the rainy season), preventing or reducing erosion potential by diverting or controlling drainage, as well as preparing and stabilizing disturbed soil areas. Erosion control BMPs that can be used to fulfill these objectives are shown in Table 3-1. It should be noted that several additional BMPs, such as Check Dams (SE-4) and Fiber Rolls (SE-5) can be used for erosion control, by reducing slope length or steepness, as well as for sediment control (i.e., perimeter control or retention of sediment). These BMPs have been included in this handbook as sediment control BMPs and are shown in Table 3-2.

Table 3-1 Erosion Control BMPs

BMP#	BMP Name
EC-1	Scheduling
EC-2	Preservation of Existing Vegetation
EC-3	Hydraulic Mulch[1]
EC-4	Hydroseeding[1]
EC-5	Soil Binders[1]
EC-6	Straw Mulch[1]
EC-7	Geotextiles & Mats[1]
EC-8	Wood Mulching[4]
EC-9	Earth Dikes and Drainage Swales[4]
EC-10	Velocity Dissipation Devices[4]
EC-11	Slope Drains[4]
EC-12	Streambank Stabilization[4]
EC-13	Reserved[2]
EC-14	Compost Blankets[3]
EC-15	Soil Preparation / Roughening[3]
EC-16	Non-Vegetative Stabilization[3]

1) BMP fact sheet updated in 2009
2) BMP fact sheet removed in 2009 (formerly PAM)
3) New BMP fact sheet added in 2009
4) BMP fact sheet updated in 2011

All inactive soil disturbed areas on the project site, and most active areas prior to the onset of rain, must be protected from erosion. Soil disturbed areas may include relatively flat areas as well as slopes. Typically, steep slopes and large exposed areas require the most robust erosion controls; flatter slopes and smaller areas still require protection, but less costly materials may be appropriate for these areas, allowing savings to be directed to the more robust BMPs for steep slopes and large exposed areas. Additional guidance on the selection of temporary slope stabilization methods is provided in Appendix F. To be effective, erosion control BMPs for slopes at disturbed areas must be protected from concentrated flows.

Some erosion control BMPs can be used effectively to temporarily prevent erosion by concentrated flows. These BMPs, used alone or in combination, prevent erosion by intercepting, diverting, conveying, and discharging concentrated flows in a manner that prevents soil detachment and transport. Temporary concentrated flow conveyance controls may be required to direct run-on around or through the project in a non-erodible fashion. Temporary concentrated flow conveyance controls include the following BMPs:

- EC-9, Earth Dikes and Drainage Swales
- EC-10, Velocity Dissipation Devices
- EC-11, Slope Drains

3.2 Sediment Control

Sediment control is any practice that traps soil particles after they have been detached and moved by rain, flowing water, or wind. Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them.

Sediment control practices include the BMPs listed in Table 3-2.

Table 3-2 Temporary Sediment Control BMPs

BMP#	BMP Name
SE-1	Silt Fence[1]
SE-2	Sediment Basin[1, 3]
SE-3	Sediment Trap[3]
SE-4	Check Dam[1]
SE-5	Fiber Rolls[1]
SE-6	Gravel Bag Berm[1]
SE-7	Street Sweeping and Vacuuming[3]
SE-8	Sandbag Barrier[1]
SE-9	Straw Bale Barrier[3]
SE-10	Storm Drain Inlet Protection[1]
SE-11	Active Treatment Systems[1]
SE-12	Temporary Silt Dike[2]
SE-13	Compost Socks and Berms[2]
SE-14	Biofilter Bags[2]

1) BMP fact sheet updated in 2009
2) New BMP fact sheet added in 2009
3) BMP fact sheet updated in 2011

Sediment control BMPs include those practices that intercept and slow or detain the flow of stormwater to allow sediment to settle and be trapped. Sediment control practices can consist of installing linear sediment barriers (such as silt fences, gravel bag berms, or fiber rolls); and constructing check dams, a sediment trap or sediment basin to retain sediment on site. Linear sediment barriers are typically placed below the toe of exposed and erodible slopes, down-slope of exposed soil areas, around soil stockpiles, and at other appropriate locations along the site perimeter. As mentioned in Section 3.1, some BMPs are dual-purpose, such as Fiber Rolls and Check Dams. By reducing effective slope length or steepness, these BMPs reduce erosion as well as promote sedimentation.

Sediment control BMPs are most effective when used in conjunction with erosion control BMPs. The combination of erosion control and sediment control is the most effective means to prevent sediment from leaving the project site and potentially entering storm drains or receiving waters. The General Permit requires that sediment controls be established and maintained at all sites and requires the combined use with erosion controls to protect disturbed areas at most sites.

3.3 Wind Erosion Control

Wind erosion control consists of applying water or other dust palliatives to prevent or minimize dust nuisance. Wind erosion control BMPs are shown in Table 3-3.

Table 3-3 Wind Erosion Control BMPs

BMP#	BMP Name
WE-1	Wind Erosion Control[1, 2]
1) BMP fact Sheet updated in 2009	
2) BMP fact sheet updated in 2011	

Other BMPs that control wind erosion are EC-1 through EC-8, and EC-14 through EC-16, shown in Section 3.1 of this handbook. Be advised that some of the dust palliatives/chemical dust suppression agents may have potential water quality impacts. A sampling and analysis protocol to test for stormwater contamination from exposure to such compounds is required in the SWPPP.

3.4 Tracking Control BMPs

Tracking control consists of preventing or reducing the tracking of sediment off-site by vehicles leaving the construction area. Tracking control BMPs are shown in Table 3-4. Street Sweeping and Vacuuming (SE-7) is also a tracking control practice. All sites must have a stabilized construction entrance and implement controls to prevent off-site tracking of sediment or other loose construction-related materials. These controls should be inspected daily.

Table 3-4 Temporary Tracking Control BMPs

BMP #	BMP Name
TC-1	Stabilized Construction Entrance/ Exit[1]
TC-2	Stabilized Construction Roadway[1]
TC-3	Entrance/Outlet Tire Wash[1]
1) BMP fact Sheet updated in 2011	

Attention to control of tracking sediment off site is essential, as dirty streets and roads near a construction site create a nuisance to the public and can generate complaints to elected officials and regulators. These complaints often result in immediate inspections and regulatory actions.

3.5 Erosion and Sediment Control BMP Fact Sheet Format

A BMP fact sheet is a short document that presents detailed information about a particular BMP. Typically each fact sheet contains the information outlined in Figure 3-1. Fact sheets for each of the above activities are provided in Section 3.6.

The fact sheets also contain side bar presentations with information on BMP categories, targeted constituents, removal effectiveness, and potential alternatives.

EC-xx Example Fact Sheet

Description and Purpose

Suitable Applications

Limitations

Implementation

Costs

Inspection and Maintenance

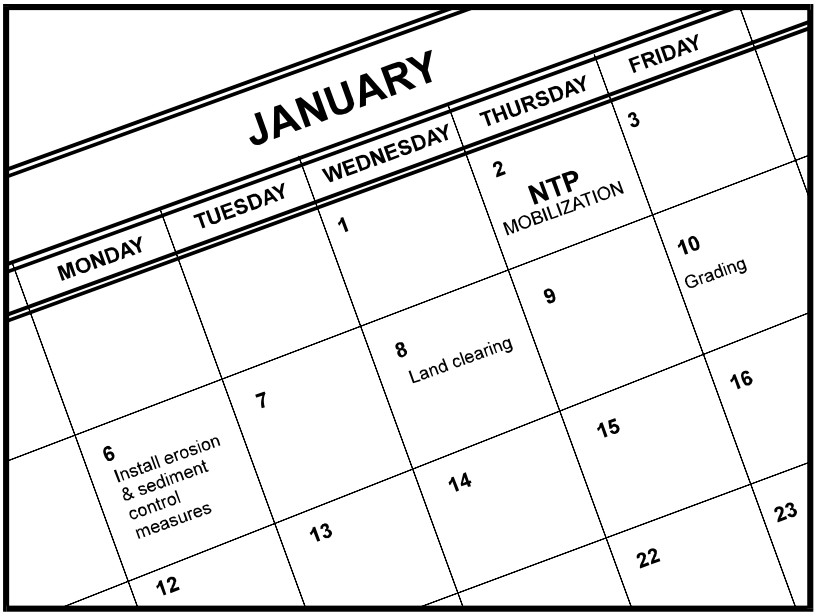
References

Figure 3-1
Example Fact Sheet

3.6 BMP Fact Sheets

BMP fact sheets for erosion, sediment, wind, and tracking controls follow. The BMP fact sheets are individually page numbered and are suitable for inclusion in SWPPPs. Copies of the fact sheets can be individually downloaded from the CASQA BMP Handbook Portal at http://www.casqa.org.

Scheduling EC-1



Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.

- Plan the project and develop a schedule showing each phase

of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

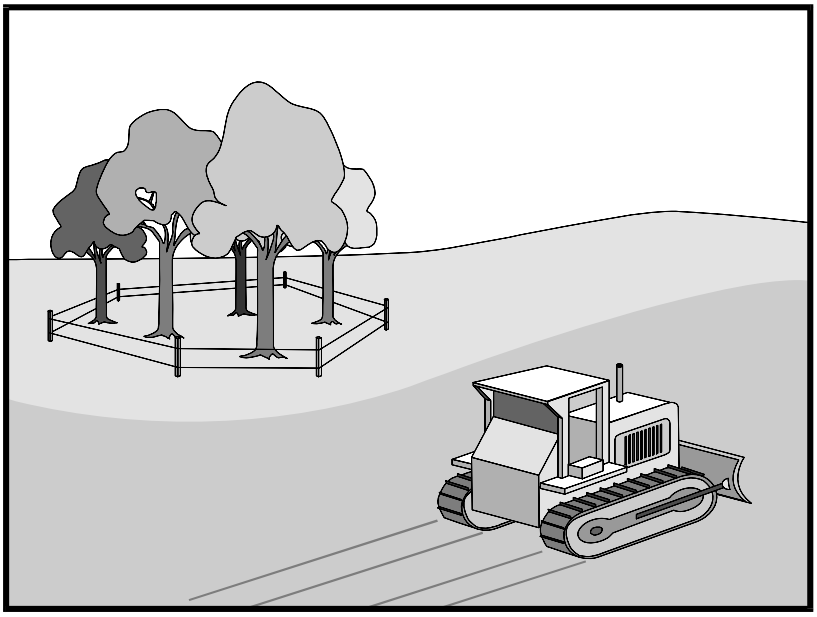
- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Preservation Of Existing Vegetation EC-2



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

Limitations

- Requires forward planning by the owner/developer,

contractor, and design staff.

- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

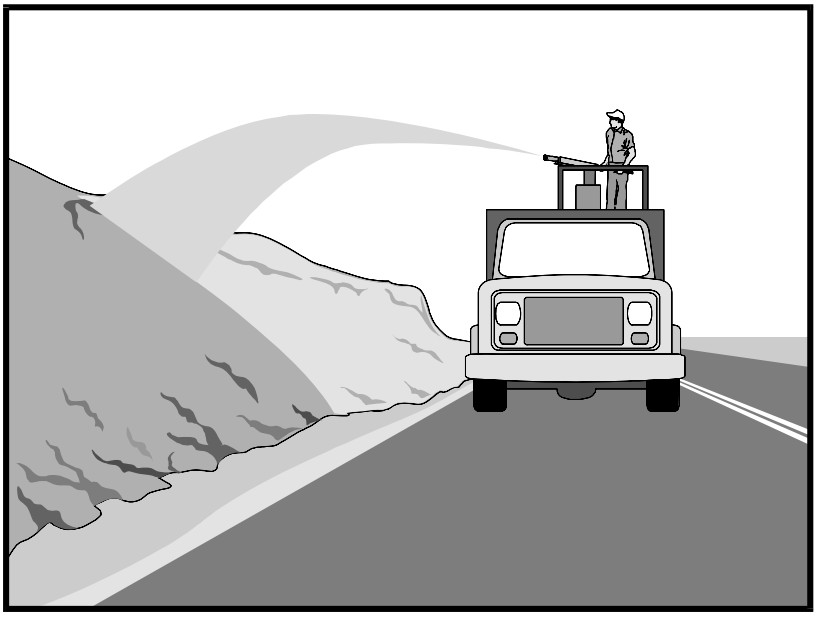
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydraulic Mulch EC-3



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

EC-16 Non-Vegetative Stabilization

Description and Purpose

Hydraulic Mulch consists of various types of fibrous materials mixed with water and sprayed onto the soil surface in slurry form to provide a layer of temporary protection from wind and water erosion.

Suitable Applications

Hydraulic mulch as a temporary, stand alone, erosion control BMP is suitable for disturbed areas that require temporary protection from wind and water erosion until permanent soil stabilization activities commence. Examples include:

- Rough-graded areas that will remain inactive for longer than permit-required thresholds (e.g., 14 days) or otherwise require stabilization to minimize erosion or prevent sediment discharges.
- Soil stockpiles.
- Slopes with exposed soil between existing vegetation such as trees or shrubs.
- Slopes planted with live, container-grown vegetation or plugs.
- Slopes burned by wildfire.

Hydraulic mulch can also be applied to augment other erosion control BMPs such as:

- In conjunction with straw mulch (see EC-6 Straw Mulch) where the rate of hydraulic mulch is reduced to 100-500 lbs per acre and the slurry is applied over the straw as a tackifying agent to hold the straw in place.
- Supplemental application of soil amendments, such as fertilizer, lime, gypsum, soil bio-stimulants or compost.

Limitations

In general, hydraulic mulch is not limited by slope length, gradient or soil type. However, the following limitations typically apply:

- Most hydraulic mulch applications, particularly bonded fiber matrices (BFMs), require at least 24 hours to dry before rainfall occurs.
- Temporary applications (i.e., without a vegetative component) may require a second application in order to remain effective for an entire rainy season.
- Treatment areas must be accessible to hydraulic mulching equipment.
- Availability of water sources in remote areas for mixing and application.
- As a stand-alone temporary BMP, hydraulic mulches may need to be re-applied to maintain their erosion control effectiveness, typically after 6-12 months depending on the type of mulch used.
- Availability of hydraulic mulching equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- Cellulose fiber mulches alone may not perform well on steep slopes or in course soils.

Implementation

- Where feasible, it is preferable to prepare soil surfaces prior to application by roughening embankments and fill areas with a crimping or punching type roller or by track walking.
- The majority of hydraulic mulch applications do not necessarily require surface/soil preparation (See EC-15 Soil Preparation) although in almost every case where re-vegetation is included as part of the practice, soil preparation can be beneficial. One of the advantages of hydraulic mulch over other erosion control methods is that it can be applied in areas where soil preparation is precluded by site conditions, such as steep slopes, rocky soils, or inaccessibility.
- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Hydraulic mulching is generally performed utilizing specialized machines that have a large water-holding/mixing tank and some form of mechanical agitation or other recirculation method to keep water, mulch and soil amendments in suspension. The mixed hydraulic slurry can be applied from a tower sprayer on top of the machine or by extending a hose to areas remote from the machine.

- Where possible apply hydraulic mulch from multiple directions to adequately cover the soil. Application from a single direction can result in shadowing, uneven coverage and failure of the BMP.
- Hydraulic mulch can also include a vegetative component, such as seed, rhizomes, or stolons (see EC-4 Hydraulic Seed).
- Typical hydraulic mulch application rates range from 2,000 pounds per acre for standard mulches (SMs) to 3,500 pounds per acre for BFMs. However, the required amount of hydraulic mulch to provide adequate coverage of exposed topsoil may appear to exceed the standard rates when the roughness of the soil surface is changed due to soil preparation methods (see EC-15 Soil Preparation) or by slope gradient.
- Other factors such as existing soil moisture and soil texture can have a profound effect on the amount of hydraulic mulch required (i.e. application rate) applied to achieve an erosion-resistant covering.
- Avoid use of mulch without a tackifier component, especially on slopes.
- Mulches used in the hydraulic mulch slurry can include:
  - Cellulose fiber
  - Thermally-processed wood fibers
  - Cotton
  - Synthetics
  - Compost (see EC-14, Compost Blanket)
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Categories of Hydraulic Mulches

Standard Hydraulic Mulch (SM)

Standard hydraulic mulches are generally applied at a rate of 2,000 pounds per acre and are manufactured containing around 5% tackifier (i.e. soil binder), usually a plant-derived guar or psyllium type. Most standard mulches are green in color derived from food-color based dyes.

Hydraulic Matrices (HM) and Stabilized Fiber Matrices (SFM)

Hydraulic matrices and stabilized fiber matrices are slurries which contain increased levels of tackifiers/soil binders; usually 10% or more by weight. HMs and SFMs have improved performance compared to a standard hydraulic mulch (SM) because of the additional percentage of tackifier and because of their higher application rates, typically 2,500 – 4,000 pounds per acre. Hydraulic matrices can include a mixture of fibers, for example, a 50/50 blend of paper and wood fiber. In the case of an SFM, the tackifier/soil binder is specified as a polyacrylamide (PAM).

Bonded Fiber Matrix (BFM)

Bonded fiber matrices (BFMs) are hydraulically-applied systems of fibers, adhesives (typically guar based) and chemical cross-links. Upon drying, the slurry forms an erosion-resistant blanket that prevents soil erosion and promotes vegetation establishment. The cross-linked adhesive in the BFM should be biodegradable and should not dissolve or disperse upon re-wetting. BFMs are typically applied at rates from 3,000 to 4,000 lbs/acre based on the manufacturer's recommendation. BFMs should not be applied immediately before, during or immediately after rainfall or if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Mechanically-Bonded Fiber Matrices (MBFM)

Mechanically-bonded fiber matrices (MBFMs) are hydraulically applied systems similar to BFM that use crimped synthetic fibers and PAM and are typically applied to a slope at a higher application rate than a standard BFM.

Hydraulic Compost Matrix (HCM)

Hydraulic compost matrix (HCM) is a field-derived practice whereby finely graded or sifted compost is introduced into the hydraulic mulch slurry. A guar-type tackifier can be added for steeper slope applications as well as any specified seed mixtures. A HCM can help to accelerate seed germination and growth. HCMs are particularly useful as an in-fill for three-dimensional re-vegetation geocomposites, such as turf reinforcement mats (TRM) (see EC-7 Geotextiles and Mats).

Costs

Average installed costs for hydraulic mulch categories are is provided in Table 1, below.

Table 1
HYDRAULIC MULCH BMPs
INSTALLED COSTS

BMP	Installed Cost/Acre
Standard Hydraulic Mulching (SM)	$1,700 - $3,600 per acre
Hydraulic Matrices (HM) and Stabilized Fiber Matrices	
Guar-based	$2,000 - $4,000 per acre
PAM-based	$2,500 - $5,610 per acre
Bonded Fiber Matrix (BFM)	$3,900 - $6,900 per acre
Mechanically Bonded Fiber Matrix (MBFM)	$4,500 - $6,000 per acre
Hydraulic Compost Matrix (HCM)	$3,000 - $3,500 per acre

Source: Caltrans Soil Stabilization BMP Research for Erosion and Sediment Controls, July 2007

Inspection and Maintenance

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected

weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Compare the number of bags or weight of applied mulch to the area treated to determine actual application rates and compliance with specifications.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Controlling Erosion of Construction Sites, Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

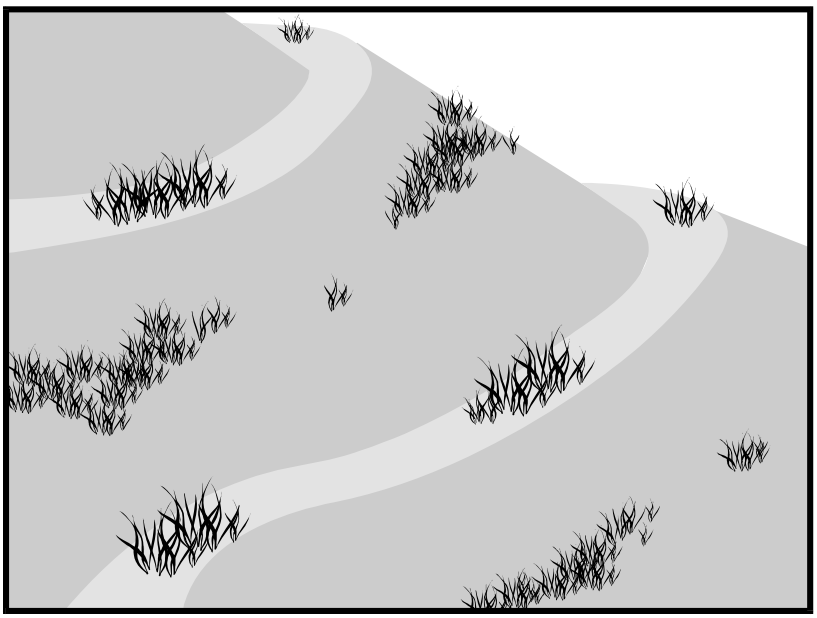
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydroseeding EC-4



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

EC-16 Non-Vegetative Stabilization

Description and Purpose

Hydroseeding typically consists of applying a mixture of a hydraulic mulch, seed, fertilizer, and stabilizing emulsion with a hydraulic mulcher, to temporarily protect exposed soils from erosion by water and wind. Hydraulic seeding, or hydroseeding, is simply the method by which temporary or permanent seed is applied to the soil surface.

Suitable Applications

Hydroseeding is suitable for disturbed areas requiring temporary protection until permanent stabilization is established, for disturbed areas that will be re-disturbed following an extended period of inactivity, or to apply permanent stabilization measures. Hydroseeding without mulch or other cover (e.g. EC-7, Erosion Control Blanket) is not a stand-alone erosion control BMP and should be combined with additional measures until vegetation establishment.

Typical applications for hydroseeding include:

- Disturbed soil/graded areas where permanent stabilization or continued earthwork is not anticipated prior to seed germination.
- Cleared and graded areas exposed to seasonal rains or temporary irrigation.
- Areas not subject to heavy wear by construction equipment or high traffic.

Limitations

- Availability of hydroseeding equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- Hydraulic seed should be applied with hydraulic mulch or a stand-alone hydroseed application should be followed by one of the following:
    - Straw mulch (see Straw Mulch EC-6)
    - Rolled erosion control products (see Geotextiles and Mats EC-7)
    - Application of Compost Blanket (see Compost Blanket EC-14)

  Hydraulic seed may be used alone only on small flat surfaces when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control.
- Hydraulic seed without mulch does not provide immediate erosion control.
- Temporary seeding may not be appropriate for steep slopes (i.e., slopes readily prone to rill erosion or without sufficient topsoil).
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation may not be appropriate for short term inactivity (i.e. less than 3-6 months).

Implementation

In order to select appropriate hydraulic seed mixtures, an evaluation of site conditions should be performed with respect to:

- Soil conditions
- Site topography and exposure (sun/wind)
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

The local office of the U.S.D.A. Natural Resources Conservation Service (NRCS) is an excellent source of information on appropriate seed mixes.

The following steps should be followed for implementation:

- Where appropriate or feasible, soil should be prepared to receive the seed by disking or otherwise scarifying (See EC-15, Soil Preparation) the surface to eliminate crust, improve air and water infiltration and create a more favorable environment for germination and growth.

- Avoid use of hydraulic seed in areas where the BMP would be incompatible with future earthwork activities.
- Hydraulic seed can be applied using a multiple step or one step process.
  - In a multiple step process, hydraulic seed is applied first, followed by mulch or a Rolled Erosion Control Product (RECP).
  - In the one step process, hydraulic seed is applied with hydraulic mulch in a hydraulic matrix. When the one step process is used to apply the mixture of fiber, seed, etc., the seed rate should be increased to compensate for all seeds not having direct contact with the soil.
- All hydraulically seeded areas should have mulch, or alternate erosion control cover to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- All seeds should be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag should be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container should be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed should be pellet inoculated. Inoculant sources should be species specific and should be applied at a rate of 2 lb of inoculant per 100 lb seed.
- Commercial fertilizer should conform to the requirements of the California Food and Agricultural Code, which can be found at http://www.leginfo.ca.gov/.html/fac_table_of_contents.html. Fertilizer should be pelleted or granular form.
- Follow up applications should be made as needed to cover areas of poor coverage or germination/vegetation establishment and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Costs

Average cost for installation and maintenance may vary from as low as $1,900 per acre for flat slopes and stable soils, to $4,000 per acre for moderate to steep slopes and/or erosive soils. Cost of seed mixtures vary based on types of required vegetation.

BMP	Installed Cost per Acre
Hydraulic Seed	$1,900-$4,000

Source: Caltrans Soil Stabilization BMP Research for Erosion and Sediment Controls, July 2007

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.

- Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.

- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system must be shut down immediately and breaks repaired before the system is put back into operation.

- Irrigation systems should be inspected for complete coverage and adjusted as needed to maintain complete coverage.

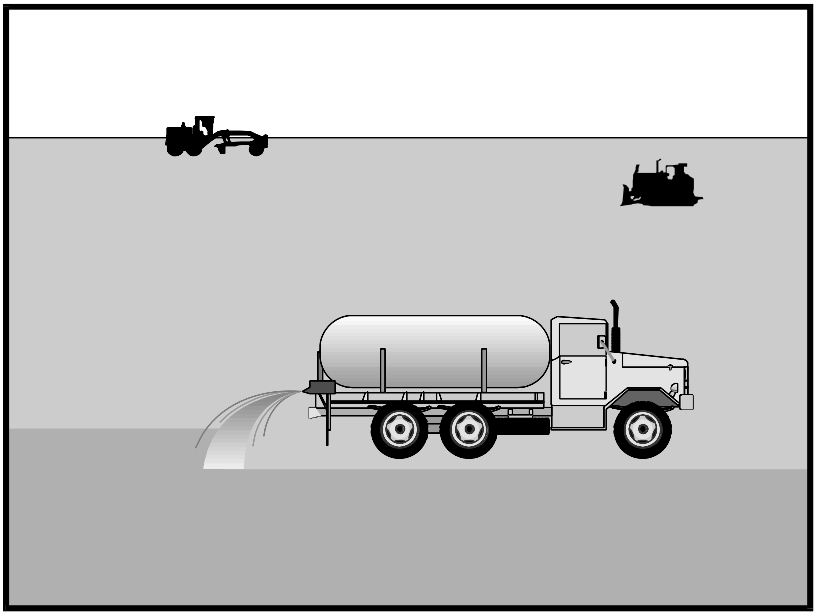
References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Soil Binders EC-5



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Soil binding consists of application and maintenance of a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water and wind induced erosion of exposed soils on construction sites.

Suitable Applications

Soil binders are typically applied to disturbed areas requiring temporary protection. Because soil binders, when used as a stand-alone practice, can often be incorporated into the soil, they are a good alternative to mulches in areas where grading activities will soon resume. Soil binders are commonly used in the following areas:

- Rough graded soils that will be inactive for a short period of time
- Soil stockpiles
- Temporary haul roads prior to placement of crushed rock
- Compacted soil road base
- Construction staging, materials storage, and layout areas

Limitations

- Soil binders are temporary in nature and may need reapplication.

- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after a storm event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.
- Plant-material-based soil binders do not generally hold up to pedestrian or vehicular traffic across treated areas as well as polymeric emulsion blends or cementitious-based binders.
- Soil binders may not sufficiently penetrate compacted soils.
- Some soil binders are soil texture specific in terms of their effectiveness. For example, polyacrylamides (PAMs) work very well on silt and clayey soils but their performance decreases dramatically in sandy soils.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours of application.
- The water quality impacts of some chemical soil binders are relatively unknown and some may have water quality impacts due to their chemical makeup.

Implementation

General Considerations

- Soil binders should conform to local municipality specifications and requirements.
- Site soil types will dictate appropriate soil binders to be used.
- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Soil binders should not pollute stormwater when cured. Obtain a Material Safety Data Sheet (MSDS) from the manufacturer to ensure non-toxicity.
- Stormwater runoff from PAM treated soils should pass through one of the following sediment control BMP prior to discharging to surface waters.
  - When the total drainage area is greater than or equal to 5 acres, PAM treated areas should drain to a sediment basin.
  - Areas less than 5 acres should drain to sediment control BMPs, such as a sediment trap, or a series of check dams. The total number of check dams used should be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam should be spaced evenly in the drainage channel through which stormwater flows are discharged off site.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.

- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Selecting a Soil Binder

Properties of common soil binders used for erosion control are provided on Table 1 at the end of this Fact Sheet. Use Table 1 to select an appropriate soil binder. Refer to WE-1, Wind Erosion Control, for dust control soil binders.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders.
- Soil types and surface materials - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application - The frequency of application is related to the functional longevity of the binder, which can be affected by subgrade conditions, surface type, climate, and maintenance schedule.
- Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean up.

Plant-Material-Based (Short Lived, <6 months) Binders

Guar: Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It should be mixed with water at the rate of 11 to 15 lb per 1,000 gallons. Recommended minimum application rates are as follows:

Application Rates for Guar Soil Stabilizer

Slope (H:V):	Flat	4:1	3:1	2:1	1:1
lb/acre:	40	45	50	60	70

Psyllium: Psyllium is composed of the finely ground muciloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together, but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates should be from 80 to 200 lb/acre, with enough water in solution to allow for a uniform slurry flow.

Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 lb/acre. Approximate drying time is 9 to 12 hours.

Plant-Material-Based (Long Lived, 6-12 months) Binders

Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and should be applied as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil: 10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

Polymeric Emulsion Blend Binders

Acrylic Copolymers and Polymers: Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming agent. The polymeric emulsion should not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound typically requires 12 to 24 hours drying time. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and the mixture applied to soil at a rate of 1,175 gallons/acre.

Liquid Polymers of Methacrylates and Acrylates: This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water in accordance with the manufacturer's recommendations, and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after application.

Copolymers of Sodium Acrylates and Acrylamides: These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Slope Gradient (H:V)	lb/acre
Flat to 5:1	3.0 – 5.0
5:1 to 3:1	5.0 – 10.0
2:1 to 1:1	10.0 – 20.0

Poly-Acrylamide (PAM) and Copolymer of Acrylamide**:** Linear copolymer polyacrylamide for use as a soil binder is packaged as a dry flowable solid, as a liquid. Refer to the manufacturer's recommendation for dilution and application rates as they vary based on liquid or dry form, site conditions and climate.

- Limitations specific to PAM are as follows:

- Do not use PAM on a slope that flows into a water body without passing through a sediment trap or sediment basin.

- The specific PAM copolymer formulation must be anionic. Cationic PAM should not be used in any application because of known aquatic toxicity problems. Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, should be used for soil applications.

- PAM designated for erosion and sediment control should be "water soluble" or "linear" or "non-cross linked".

- PAM should not be used as a stand-alone BMP to protect against water-based erosion. When combined with mulch, its effectiveness increases dramatically.

Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 lb/acre. Drying times are 0 to 4 hours.

Cementitious-Based Binders

Gypsum: This is a formulated gypsum based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in a hydraulic seeder and applied at rates 4,000 to 12,000 lb/acre. Drying time is 4 to 8 hours.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. In general, the following steps should be followed:

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.

- Prior to application, roughen embankment and fill areas.

- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should not be applied during or immediately before rainfall.

- Avoid over spray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.

- Soil binders should not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 40°F during the curing period.

- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.

- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time.

- For liquid agents:
  - Crown or slope ground to avoid ponding.
  - Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 or according to manufacturer's recommendations.
  - Apply solution under pressure. Overlap solution 6 to 12 in.
  - Allow treated area to cure for the time recommended by the manufacturer; typically at least 24 hours.
  - Apply second treatment before first treatment becomes ineffective, using 50% application rate.
  - In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2.

Costs

Costs vary according to the soil stabilizer selected for implementation. The following are approximate installed costs:

Soil Binder	Cost per Acre (2000)[1]	Estimated Cost per Acre (2009)[2]
Plant-Material-Based (Short Lived) Binders	$700-$900	$770-$990
Plant-Material-Based (Long Lived) Binders	$1,200-$1,500	$1,320-$1,650
Polymeric Emulsion Blend Binders	$700 -$1,500	$770-$1,650
Cementitious-Based Binders	$800-$1,200	$880-$1,350

1. Source: Erosion Control Pilot Study Report, Caltrans, June 2000.

2. 2009 costs reflect a 10% escalation over year 2000 costs. Escalation based on informal survey of industry trends. Note: Expected cost increase is offset by competitive economic conditions.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

Table 1 Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	**Plant Material Based (Long Lived)**	**Polymeric Emulsion Blends**	**Cementitious-Based Binders**
Relative Cost	Low	Moderate to High	Low to High	Low to Moderate
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies (1)	Varies (1)	Varies (1)	4,000 to 12,000 lbs/acre

(1) See Implementation for specific rates.

References

Erosion Control Pilot Study Report, State of California Department of Transportation (Caltrans), June 2000.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

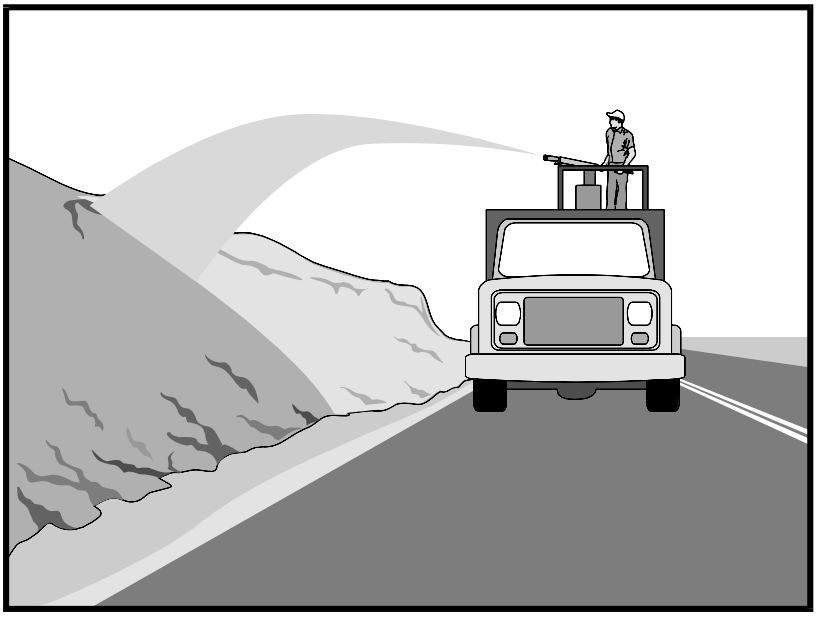
Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Straw Mulch EC-6



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

Description and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or crimper, or anchoring it with a tackifier or stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.

Suitable Applications

Straw mulch is suitable for disturbed areas requiring temporary protection until permanent stabilization is established. Straw mulch can be specified for the following applications:

- As a stand-alone BMP on disturbed areas until soils can be prepared for permanent vegetation. The longevity of straw mulch is typically less than six months.
- Applied in combination with temporary seeding strategies
- Applied in combination with permanent seeding strategies to enhance plant establishment and final soil stabilization
- Applied around containerized plantings to control erosion until the plants become established to provide permanent stabilization

Limitations

- Availability of straw and straw blowing equipment may be limited just prior to the rainy season and prior to storms due to high demand.

- There is a potential for introduction of weed seed and unwanted plant material if weed-free agricultural straw is not specified.
- Straw mulch applied by hand is more time intensive and potentially costly.
- Wind may limit application of straw and blow straw into undesired locations.
- May have to be removed prior to permanent seeding or prior to further earthwork.
- "Punching" of straw does not work in sandy soils, necessitating the use of tackifiers.
- Potential fugitive dust control issues associated with straw applications can occur. Application of a stabilizing emulsion or a water stream at the same time straw is being blown can reduce this problem.
- Use of plastic netting should be avoided in areas where wildlife may be entrapped and may be prohibited for projects in certain areas with sensitive wildlife species, especially reptiles and amphibians.

Implementation

- Straw should be derived from weed-free wheat, rice, or barley. Where required by the plans, specifications, permits, or environmental documents, native grass straw should be used.
- Use tackifier to anchor straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track walking may also be used to incorporate straw mulch into the soil on slopes. Track walking can be used where other methods are impractical.
- Avoid placing straw onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Straw mulch with tackifier should not be applied during or immediately before rainfall.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Application Procedures

- When using a tackifier to anchor the straw mulch, roughen embankment or fill areas by rolling with a crimping or punching-type roller or by track walking before placing the straw mulch. Track walking should only be used where rolling is impractical.
- Apply straw at a rate of between 3,000 and 4,000 lb/acre, either by machine or by hand distribution and provide 100% ground cover. A lighter application is used for flat surfaces and a heavier application is used for slopes.
- Evenly distribute straw mulch on the soil surface.
- Anchoring straw mulch to the soil surface by "punching" it into the soil mechanically (incorporating) can be used in lieu of a tackifier.

- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity.
  - A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier should be selected based on longevity and ability to hold the fibers in place. A tackifier is typically applied at a rate of 125 lb/acre. In windy conditions, the rates are typically 180 lb/acre.
  - On very small areas, a spade or shovel can be used to punch in straw mulch.
  - On slopes with soils that are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife blade roller or a straight bladed coulter, known commercially as a "crimper."

Costs

Average annual cost for installation and maintenance is included in the table below. Application by hand is more time intensive and potentially more costly.

BMP	Unit Cost per Acre
Straw mulch, crimped or punched	$2,458-$5,375
Straw mulch with tackifier	$1,823-$4,802

Source: Caltrans Soil Stabilization BMP Research for Erosion and Sediment Controls, July 2007

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- The key consideration in inspection and maintenance is that the straw needs to last long enough to achieve erosion control objectives. Straw mulch as a stand-alone BMP is temporary and is not suited for long-term erosion control.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are inactive. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required to maintain effective soil stabilization over disturbed areas and slopes.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Controlling Erosion of Construction Sites, Agricultural Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

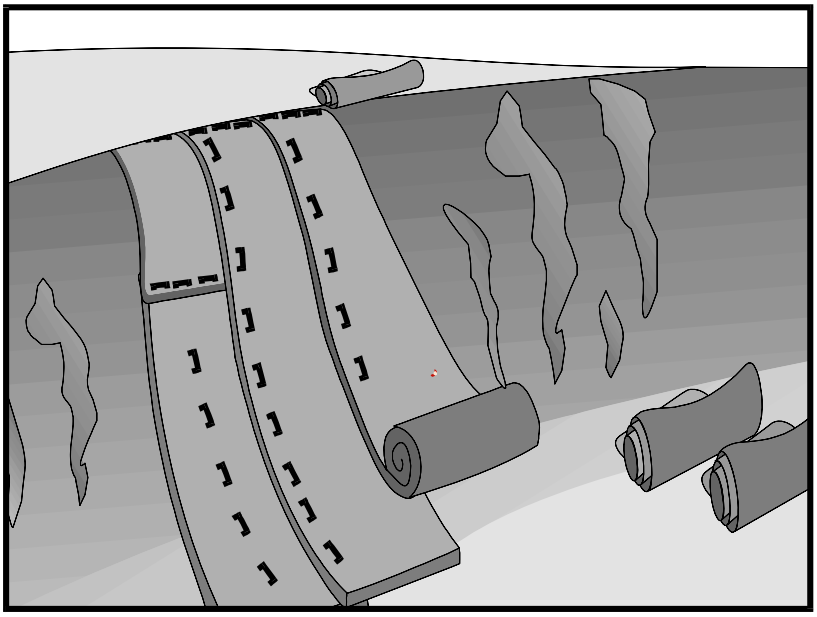
Soil Erosion by Water, Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Geotextiles and Mats EC-7



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

Description and Purpose

Mattings, or Rolled Erosion Control Products (RECPs), can be made of natural or synthetic materials or a combination of the two. RECPs are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, RECPs may be used to stabilize soils until vegetation is established or to reinforce non-woody surface vegetation.

Suitable Applications

RECPs are typically applied on slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks, swales and other drainage channels where moving water at velocities between 3 ft/s and 6 ft/s are likely to cause scour and wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. RECPs may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). RECPs should be considered when the soils are fine grained and potentially erosive. RECPs should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop

- Channels with flows exceeding 3.3 ft/s
- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies

Limitations

- RECP installed costs are generally higher than other erosion control BMPs, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- RECPs may delay seed germination, due to reduction in soil temperature.
- RECPs are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers). If a staple or pin cannot be driven into the soil because the underlying soil is too hard or rocky, then an alternative BMP should be selected.
- If used for temporary erosion control, RECPs should be removed and disposed of prior to application of permanent soil stabilization measures.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until more environmentally friendly measures, such as seeding and mulching, may be installed.
    - Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
    - Plastic sheeting results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- RECPs may have limitations based on soil type, slope gradient, or channel flow rate; consult the manufacturer for proper selection.
- Not suitable for areas that have foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.
- RECPs that incorporate a plastic netting (e.g. straw blanket typically uses a plastic netting to hold the straw in place) may not be suitable near known wildlife habitat. Wildlife can become trapped in the plastic netting.
- RECPs may have limitations in extremely windy climates. However, when RECPs are properly trenched at the top and bottom and stapled in accordance with the manufacturer's recommendations, problems with wind can be minimized.

Implementation

Material Selection

- Natural RECPs have been found to be effective where re-vegetation will be provided by re-seeding. The choice of material should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

- The following natural and synthetic RECPs are commonly used:

Geotextiles

- Material can be a woven or a non-woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Generally plastic sheeting should only be used as stockpile covering or for very small graded areas for short periods of time (such as through one imminent storm event). If plastic sheeting must be used, choose a plastic that will withstand photo degradation.

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope (when used as a temporary slope protection) and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil (when used as a temporary slope protection).

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable RECPs are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable. See typical installation details at the end of this fact sheet.

- **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. The performance of jute as a stand-alone RECP is low. Most other RECPs outperform jute as a temporary erosion control product and therefore jute is not commonly used. It is designed to be used in conjunction with vegetation. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

  - **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips,

which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper soil preparation is essential to ensure complete contact of the RECP with the soil. Soil Roughening is not recommended in areas where RECPs will be installed.
- Grade and shape the area of installation.
- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding/Planting

Seed the area before blanket installation for erosion control and re-vegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all areas disturbed during blanket installation must be re-seeded. Where soil filling is specified for turf reinforcement mats (TRMs), seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots shall be installed as required by the manufacturer.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the seedbed should be friable, made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.
- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.
- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft (or greater, per manufacturer's specifications).
- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2. Check manufacturer's specifications to determine if a higher density staple pattern is required.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.

- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement mat (TRM))

Installation should be in accordance with the manufacturer's recommendations. Typical installation guidelines are as follows:

- After seeding, spread and lightly rake ½-3/4 inches of fine topsoil into the TRM apertures to completely fill TRM thickness. Use backside of rake or other flat implement.
- Alternatively, if allowed by product specifications, spread topsoil using lightweight loader, backhoe, or other power equipment. Avoid sharp turns with equipment.
- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Installed costs can be relatively high compared to other BMPs. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre (2000)[1]	Estimated Cost per Acre (2009)[2]
Biodegradable	Jute Mesh	$6,000-$7,000	$6,600-$7,700
	Curled Wood Fiber	$8,000-$10,500	$8,800-$11,050
	Straw	$8,000-$10,500	$8,800-$11,050
	Wood Fiber	$8,000-$10,500	$8,800-$11,050
	Coconut Fiber	$13,000-$14,000	$14,300-$15,400
	Coconut Fiber Mesh	$30,000-$33,000	$33,000-$36,300
	Straw Coconut Fiber	$10,000-$12,000	$11,000-$13,200
Non-Biodegradable	Plastic Netting	$2,000-$2,200	$2,200-$2,220
	Plastic Mesh	$3,000-$3,500	$3,300-$3,850
	Synthetic Fiber with Netting	$34,000-$40,000	$37,400-$44,000
	Bonded Synthetic Fibers	$45,000-$55,000	$49,500-$60,500
	Combination with Biodegradable	$30,000-$36,000	$33,000-$39,600

1. Source: Erosion Control Pilot Study Report, Caltrans, June 2000.
2. 2009 costs reflect a 10% escalation over year 2000 costs. Escalation based on informal survey of industry trends. Note: Expected cost increase is offset by competitive economic conditions.

Inspection and Maintenance

- RECPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.

References

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005

Erosion Control Pilot Study Report, State of California Department of Transportation (Caltrans), June 2000.

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

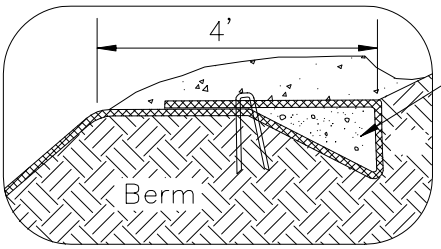
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

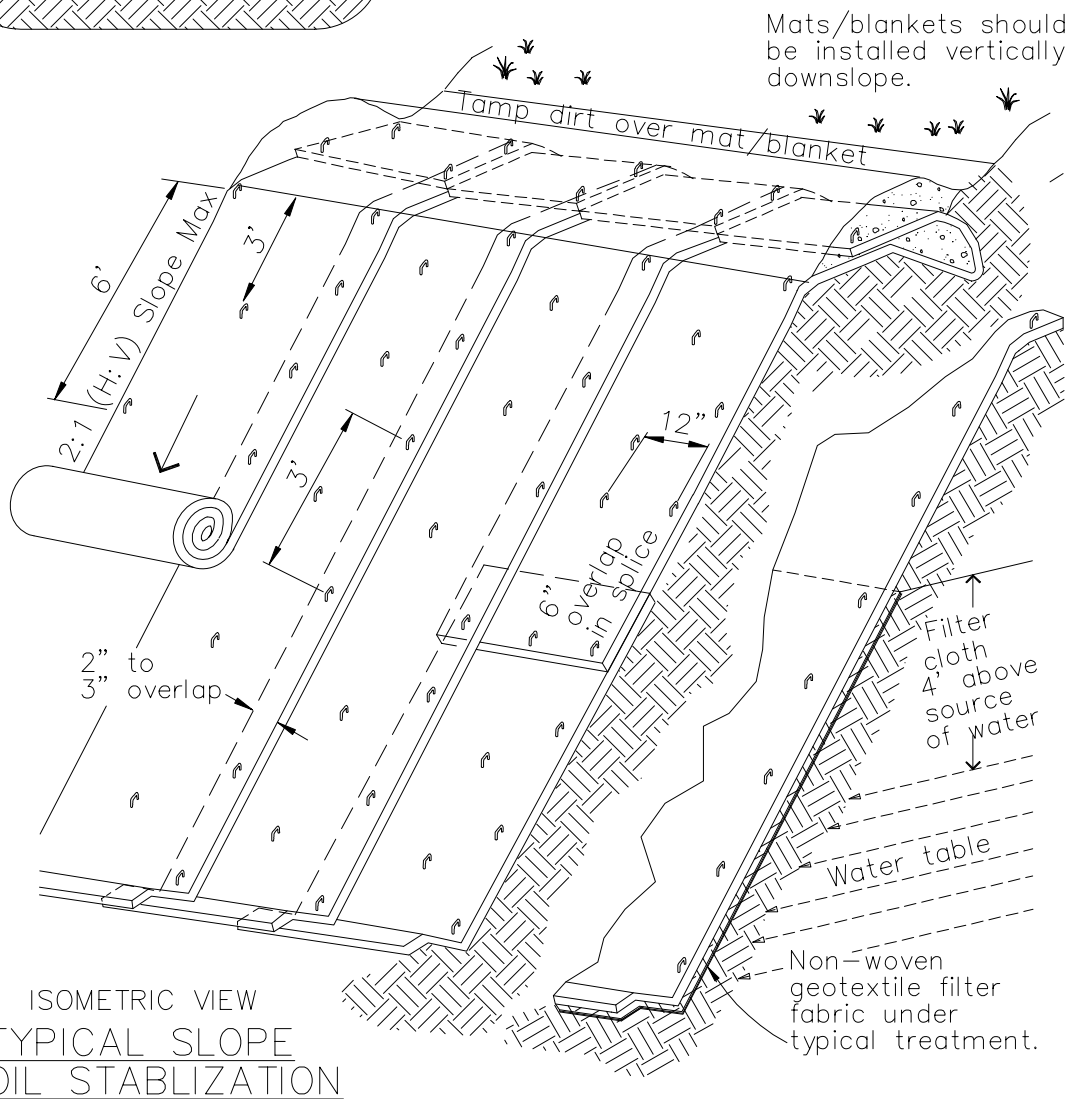
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.





ISOMETRIC VIEW

TYPICAL SLOPE SOIL STABLIZATION

NTS

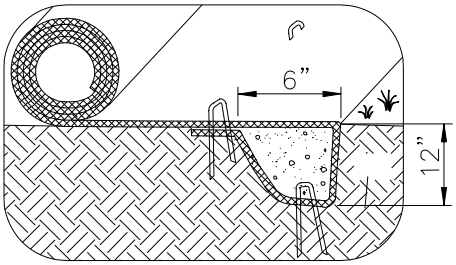
WET SLOPE LINING

NTS

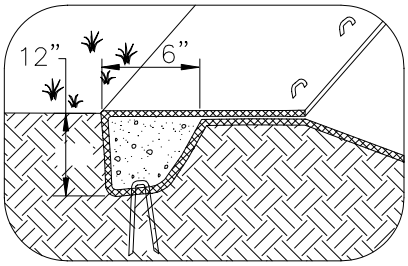
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

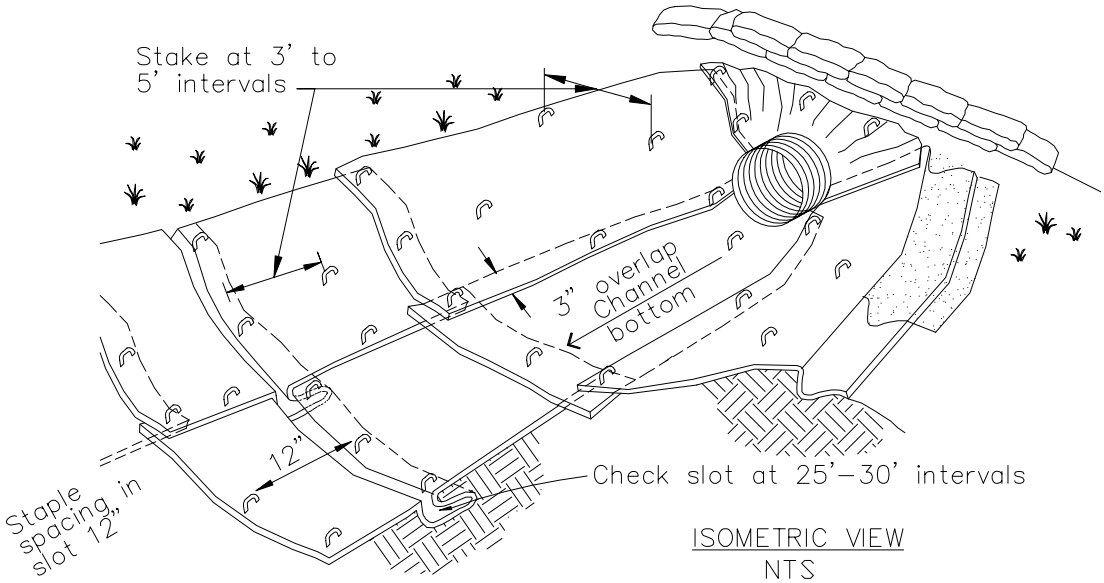
TYPICAL INSTALLATION DETAIL



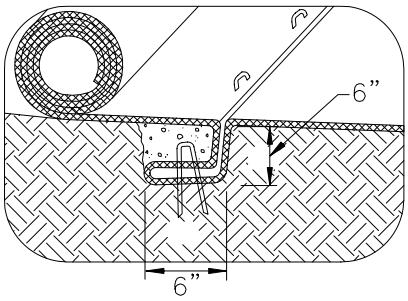
INITIAL CHANNEL ANCHOR TRENCH
NTS



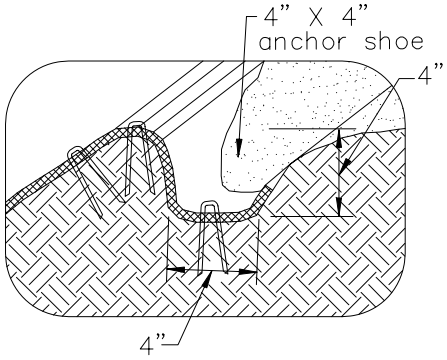
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS



LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:

1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer’s recommendations

TYPICAL INSTALLATION DETAIL

Wood Mulching EC-8

Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

Description and Purpose

Wood mulching consists of applying a mixture of shredded wood mulch, bark or compost to disturbed soils. The primary function of wood mulching is to reduce erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff.

Suitable Applications

Wood mulching is suitable for disturbed soil areas requiring temporary protection until permanent stabilization is established.

Limitations

- Not suitable for use on slopes steeper than 3:1 (H:V). Best suited to flat areas or gentle slopes or 5:1 (H:V) or flatter.
- Wood mulch and compost may introduce unwanted species.
- Not suitable for areas exposed to concentrated flows.
- May need to be removed prior to further earthwork.

Implementation

Mulch Selection

There are many types of mulches. Selection of the appropriate type of mulch should be based on the type of application, site conditions, and compatibility with planned or future uses.

Application Procedures

Prior to application, after existing vegetation has been

removed, roughen embankment and fill areas by rolling with a device such as a punching type roller or by track walking. The construction application procedures for mulches vary significantly depending upon the type of mulching method specified. Two methods are highlighted here:

- Green Material: This type of mulch is produced by the recycling of vegetation trimmings such as grass, shredded shrubs, and trees. Methods of application are generally by hand although pneumatic methods are available.
  - Green material can be used as a temporary ground cover with or without seeding.
  - The green material should be evenly distributed on site to a depth of not more than 2 in.
- Shredded Wood: Suitable for ground cover in ornamental or revegetated plantings.
  - Shredded wood/bark is conditionally suitable. See note under limitations.
  - Distribute by hand or use pneumatic methods.
  - Evenly distribute the mulch across the soil surface to a depth of 2 to 3 in.
- Avoid mulch placement onto roads, sidewalks, drainage channels, existing vegetation, etc.

Costs

Average annual cost for installation and maintenance (3-4 months useful life) is around $4,000 per acre, but cost can increase if the source is not close to the project site.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- Regardless of the mulching technique selected, the key consideration in inspection and maintenance is that the mulch needs to last long enough to achieve erosion control objectives. If the mulch is applied as a stand alone erosion control method over disturbed areas (without seed), it should last the length of time the site will remain barren or until final re-grading and revegetation.
- Where vegetation is not the ultimate cover, such as ornamental and landscape applications of bark or wood chips, inspection and maintenance should focus on longevity and integrity of the mulch.
- Reapply mulch when bare earth becomes visible.

References

Controlling Erosion of Construction Sites Agriculture Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

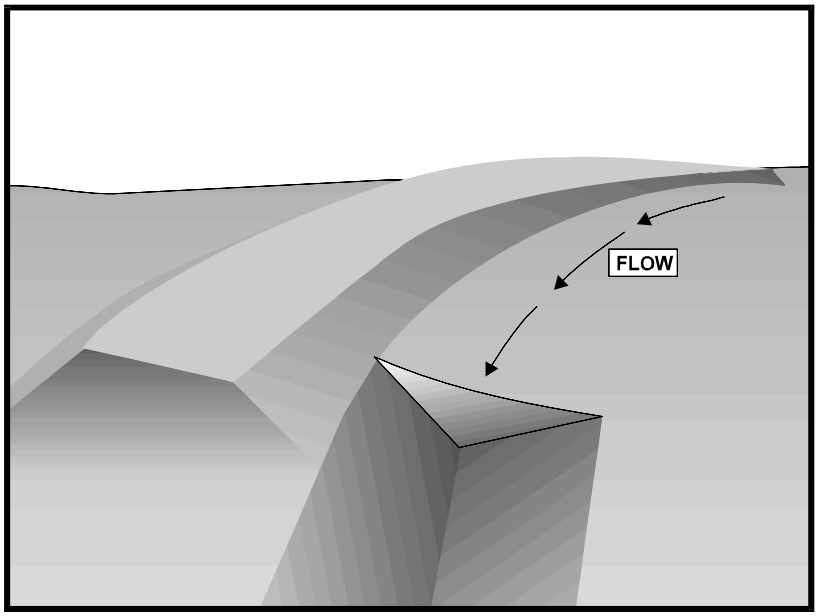
Sedimentation and Erosion Control, An Inventory of Current Practices Draft, U.S. EPA, April 1990.

Soil Erosion by Water Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Earth Dikes and Drainage Swales EC-9



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in drainage swales.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert

runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin

(SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.

- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.
- Construct the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/yd^3.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

References

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company, 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995

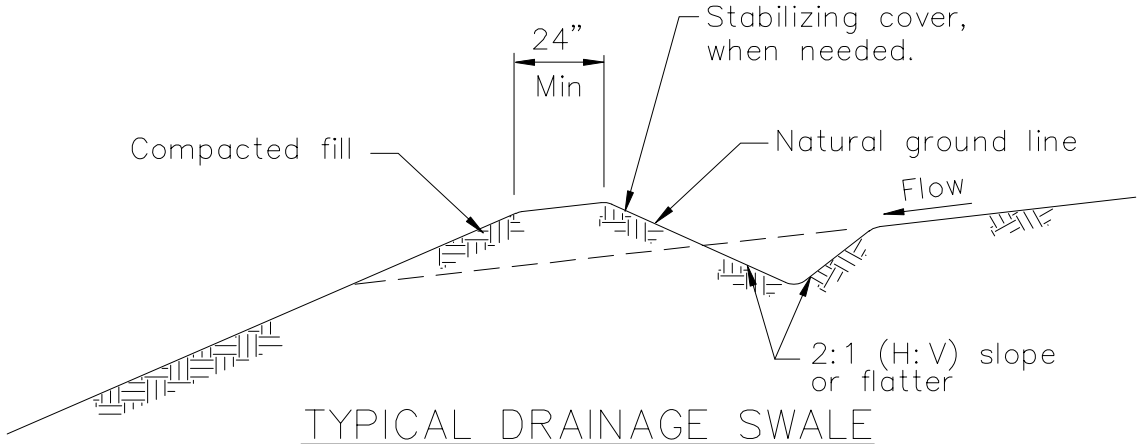
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

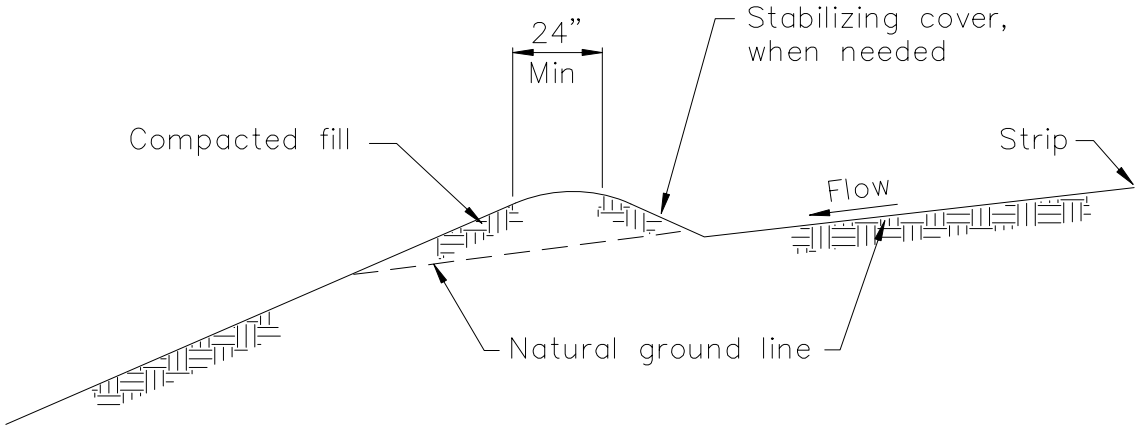
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



TYPICAL DRAINAGE SWALE
NOT TO SCALE

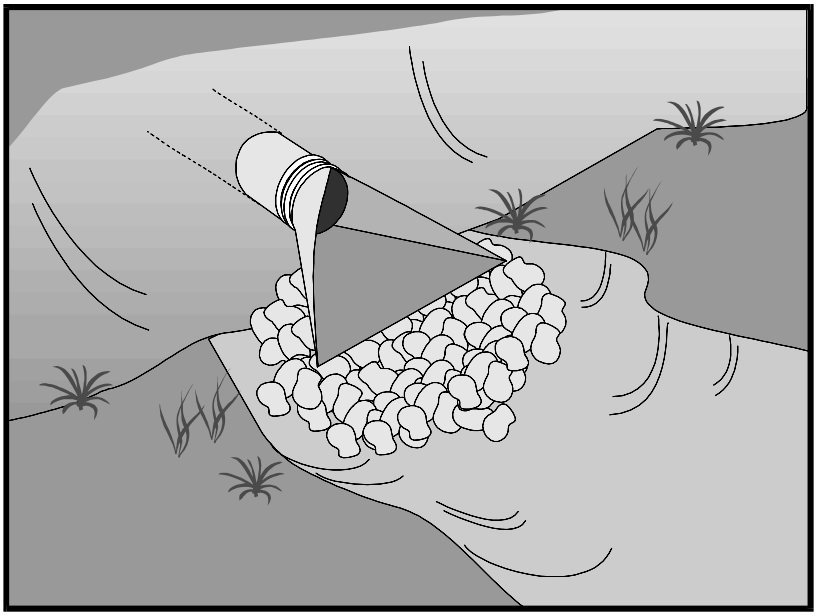
NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE

Velocity Dissipation Devices EC-10



Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.

Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in velocity dissipation devices.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.

- Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
- Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.
- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.
- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur. Minimize areas of standing water by removing sediment blockages and filling scour depressions.
- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

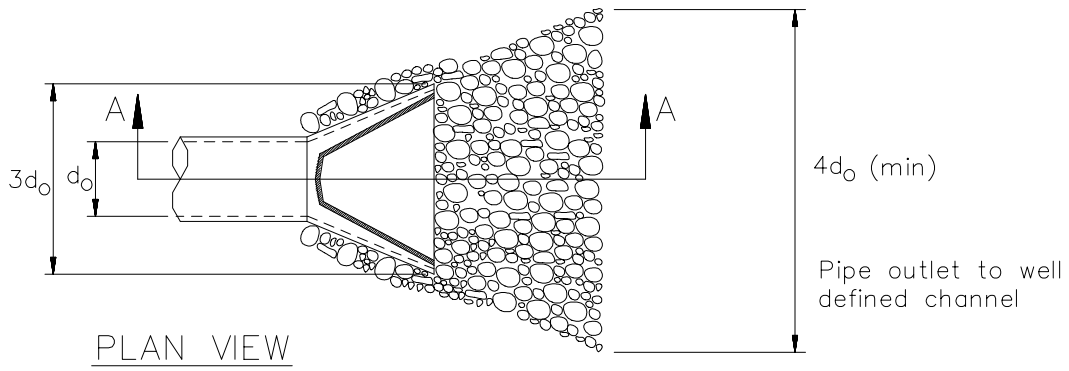
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

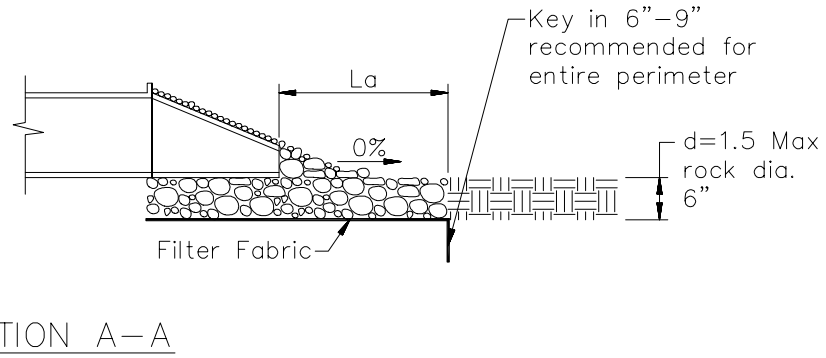
Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, state of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

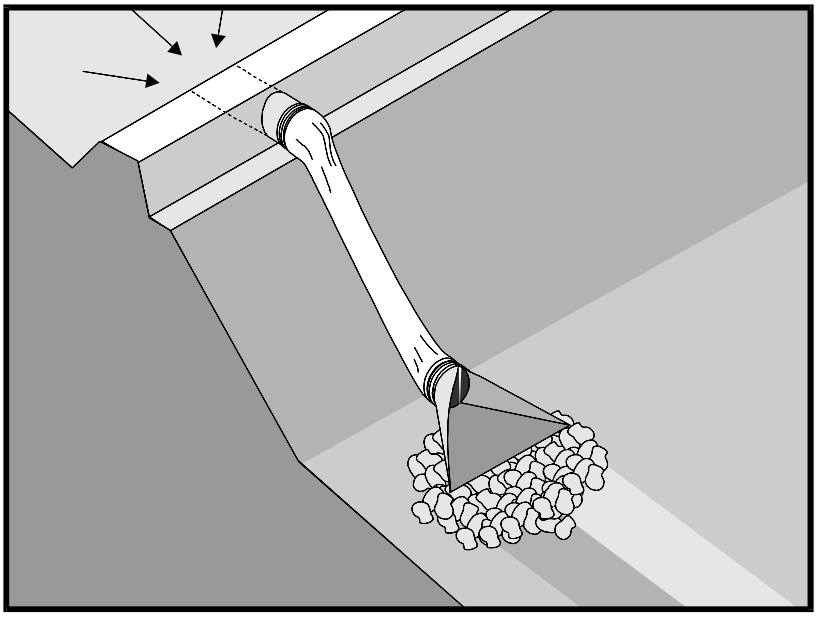




Pipe Diameter inches	Discharge ft³/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Slope Drains EC-11



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-9 Earth Dike, Drainage Swales

Description and Purpose

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with earth dikes and drainage ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Suitable Applications

- Where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Drainage for top of cut and fill slopes where water can accumulate.
- Emergency spillway for a sediment basin.

Limitations

Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion.

- Maximum drainage area per slope drain is 10 acres. (For large areas use a paved chute, rock lined channel, or additional pipes.)
- Severe erosion may result when slope drains fail by overtopping, piping, or pipe separation.
  - During large storms, pipe slope drains may become clogged or over charged, forcing water around the pipe

and causing extreme slope erosion.

- If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion and potential failure of the structure.

- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in energy dissipaters associated with slope drain outlets.

Implementation

General

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the stormwater from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent stormwater collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion.

Installation

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of a slope and the outlet at the bottom of the slope. This BMP typically is used in combination with a diversion control, such as an earth dike or drainage swale at the top of the slope.

The following criteria must be considered when siting slope drains.

- Permanent structures included in the project plans can often serve as construction BMPs if implemented early. However, the permanent structure must meet or exceed the criteria for the temporary structure.
- Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- Slope drains must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- Outlets must be stabilized with riprap, concrete or other type of energy dissipator, or directed into a stable sediment trap or basin. See EC-10, Velocity Dissipation Devices.
- Debris racks are recommended at the inlet. Debris racks located several feet upstream of the inlet can usually be larger than racks at the inlet, and thus provide enhanced debris protection and less plugging.
- Safety racks are also recommended at the inlet and outlet of pipes where children or animals could become entrapped.
- Secure inlet and surround with dikes to prevent gully erosion and anchor pipe to slope.

- When using slope drains, limit drainage area to 10 acres per pipe. For larger areas, use a rock lined channel or a series of pipes.
- Size to convey at least the peak flow of a 10-year storm. The design storm is conservative due to the potential impact of system failures.
- Maximum slope generally limited to 2:1 (H:V) as energy dissipation below steeper slopes is difficult.
- Direct surface runoff to slope drains with interceptor dikes. See BMP EC-9, Earth Dikes and Drainage Swales. Top of interceptor dikes should be 12 in. higher than the top of the slope drain.
- Slope drains can be placed on or buried underneath the slope surface.
- Recommended materials include both metal and plastic pipe, either corrugated or smooth wall. Concrete pipe can also be used.
- When installing slope drains:
  - Install slope drains perpendicular to slope contours.
  - Compact soil around and under entrance, outlet, and along length of pipe.
  - Securely anchor and stabilize pipe and appurtenances into soil.
  - Check to ensure that pipe connections are watertight.
  - Protect area around inlet with filter cloth. Protect outlet with riprap or other energy dissipation device. For high energy discharges, reinforce riprap with concrete or use reinforced concrete device.
  - Protect outlet of slope drains using a flared end section when outlet discharges to a flexible energy dissipation device.
  - A flared end section installed at the inlet will improve flow into the slope drain and prevent erosion at the pipe entrance. Use a flared end section with a 6 in. minimum toe plate to help prevent undercutting. The flared section should slope towards the pipe inlet.

Design and Layout

The capacity for temporary drains should be sufficient to convey at least the peak runoff from a 10-year rainfall event. The pipe size may be computed using the Rational Method or a method established by the local municipality. Higher flows must be safely stored or routed to prevent any offsite concentration of flow and any erosion of the slope. The design storm is purposely conservative due to the potential impacts associated with system failures.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

Minimum Pipe Diameter (Inches)	Maximum Drainage Area (Acres)
12	1.0
18	3.0
21	5.0
24	7.0
30	10.0

Larger drainage areas can be treated if the area can be subdivided into areas of 10 acres or less and each area is treated as a separate drainage. Drainage areas exceeding 10 acres must be designed by a Registered Civil Engineer and approved by the agency that issued the grading permit.

Materials:

Soil type, rainfall patterns, construction schedule, local requirements, and available supply are some of the factors to be considered when selecting materials. The following types of slope drains are commonly used:

- **Rigid Pipe:** This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured onto the slope surface or buried in a trench. Concrete thrust blocks must be used when warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars.

- **Flexible Pipe**: The flexible pipe slope drain consists of a flexible tube of heavy duty plastic, rubber, or composite material. The tube material is securely anchored onto the slope surface. The tube should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or watertight collars.

- **Section Downdrains**: The section downdrain consists of pre-fabricated, section conduit of half round or third round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.

- **Concrete-lined Terrace Drain:** This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are typically specified as permanent structures and if installed early, can serve as slope drains during construction, which should be designed according to local drainage design criteria.

Costs

- Cost varies based on pipe selection and selected outlet protection.

Corrugated Steel Pipes, Per Foot	
Size	Supplied and Installed Cost (No Trenching Included)
12”	$19.60 per LF
15”	$22.00
18”	$26.00
24”	$32.00
30”	$50.00
PVC Pipes, Per Foot	
Size	Supplied and Installed Cost (No Trenching Included)
12”	$24.50
14”	$49.00
16”	$51.00
18”	$54.00
20”	$66.00
24”	$93.00
30”	$130.00

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur. Minimize areas of standing water by removing sediment blockages and filling scour depressions.
- Inspect outlet for erosion and downstream scour. If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel unless other preventative measures are implemented.
- Insert inlet for clogging or undercutting. Remove debris from inlet to maintain flows. Repair undercutting at inlet and if needed, install flared section or rip rap around the inlet to prevent further undercutting.
- Inspect pipes for leakage. Repair leaks and restore damaged slopes.
- Inspect slope drainage for accumulations of debris and sediment.

- Remove built up sediment from entrances and outlets as required. Flush drains if necessary; capture and settle out sediment from discharge.
- Make sure water is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.).
- Pipe anchors must be checked to ensure that the pipe remains anchored to the slope. Install additional anchors if pipe movement is detected.

References

Draft – Sedimentation and Erosion Control, An Inventory of Current Practices, U.S.E.P.A., April 1990.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

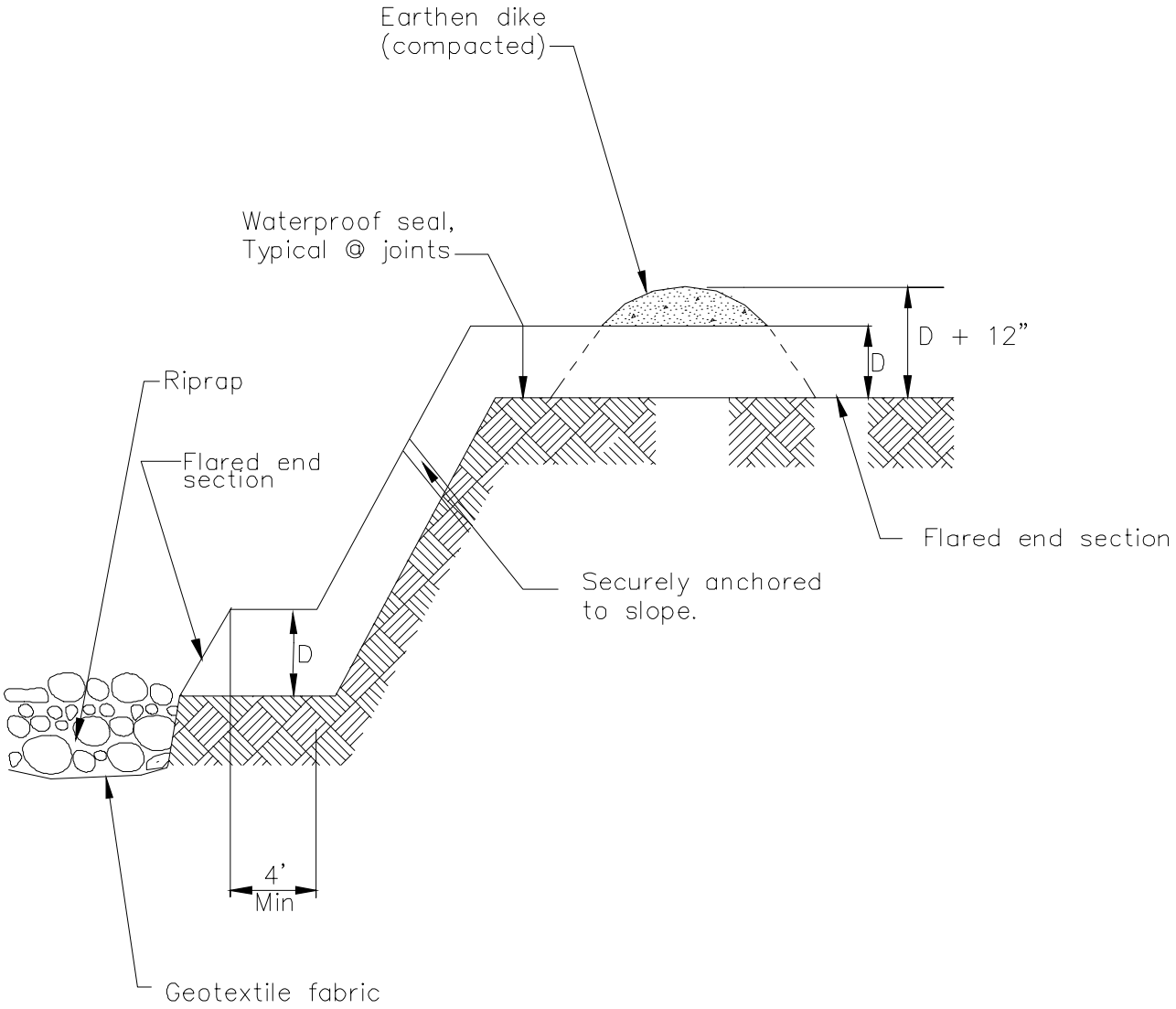
National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



TYPICAL SLOPE DRAIN
NOT TO SCALE

Streambank Stabilization EC-12

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

Combination of erosion and sediment controls.

Description and Purpose

Stream channels, streambanks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from construction activities can increase the stream's sediment load, which can cause channel erosion or sedimentation and have adverse affects on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of construction activities on watercourses. Streams on the 303(d) list and listed for sediment may require numerous measures to prevent any increases in sediment load to the stream.

Suitable Applications

These procedures typically apply to all construction projects that disturb or occur within stream channels and their associated riparian areas.

Limitations

Specific permit requirements or mitigation measures such as Regional Water Quality Control Board (RWQCB) 401 Certification, U.S. Army Corps of Engineers 404 permit and approval by California Department of Fish and Game supercede the guidance in this BMP.

- If numerical based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required. Streams listed as 303(d) impaired for sediment, silt, or turbidity, are required to

conduct sampling to verify that there is no net increase in sediment load due to construction activities.

Implementation

Planning

- Proper planning, design, and construction techniques can minimize impacts normally associated with in stream construction activities. Poor planning can adversely affect soil, fish, wildlife resources, land uses, or land users. Planning should take into account: scheduling; avoidance of in-stream construction; minimizing disturbance area and construction time period; using pre-disturbed areas; selecting crossing location; and selecting equipment.

Scheduling

- Construction activities should be scheduled according to the relative sensitivity of the environmental concerns and in accordance with EC-1, Scheduling. Scheduling considerations will be different when working near perennial streams vs. ephemeral streams and are as follows.

- When in-stream construction is conducted in a perennial stream, work should optimally be performed during the rainy season. This is because in the summer, any sediment-containing water that is discharged into the watercourse will cause a large change in both water clarity and water chemistry. During the rainy season, there is typically more and faster flowing water in the stream so discharges are diluted faster. However, should in-stream work be scheduled for summer, establishing an isolation area, or diverting the stream, will significantly decrease the amount of sediment stirred up by construction work. Construction work near perennial streams should optimally be performed during the dry season (see below).

- When working in or near ephemeral streams, work should be performed during the dry season. By their very nature, ephemeral streams are usually dry in the summer, and therefore, in-stream construction activities will not cause significant water quality problems. However, when tying up the site at the end of the project, wash any fines (see Washing Fines) that accumulated in the channel back into the bed material, to decrease pollution from the first rainstorm of the season.

- When working near ephemeral or perennial streams, erosion and sediment controls (see silt fences, straw bale barriers, etc.) should be implemented to keep sediment out of stream channel.

Minimize Disturbance

- Minimize disturbance through: selection of the narrowest crossing location; limiting the number of equipment trips across a stream during construction; and, minimizing the number and size of work areas (equipment staging areas and spoil storage areas). Place work areas at least 50 ft from stream channel. Field reconnaissance should be conducted during the planning stage to identify work areas.

Use of Pre-Disturbed Areas

- Locate project sites and work areas in areas disturbed by prior construction or other activity when possible.

Selection of Project Site

- Avoid steep and unstable banks, highly erodible or saturated soils, or highly fractured rock.
- Select project site that minimizes disturbance to aquatic species or habitat.

Equipment Selection

- Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in^2, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

Streambank Stabilization

Preservation of Existing Vegetation

- Preserve existing vegetation in accordance with EC-2, Preservation of Existing Vegetation. In a streambank environment, preservation of existing vegetation provides the following benefits.

Water Quality Protection

- Vegetated buffers on slopes trap sediment and promote groundwater recharge. The buffer width needed to maintain water quality ranges from 15 to 100 ft. On gradual slopes, most of the filtering occurs within the first 30 ft. Steeper slopes require a greater width of vegetative buffer to provide water quality benefits.

Streambank Stabilization

- The root system of riparian vegetation stabilizes streambanks by increasing tensile strength in the soil. The presence of vegetation modifies the moisture condition of slopes (infiltration, evapo transpiration, interception) and increases bank stability.

Riparian Habitat

- Buffers of diverse riparian vegetation provide food and shelter for riparian and aquatic organisms. Minimizing impacts to fisheries habitat is a major concern when working near streams and rivers. Riparian vegetation provides shade, shelter, organic matter (leaf detritus and large woody debris), and other nutrients that are necessary for fish and other aquatic organisms. Buffer widths for habitat concerns are typically wider than those recommended for water quality concerns (100 to 1500 ft).
- When working near watercourses, it is important to understand the work site's placement in the watershed. Riparian vegetation in headwater streams has a greater impact on overall water quality than vegetation in downstream reaches. Preserving existing vegetation upstream is necessary to maintain water quality, minimize bank failure, and maximize riparian habitat, downstream of the work site.

Limitations

- Local county and municipal ordinances regarding width, extent and type of vegetative buffer required may exceed the specifications provided here; these ordinances should be investigated prior to construction.

Streambank Stabilization Specific Installation

- As a general rule, the width of a buffer strip between a road and the stream is recommended to be 50 ft plus four times the percent slope of the land, measured between the road and the top of stream bank.

Hydraulic Mulch

- Apply hydraulic mulch on disturbed streambanks above mean high water level in accordance with EC-3, Hydraulic Mulch to provide temporary soil stabilization.

Limitations

- Do not place hydraulic mulch or tackifiers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication (eutrophication is an algal bloom caused by excessively high nutrient levels in the water).

Hydroseeding

- Hydroseed disturbed streambanks in accordance with EC-4, Hydroseeding.

Limitations

- Do not place tackifiers or fertilizers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication.

Soil Binders

- Apply soil binders to disturbed streambanks in accordance with EC-5, Soil Binders.

Limitations

- Do not place soil binders below the mean high water level. Soil binder must be environmentally benign and non-toxic to aquatic organisms.

Straw Mulch

- Apply straw mulch to disturbed streambanks in accordance with EC-6, Straw Mulch.

Limitations

- Do not place straw mulch below the mean high water level, as this material could wash into the channel and impact water quality or possibly cause eutrophication.

Geotextiles and Mats

- Install geotextiles and mats as described in EC-7, Geotextiles and Mats, to stabilize disturbed channels and streambanks. Not all applications should be in the channel, for example, certain geotextile netting may snag fish gills and are not appropriate in fish bearing streams. Geotextile fabrics that are not biodegradable are not appropriate for in stream use. Additionally, geotextile fabric or blankets placed in channels must be adequate to sustain anticipated hydraulic forces.

Earth Dikes, Drainage Swales, and Lined Ditches

- Convey, intercept, or divert runoff from disturbed streambanks using EC-9, Earth Dikes and Drainage Swales.

Limitations

- Do not place earth dikes in watercourses, as these structures are only suited for intercepting sheet flow, and should not be used to intercept concentrated flow.
- Appropriately sized velocity dissipation devices (EC-10) must be placed at outlets to minimize erosion and scour.

Velocity Dissipation Devices

- Place velocity dissipation devices at outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits or channels in accordance with EC-10, Velocity Dissipation Devices.

Slope Drains

- Use slope drains to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device or stabilized area in accordance with EC-11, Slope Drains.

Limitations

- Appropriately sized outlet protection and velocity dissipation devices (EC-10) must be placed at outlets to minimize erosion and scour.

Streambank Sediment Control

Silt Fences

- Install silt fences in accordance with SE-1, Silt Fence, to control sediment. Silt fences should only be installed where sediment laden water can pond, thus allowing the sediment to settle out.

Fiber Rolls

- Install fiber rolls in accordance with SE-5, Fiber Rolls, along contour of slopes above the high water level to intercept runoff, reduce flow velocity, release the runoff as sheet flow and provide removal of sediment from the runoff. In a stream environment, fiber rolls should be used in conjunction with other sediment control methods such as SE-1, Silt Fence or SE-9 Straw Bale Barrier. Install silt fence, straw bale barrier, or other erosion control method along toe of slope above the high water level.

Gravel Bag Berm

- A gravel bag berm or barrier can be utilized to intercept and slow the flow of sediment laden sheet flow runoff in accordance with SE-6, Gravel Bag Berm. In a stream environment gravel bag barriers can allow sediment to settle from runoff before water leaves the construction site and can be used to isolate the work area from the live stream.

Limitations

- Gravel bag barriers are not recommended as a perimeter sediment control practice around streams.

Straw Bale Barrier

- Install straw bale barriers in accordance with SE-9, Straw Bale Barrier, to control sediment. Straw bale barriers should only be installed where sediment laden water can pond, thus allowing the sediment to settle out. Install a silt fence in accordance with SE-1, Silt Fence,

on down slope side of straw bale barrier closest to stream channel to provide added sediment control.

Rock Filter

Description and Purpose

Rock filters are temporary erosion control barriers composed of rock that is anchored in place. Rock filters detain the sediment laden runoff, retain the sediment, and release the water as sheet flow at a reduced velocity. Typical rock filter installations are illustrated at the end of this BMP.

Applications

- Near the toe of slopes that may be subject to flow and rill erosion.

Limitations

- Inappropriate for contributing drainage areas greater than 5 acres.
- Requires sufficient space for ponded water.
- Ineffective for diverting runoff because filters allow water to slowly seep through.
- Rock filter berms are difficult to remove when construction is complete.
- Unsuitable in developed areas or locations where aesthetics is a concern.

Specifications

- Rock: open graded rock, 0.75 to 5 in. for concentrated flow applications.
- Woven wire sheathing: 1 in. diameter, hexagonal mesh, galvanized 20gauge (used with rock filters in areas of concentrated flow).
- In construction traffic areas, maximum rock berm heights should be 12 in. Berms should be constructed every 300 ft on slopes less than 5%, every 200 ft on slopes between 5% and 10%, and every 100 ft on slopes greater than 10%.

Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Reshape berms as needed and replace lost or dislodged rock, and filter fabric.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

K-rail

Description and Purpose

This is temporary sediment control that uses K-rails to form the sediment deposition area, or to isolate the near bank construction area. Install K-rails at toe of slope in accordance with procedures described in NS-5, Clear Water Diversion.

Barriers are placed end to end in a pre-designed configuration and gravel filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

Appropriate Applications

- This technique is useful at the toe of embankments, cuts or fills slopes.

Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight.

Implementation

- Refer to NS-5, Clear Water Diversion, for implementation requirements.

Instream Construction Sediment Control

There are three different options currently available for reducing turbidity while working in a stream or river. The stream can be isolated from the area in which work is occurring by means of a water barrier, the stream can be diverted around the work site through a pipe or temporary channel, or one can employ construction practices that minimize sediment suspension.

Whatever technique is implemented, an important thing to remember is that dilution can sometimes be the solution. A probable "worst time" to release high TSS into a stream system might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. Conversely, the addition of high TSS or sediment during a big storm discharge might have a relatively low impact, because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system. The optimum time to "pull" in-stream structures may be during the rising limb of a storm hydrograph.

Techniques to minimize Total Suspended Solids (TSS)

- **Padding** - Padding laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in re-vegetation.

- **Clean, washed gravel** - Using clean, washed gravel decreases solid suspension, as there are fewer small particles deposited in the stream.

- **Excavation using a large bucket** - Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount. Therefore, using a large excavator bucket instead of a small one, will reduce the total amount of soil that washes downstream.

- **Use of dozer for backfilling** - Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.

- **Partial dewatering with a pump** - Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment.

Washing Fines

Definition and Purpose

- Washing fines is an "in-channel" sediment control method, which uses water, either from a water truck or hydrant, to wash stream fines that were brought to the surface of the channel bed during restoration, back into the interstitial spaces of the gravel and cobbles.

- The purpose of this technique is to reduce or eliminate the discharge of sediment from the channel bottom during the first seasonal flow. Sediment should not be allowed into stream channels; however, occasionally in-channel restoration work will involve moving or otherwise disturbing fines (sand and silt sized particles) that are already in the stream, usually below bankfull discharge elevation. Subsequent re-watering of the channel can result in a plume of turbidity and sedimentation.

- This technique washes the fines back into the channel bed. Bedload materials, including gravel cobbles, boulders and those fines, are naturally mobilized during higher storm flows. This technique is intended to delay the discharge until the fines would naturally be mobilized.

Appropriate Applications

- This technique should be used when construction work is required in channels. It is especially useful in intermittent or ephemeral streams in which work is performed "in the dry", and which subsequently become re-watered.

Limitations

- The stream must have sufficient gravel and cobble substrate composition.

- The use of this technique requires consideration of time of year and timing of expected stream flows.

- The optimum time for the use of this technique is in the fall, prior to winter flows.

- Consultation with, and approval from the Department of Fish and Game and the Regional Water Quality Control Board may be required.

Implementation

- Apply sufficient water to wash fines, but not cause further erosion or runoff.

- Apply water slowly and evenly to prevent runoff and erosion.

- Consult with Department of Fish and Game and the Regional Water Quality Control Board for specific water quality requirements of applied water (e.g. chlorine).

Inspection and Maintenance

- None necessary

Costs

Cost may vary according to the combination of practices implemented.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events until final stabilization is achieved.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Inspect and repair equipment (for damaged hoses, fittings, and gaskets).

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

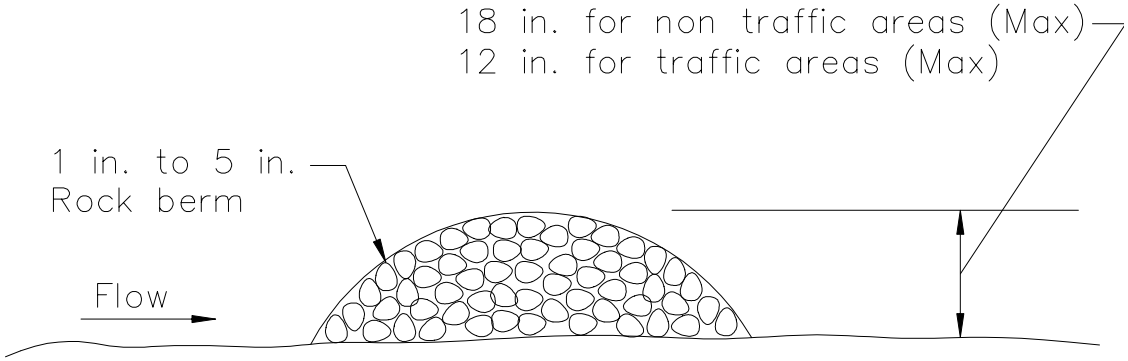
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, An Inventory of Current Practices (Draft), UESPA, 1990.

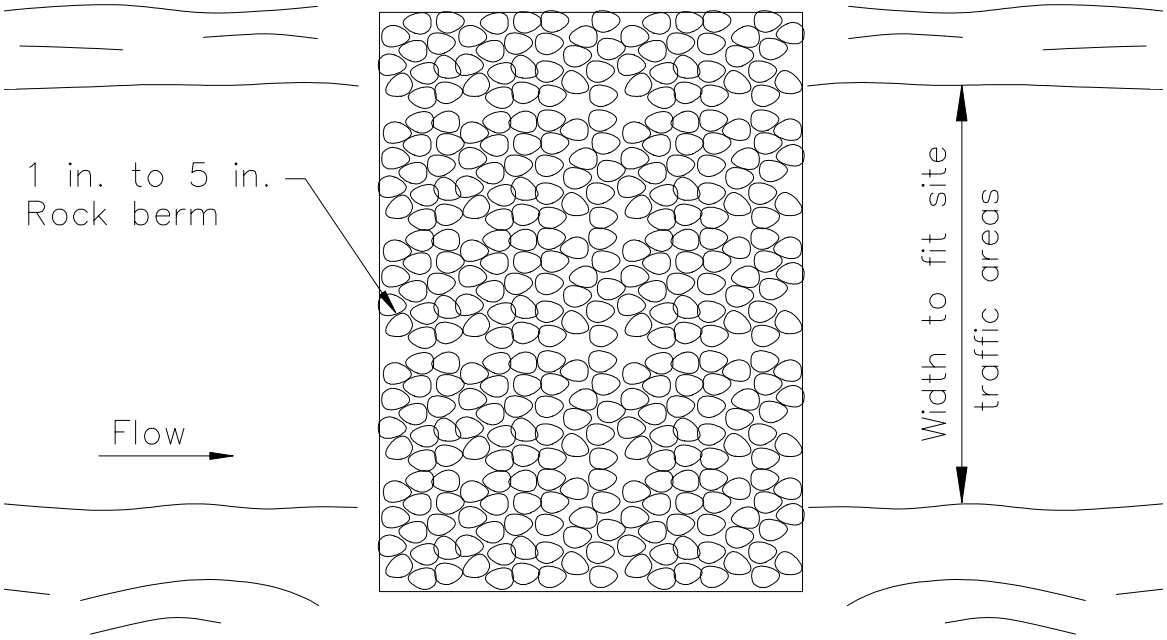
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



SECTION



PLAN

TYPICAL ROCK FILTER

NOT TO SCALE

Reserved EC-13

BMP Factsheet removed in 2009.
Formerly PAM. See SE-11, Active Treatment Systems.

Categories

EC	Erosion Control
SE	Sediment Control
TC	Tracking Control
WE	Wind Erosion Control
NS	Non-Stormwater Management Control
WM	Waste Management and Materials Pollution Control

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment
Nutrients
Trash
Metals
Bacteria
Oil and Grease
Organics

Potential Alternatives

Compost Blanket EC-14

Description and Purpose

A compost blanket is applied to slopes and earth disturbed areas to prevent erosion, and in some cases, increase infiltration and/or establish vegetation. The compost blanket can be applied by hand, conveyor system, compost spreader, or pneumatic delivery (blower) system. The blanket thickness is determined from the slope steepness and anticipated precipitation. A compost blanket protects the soil surface from raindrop erosion, particularly rills and gullies that may form under other methods of erosion control.

A compost blanket, if properly installed, can be very successful at vegetation establishment, weed suppression and erosion control. The compost blanket comes into direct contact with the underlying soil, reducing rill formation. Furthermore, compost provides organic matter and nutrients important for vegetation growth. The compost blanket provides soil structure that allows water to infiltrate the soil surface and retain moisture, which also promotes seed germination and vegetation growth, in addition to reducing runoff.

Compost is typically derived from combinations of feedstocks, biosolids, leaf and yard trimmings, manure, wood, or mixed solid waste. Many types of compost are products of municipal recycle or "Greenwaste" programs. Compost is organic and biodegradable and can be left onsite. There are many types of compost with a variety of properties with specific functions, and accordingly, compost selection is an important design consideration in the application of this type of erosion control.

Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Suitable Applications

A compost blanket is appropriate for slopes and earth disturbed areas requiring protection until permanent stabilization is established. A compost blanket can also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment. Examples include:

- Rough-graded areas that will remain inactive for longer than 14 days
- Soil stockpiles
- Slopes with exposed soil between existing vegetation such as trees or shrubs
- Slopes planted with live, container-grown vegetation
- Disturbed areas where plants are slow to develop

A compost blanket is typically used on slopes of 2:1 (H:V) or gentler. However, a compost blanket can be effective when applied to slopes as steep as 1:1 (H:V) with appropriate design considerations including slope length, blanket thickness, adding components such as a tackifier, or using compost blankets in conjunction with other techniques, such as compost socks and berms or fiber rolls.

Compost can be pre-seeded prior to application to the soil (recommended by the EPA for construction site stormwater runoff control) or seeded after the blanket has been installed. The compost medium can also remove pollutants in stormwater including heavy metals; oil and grease; and hydrocarbons (USEPA, 1998).

Limitations

- Compost can potentially leach nutrients (dissolved phosphorus and nitrogen) into runoff and potentially impact water quality. Compost should not be used directly upstream from nutrient impaired waterbodies (Adams et. al, 2008).
- Compost may also contain other undesirable constituents that are detrimental to water quality. Carefully consider the qualifications and experience of any compost producer/supplier.
- A compost blanket applied by hand is more time intensive and potentially costly. Using a pneumatic blower truck is the recommended cost effective method of application.
- When blowers are used, the treatment areas should be within 300 ft of a road or surface capable of supporting trucks.
- Wind may limit application of compost and result in application to undesired locations.
- Compost blankets should not be applied in areas of concentrated flows.
- Steeper slopes may require additional blanket thickness and other stability measures such as using tackifiers or slope interruption devices (compost socks and berms, or fiber rolls). The same applies for sites with high precipitation totals or during the rainy season.

Implementation

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Compost Materials

- California Compost Regulations (Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7, Section 17868.3) define and require a quality of compost for application. Compost should comply with all physical and chemical requirements. Specific requirements are provided in Table 1 below, taken from Caltrans Standard Special Provision 10-1 (SSP 10-1), Erosion Control (Compost Blanket).

- The compost producer should be fully permitted as specified under the California Integrated Waste Management Board, Local Enforcement Agencies and any other State and Local Agencies that regulate Solid Waste Facilities. If exempt from State permitting requirements, the composting facility should certify that it follows guidelines and procedures for production of compost meeting the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7.

- The compost producer should be a participant in United States Composting Council's Seal of Testing Assurance program.

- Compost moisture should be considered for composition quality and application purposes. A range of 30-50% is typical. Compost that is too dry is hard to apply and compost that is too wet is more difficult (and more expensive) to transport. For arid or semi-arid areas, or for application during the dry season, use compost with greater moisture content than areas with wetter climates. For wetter or more humid climates or for application during the wet season, drier composts can be used as the compost will absorb moisture from the ambient air.

- Organic content of the compost is also important and should range from 30 to 65% depending on site conditions.

- Compost should be high-quality mature compost. Immature compost can potentially leach nutrients.

- Compost should not be derived from mixed municipal solid waste and should be free of visible contaminants.

- Compost should not contain paint, petroleum products, pesticides or any other chemical residues harmful to animal life or plant growth. Metal concentrations in compost should not exceed the maximum metal concentrations listed under Title 14, California Code of Regulations, Division 7, Chapter 3.1, Section 17868.2.

- Compost should not possess objectionable odors.

- Compost should be weed free.

Table 1. Physical/Chemical Requirements of Compost
Reference - Caltrans SSP-10 Erosion Control Blanket (Compost)

Property	Test Method	Requirement
pH	*TMECC 04.11-A Elastometric pH 1:5 Slurry Method pH Units	6.0–8.0
Soluble Salts	TMECC 04.10-A Electrical Conductivity 1:5 Slurry Method dS/m (mmhos/cm)	0-10.0
Moisture Content	TMECC 03.09-A Total Solids & Moisture at 70+/- 5 deg C % Wet Weight Basis	30-60
Organic Matter Content	TMECC 05.07-A Loss-On-Ignition Organic Matter Method (LOI) % Dry Weight Basis	30–65
Maturity	TMECC 05.05-A Germination and Vigor Seed Emergence Seedling Vigor % Relative to Positive Control	80 or Above 80 or Above
Stability	TMECC 05.08-B Carbon Dioxide Evolution Rate mg CO_2-C/g OM per day	8 or below
Particle Size	TMECC 02.02-B Sample Sieving for Aggregate Size Classification % Dry Weight Basis	100% Passing, 3 inch 90-100% Passing, 1 inch 65-100% Passing, 3/4 inch 0 - 75% Passing, 1/4 inch Maximum length 6 inches
Pathogen	TMECC 07.01-B Fecal Coliform Bacteria < 1000 MPN/gram dry wt.	Pass
Pathogen	TMECC 07.01-B Salmonella < 3 MPN/4 grams dry wt.	Pass
Physical Contaminants	TMECC 02.02-C Man Made Inert Removal and Classification: Plastic, Glass and Metal % > 4mm fraction	Combined Total: < 1.0
Physical Contaminants	TMECC 02.02-C Man Made Inert Removal and Classification: Sharps (Sewing needles, straight pins and hypodermic needles) % > 4mm fraction	None Detected

*TMECC refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).

Installation

- Prior to compost application, prepare the slope by removing loose rocks, roots, stumps, and other debris greater than 2” in diameter. Prepare the slope area surface by scarifying or track walking/roughening if necessary.
- Select method to apply the compost blanket. A pneumatic blower is most cost effective and most adaptive in applying compost to steep, rough terrain, and hard to reach locations.
- A compost blanket thickness of 1” to 4” should be applied to slopes of 2:1 (H:V) or gentler, based on site-specific conditions. Increase blanket thickness with increased slope steepness and/or during installation during the rainy season (for example, 2” to 3” should be used for a

3:1 slope, while 1" to 2" can be used for a 4:1 slope). Erosion control using a compost blanket is not recommended for slopes greater than 1:1 (H:V).

- For steeper slopes, tackifiers should be utilized and/or other stabilization techniques employed. For example, compost socks or berms can be installed at intervals over the compost blanket (in a similar manner as Fiber Rolls, SE-5).
- Compost socks or berms (or equivalent linear sediment control BMP) should be placed at the top and/or bottom of the slope for additional erosion control performance.
- For optimum vegetation establishment, a blanket thickness of 1" to 2" is recommended. If vegetation establishment is not the primary function of the compost blanket, a thicker blanket may be recommended based on slope or rainfall conditions.
- Evenly distribute compost on the soil surface to the desired blanket thickness (1/2" to 4" as calculated prior based on site conditions and objectives). Even distribution is an important factor in preventing future rill and gully erosion.
- The compost blanket should extend 3 to 6 feet over the top of the shoulder of the slope. A compost sock or compost berm can be used at the top of the slope as an auxiliary technique to prevent runoff from flowing underneath the compost blanket.
- Use additional anchoring and erosion control BMPs in conjunction of the compost blanket as needed.

Costs

The cost associated with a compost blanket is similar to that of a straw mat and generally less expensive than a geotextile blanket (USEPA, 2009). Caltrans has provided a recent estimate for $5,000 to $8,000 per acre for application of an unseeded 1 inch compost blanket (Caltrans Compost Specifications, 2009). Recently obtained vendor costs indicate that proprietary blends of compost that are seeded and contain a nutrient rich "tackifier" can cost approximately $0.35 per square foot, or approximately $15,000 per acre for a 2 inch blanket. Application by hand is more time intensive and likely more costly.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident, another layer of compost should be reapplied as soon as possible. It may be necessary to install an additional type of stormwater BMP at the top of slope or as a slope interrupter to control flow, such as a fiber roll (SE-5) or compost sock (SE-11).
- Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- Limit or prohibit foot traffic to minimize damage to BMP or impede vegetation establishment.

References

An Analysis of Composting as an Environmental Remediation Technology, U.S. Environmental Protection Agency (USEPA), Solid Waste and Emergency Response (5305W), EPA530-R-8-008, 1998.

Characteristics of Compost: Moisture Holding and Water Quality Improvement, Center for Research in Water Resources, Kirchoff, C., Malina, J., and Barrett, M., 2003.

Compost Utilization for Erosion Control, The University of Georgia College of Agricultural and Environmental Sciences, pubs.caes.uga.edu/caespubs/pubcd/B1200.htm, Faucette, B. and Risse, M., 2009.

Demonstration Project Using Yard Debris Compost for Erosion Control, Final Report, presented to Metropolitan Service District, W&H Pacific, 1993.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, 2005.

Standard Special Provision 10-1, Erosion Control (Compost Blanket), California Department of Transportation (Caltrans). 2007 Update.

Evaluation of Environmental Benefits and Impacts of Compost and Industry Standard Erosion and Sediment Controls Measures Used in Construction Activities, Dissertation, Institute of Ecology, University of Georgia, Faucette, B., 2004.

Filter Sock Presentation provided at Erosion, Sediment Control and Stormwater Management with Compost BMPs Workshop, U.S. Composting Council 13th Annual Conference and Trade Show, McCoy, S., 2005.

National Pollutant Discharge Elimination System (NPDES), Compost Blankets, U.S. Environmental Protection Agency (USEPA). http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=118, 2009.

Standard Specifications for Transportation Materials and Methods of Sampling and Testing Designation M10-03, Compost for Erosion/Sediment Control (Compost Blankets), Provisional, American Association of State Highway Transportation Officials (AASHTO), 2003.

Stormwater Best Management Practices (BMPs) Field Trials of Erosion Control Compost in Reclamation of Rock Quarry Operations, Nonpoint Source Protection Program CWA §319(h), Texas Commission on Environmental Quality, Adams, T., McFarland, A., Hauck, L., Barrett, M., and Eck, B., 2008.

Soil Preparation/Roughening EC-15

Description and Purpose

Soil Preparation/Roughening involves assessment and preparation of surface soils for BMP installation. This can include soil testing (for seed base, soil characteristics, or nutrients), as well as roughening surface soils by mechanical methods (including sheepsfoot rolling, track walking, scarifying, stair stepping, and imprinting) to prepare soil for additional BMPs, or to break up sheet flow. Soil Preparation can also involve tilling topsoil to prepare a seed bed and/or incorporation of soil amendments, to enhance vegetative establishment.

Suitable Applications

Soil preparation: Soil preparation is essential to proper vegetative establishment. In particular, soil preparation (i.e. tilling, raking, and amendment) is suitable for use in combination with any soil stabilization method, including RECPs or sod. Soil preparation should not be confused with roughening.

Roughening: Soil roughening is generally referred to as track walking (sometimes called imprinting) a slope, where treads from heavy equipment run parallel to the contours of the slope and act as mini terraces. Soil preparation is most effective when used in combination with erosion controls. Soil Roughening is suitable for use as a complementary process for controlling erosion on a site. Roughening is not intended to be used as a stand-alone BMP, and should be used with perimeter controls, additional erosion control measures, grade breaks, and vegetative establishment for maximum effectiveness. Roughening is intended to only affect surface soils and should not compromise slope stability or overall compaction. Suitable applications for soil roughening include:

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-7 Geotextiles and Mats

- Along any disturbed slopes, including temporary stockpiles, sediment basins, or compacted soil diversion berms and swales.
- Roughening should be used in combination with hydraulically applied stabilization methods, compost blanket, or straw mulch; but should not be used in combination with RECPs or sod because roughening is intended to leave terraces on the slope.

Limitations

- Preparation and roughening must take place prior to installing other erosion controls (such as hydraulically applied stabilizers) or sediment controls (such as fiber rolls) on the faces of slopes.
- In such cases where slope preparation is minimal, erosion control/revegetation BMPs that do not require extensive soil preparation - such as hydraulic mulching and seeding applications - should be employed.
- Consideration should be given to the type of erosion control BMP that follows surface preparation, as some BMPs are not designed to be installed over various types of tillage/roughening, i.e., RECPs (erosion control blankets) should not be used with soil roughening due to a "bridging" effect, which suspends the blanket above the seed bed.
- Surface roughness has an effect on the amount of mulch material that needs to be applied, which shows up as a general increase in mulch material due to an increase in surface area (Topographic Index -see EC-3 Hydraulic Mulching).

Implementation

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

General

A roughened surface can significantly reduce erosion. Based on tests done at the San Diego State Erosion Research Laboratory, various roughening techniques on slopes can result in a 12 - 76% reduction in the erosion rate versus smooth slopes.

Materials

Minimal materials are required unless amendments and/or seed are added to the soil. The majority of soil roughening/preparation can be done with equipment that is on hand at a normal construction site, such as bull dozers and compaction equipment.

Installation Guidelines

Soil Preparation

- Where appropriate or feasible, soil should be prepared to receive the seed by disking or otherwise scarifying the surface to eliminate crust, improve air and water infiltration and create a more favorable environment for germination and growth.
- Based upon soil testing conducted, apply additional soil amendments (e.g. fertilizers, additional seed) to the soil to help with germination. Follow EC-4, Hydroseeding, when selecting and applying seed and fertilizers.

Cut Slope Roughening:

- Stair-step grade or groove the cut slopes that are steeper than 3:1.
- Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.
- Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
- Do not make individual vertical cuts more than 2 feet (0.6 m) high in soft materials or more than 3 feet (0.9 m) high in rocky materials.
- Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening:

- Place on fill slopes with a gradient steeper than 3:1 in lifts not to exceed 8 inches (0.2 m), and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4-6 inches (0.1-0.2 m) deep.
- Use grooving or tracking to roughen the face of the slopes, if necessary.
- Do not blade or scrape the final slope face.

Roughening for Slopes to be Mowed:

- Slopes which require mowing activities should not be steeper than 3:1.
- Roughen these areas to shallow grooves by track walking, scarifying, sheepsfoot rolling, or imprinting.
- Make grooves close together (less than 10 inches), and not less than 1 inch deep, and perpendicular to the direction of runoff (i.e., parallel to the slope contours).
- Excessive roughness is undesirable where mowing is planned.

Roughening With Tracked Machinery:

- Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.
- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.
- Seed and mulch roughened areas as soon as possible to obtain optimum seed germination and growth.

Costs

Costs are based on the additional labor of tracking or preparation of the slope plus the cost of any required soil amendment materials.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check the seeded slopes for signs of erosion such as rills and gullies. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.
- Inspect BMPs weekly during normal operations, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Non-Vegetative Stabilization EC-16

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Non-vegetative stabilization methods are used for temporary or permanent stabilization of areas prone to erosion and should be used only where vegetative options are not feasible; examples include:

- Areas of vehicular or pedestrian traffic such as roads or paths;
- Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
- Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
- Areas where vegetation will not grow adequately within the construction time frame.

There are several non-vegetative stabilization methods and selection should be based on site-specific conditions.

Decomposed Granite (DG) is a permanent erosion protection method that consists of a layer of stabilized decomposed granite placed over an erodible surface.

Degradable Mulches of various types (see EC-3, EC-6, EC-8) can be used for temporary non-vegetative stabilization; examples include straw mulch, compost, wood chips or hydraulic mulch.

Geotextiles and Mats can be used for temporary non-vegetative stabilization (see EC-7). These BMPs are typically manufactured

from degradable or synthetic materials and are designed and specified based on their functional longevity, i.e., how long they will persist and provide erosion protection. All geotextiles and mats should be replaced when they exceed their functional longevity or when permanent stabilization methods are instituted.

Gravel Mulch is a non-degradable erosion control product that is composed of washed and screened coarse to very coarse gravel, 16 mm to 64 mm (0.6" - 2.5"), similar to an AASHTO No. 3 coarse aggregate.

Rock Slope Protection consists of utilizing large rock or rip-rap (4"- 24") to stabilize slopes with a high erosion potential and those subject to scour along waterways.

Soil Binders can be used for temporary non-vegetative stabilization (see EC-5). The key to their use is functional longevity. In most cases, the soil binder will need to be routinely monitored and re-applied to maintain an erosion-resistant coverage.

Suitable Applications

Non-vegetated stabilization methods are suitable for use on disturbed soil areas and on material stockpiles that need to be temporarily or permanently protected from erosion by water and wind. Non-vegetated stabilization should only be utilized when vegetation cannot be established in the required timeframe, due to soil or climactic conditions, or where vegetation may be a potential fire hazard.

Decomposed Granite (DG) and Gravel Mulch are suitable for use in areas where vegetation establishment is difficult, on flat surfaces, trails and pathways, and when used in conjunction with a stabilizer or tackifier, on shallow slopes (i.e., 10:1 [H:V]). DG and gravel can also be used on shallow rocky slopes where vegetation cannot be established for permanent erosion control.

Degradable Mulches can be used to cover and protect soil surfaces from erosion both in temporary and permanent applications. In many cases, the use of mulches by themselves requires routine inspection and re-application. See EC-3 Hydraulic Mulch, EC-6 Straw Mulch, EC-8 Wood Mulch, or EC-14 Compost Blankets for more information.

Geotextiles and Mats can be used as a temporary stand-alone soil stabilization method. Depending on material selection, geotextiles and mats can be a short-term (3 mos – 1 year) or long-term (1-2 years) temporary stabilization method. For more information on geotextiles and mats see EC-7 Geotextiles and Mats.

Rock Slope Protection can be used when the slopes are subject to scour or have a high erosion potential, such as slopes adjacent to flowing waterways or slopes subject to overflow from detention facilities (spillways).

Soil Binders can be used for temporary stabilization of stockpiles and disturbed areas not subject to heavy traffic. See EC-5 Soil Binders for more information.

Limitations

General

- Refer to EC-3, EC-6, EC-8, and EC-14 for limitations on use of mulches. Refer to EC-7 for limitations on use of geotextiles and mats. Refer to EC-5 for limitations on use of Soil Binders.

Decomposed Granite

- Not available in some geographic regions.
- If not tackified, material may be susceptible to erosion even on slight slopes (e.g., 30:1 [H:V]).
- Installed costs may be more expensive than vegetative stabilization methods.

Gravel Mulch

- Availability is limited in some geographic regions.
- If not properly screened and washed, can contain fine material that can erode and/or create dust problems.
- If inadequately sized, material may be susceptible to erosion on sloped areas.
- Pore spaces fill with dirt and debris over time; may provide a growing medium for weeds.

Rock Slope Protection

- Installation is labor intensive.
- Installed costs can be significantly higher than vegetative stabilization methods.
- Rounded stones may not be used on slopes greater than 2:1 [H:V].

Implementation

General

Non-vegetated stabilization should be used in accordance with the following general guidance:

- Should be used in conjunction with other BMPs, including drainage, erosion controls and sediment controls.
- Refer to EC-3, EC-6, EC-8, and EC-14 for implementation details for mulches. Refer to EC-7 for implementation details for geotextiles and mats. Refer to EC-5 for implementation details for soil binders.
- Non-vegetated stabilization measures should be implemented as soon as the disturbance in the areas they are intended to protect has ceased.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Decomposed Granite Stabilization

- If used for a road or path should be installed on a prepared base.

- Should be mixed with a stabilizer if used for roads or pathways, or on slope applications.
- Though porous it is recommended to prevent standing water on or next to a decomposed granite road or pathway.

Gravel Mulch

- Should be sized based on slope, rainfall, and upgradient run-on conditions. Stone size should be increased as potential for erosion increases (steeper slopes, high intensity rainfall).
- If permanent, a weed control fabric should be placed prior to installation.
- Should be installed at a minimum 2" depth.
- Should completely cover all exposed surfaces.

Rock Slope Protection

- Rock slope protection installation should follow Caltrans Standard Specification 72-2: Rock Slope Protection. Refer to the specification for rock conformity requirements and installation methods.
- When using rock slope protection, rock size and installation method should be specified by an Engineer.
- A geotextile fabric should be placed prior to installation.

Costs

- Costs are highly variable depending not only on technique chosen, but also on materials chosen within specific techniques. In addition, availability of certain materials will vary by region/location, which will also affect the cost. Costs of mulches, geotextiles and mats, and soil binders are presented in their respective fact sheets. Costs for decomposed granite, gravel mulch stabilization and rock slope protection may be higher depending on location and availability of materials. Caltrans has provided an estimate for gravel mulch of \$10 - \$15/yd^2 in flat areas and \$11 - \$23/yd^2 on side slopes.

Inspection and Maintenance

General

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- For permanent installation, require inspection periodically and after major storm events to look for signs of erosion or damage to the stabilization.
- All damage should be repaired immediately.
- Refer to EC-3, EC-6, EC-8, and EC-14 for inspection and maintenance requirements for mulches. Refer to EC-7 for inspection and maintenance requirements for geotextiles and mats. Refer to EC-5 for inspection and maintenance requirements for soil binders.

Decomposed Granite and Gravel Mulch Stabilization

- Rake out and add decomposed granite or gravel as needed to areas subject to rill erosion. Inspect upgradient drainage controls and repair/modify as necessary.
- Should remain stable under loose surface material. Any significant problem areas should be repaired to restore uniformity to the installation.

References

Arid Zone Forestry: A Guide for Field Technicians. Food and Agriculture Organization of the United Nations, 1989.

Design of Roadside Channels with Flexible Linings, Hydraulic Engineering Circular Number 15, Third Edition, Federal Highway Administration, 2007.

Design Standards for Urban Infrastructure - Soft Landscape Design, Department of Territory and Municipal Services - Australian Capital Territory http://www.tams.act.gov.au/work/standards_and_procedures/design_standards_for_urban_infrastructure

Erosion and Sediment Control Handbook: A Guide for Protection of State Waters through the use of Best Management Practices during Land Disturbing Activities, Tennessee Department of Environment and Conservation, 2002.

Gravel Mulch, Landscape Architecture Non-Standard Specification 10-2, California Department of Transportation (Caltrans), http://www.dot.ca.gov/hq/LandArch/roadside/detail-gm.htm

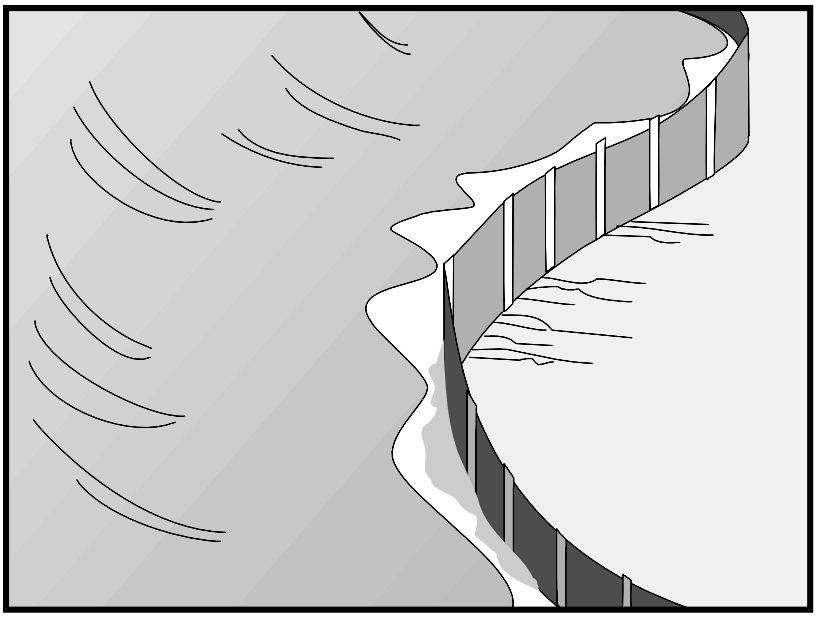
Maine Erosion and Sediment Control BMPs, DEPLW0588, Maine Department of Environmental Protection: Bureau of Land and Water Quality, 2003.

National Menu of Best Management Practices, US Environmental Protection Agency, 2006.

Standard Specification 72-2: Rock Slope Protection. California Department of Transportation, 2006.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Silt Fence SE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-10 Storm Drain Inlet Protection

SE-14 Biofilter Bags

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (SE-10). Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard. Runoff typically ponds temporarily on the upstream side of silt fence.
- Do not use silt fence to divert water flows or place across any contour line. Fences not constructed on a level contour, or fences used to divert flow will concentrate flows resulting in additional erosion and possibly overtopping or failure of the silt fence.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Not effective unless trenched and keyed in.
- Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

A silt fence is a temporary sediment barrier consisting of woven geotextile stretched across and attached to supporting posts, trenched-in, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.

- Silt fences should remain in place until the disturbed area is permanently stabilized, after which, the silt fence should be removed and properly disposed.
- Silt fence should be used in combination with erosion source controls up slope in order to provide the most effective sediment control.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Woven geotextile material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the slope of area draining to the silt fence is 4:1 (H:V) or less.
- Used for shorter durations, typically 5 months or less
- Area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Use is generally limited to 8 months or less.
- Area draining to fence produces moderate sediment loads.
- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fence fabric has higher tensile strength.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
  - Posts are metal (steel or aluminum)

Materials

<u>Standard Silt Fence</u>

- Silt fence material should be woven geotextile with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The

reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts or bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement for health and safety purposes.

Installation Guidelines – Traditional Method

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength geotextile is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench.

- When extra-strength geotextile and closer post spacing are used, the mesh support fence may be eliminated.

- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with native material and compacted.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where, due to specific site conditions, a 3 ft setback is not available, the silt fence may be constructed at the

toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and more difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.
- Cross barriers should be a minimum of $^1/_3$ and a maximum of ½ the height of the linear barrier.
- See typical installation details at the end of this fact sheet.

Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 inches into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the gerotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2 person crew). In addition, installation using static slicing has been found to be more efficient on slopes, in rocky soils, and in saturated soils.
    - Minimal soil disturbance.
    - Greater level of compaction along fence, leading to higher performance (i.e. greater sediment retention).
    - Uniform installation.
    - Less susceptible to undercutting/undermining.

Costs

- It should be noted that costs vary greatly across regions due to available supplies and labor costs.
- Average annual cost for installation using the traditional silt fence installation method (assumes 6 month useful life) is $7 per linear foot based on vendor research. Range of cost is $3.50 - $9.10 per linear foot.
- In tests, the slicing method required 0.33 man hours per 100 linear feet, while the trenched based systems required as much as 1.01 man hours per linear foot.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair undercut silt fences.

- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.
- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

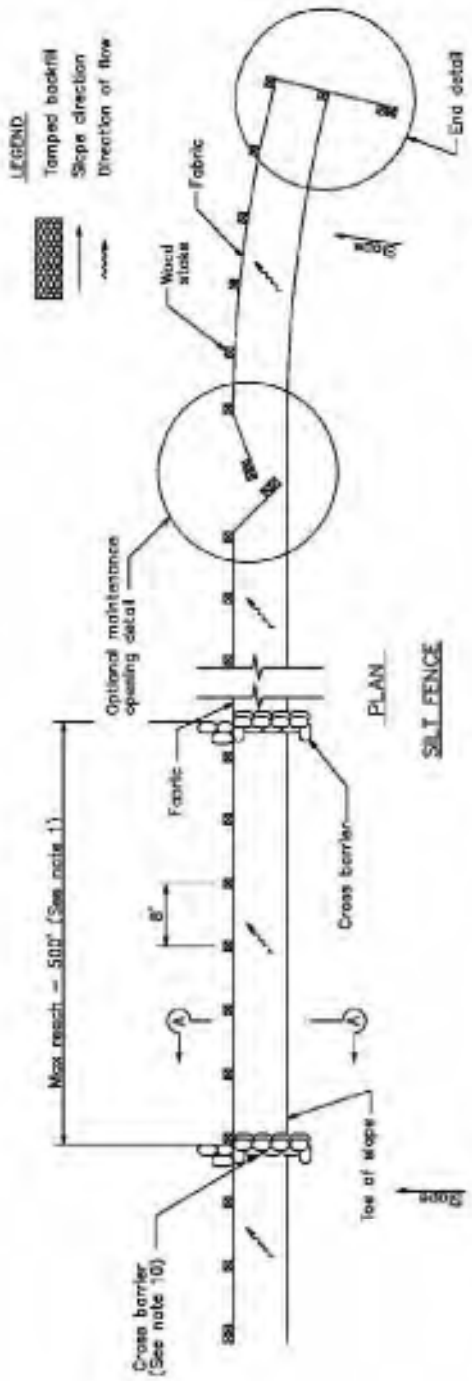
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

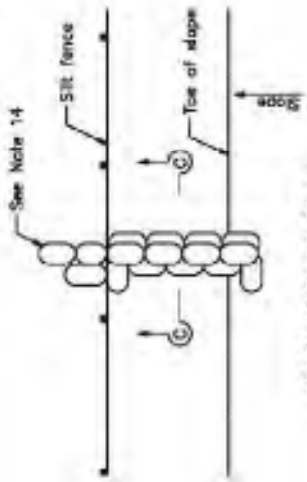
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

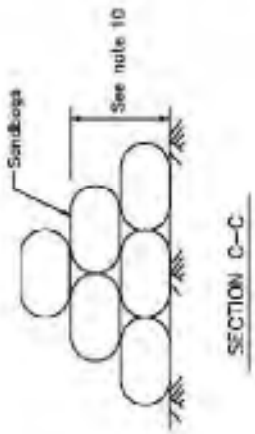
U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

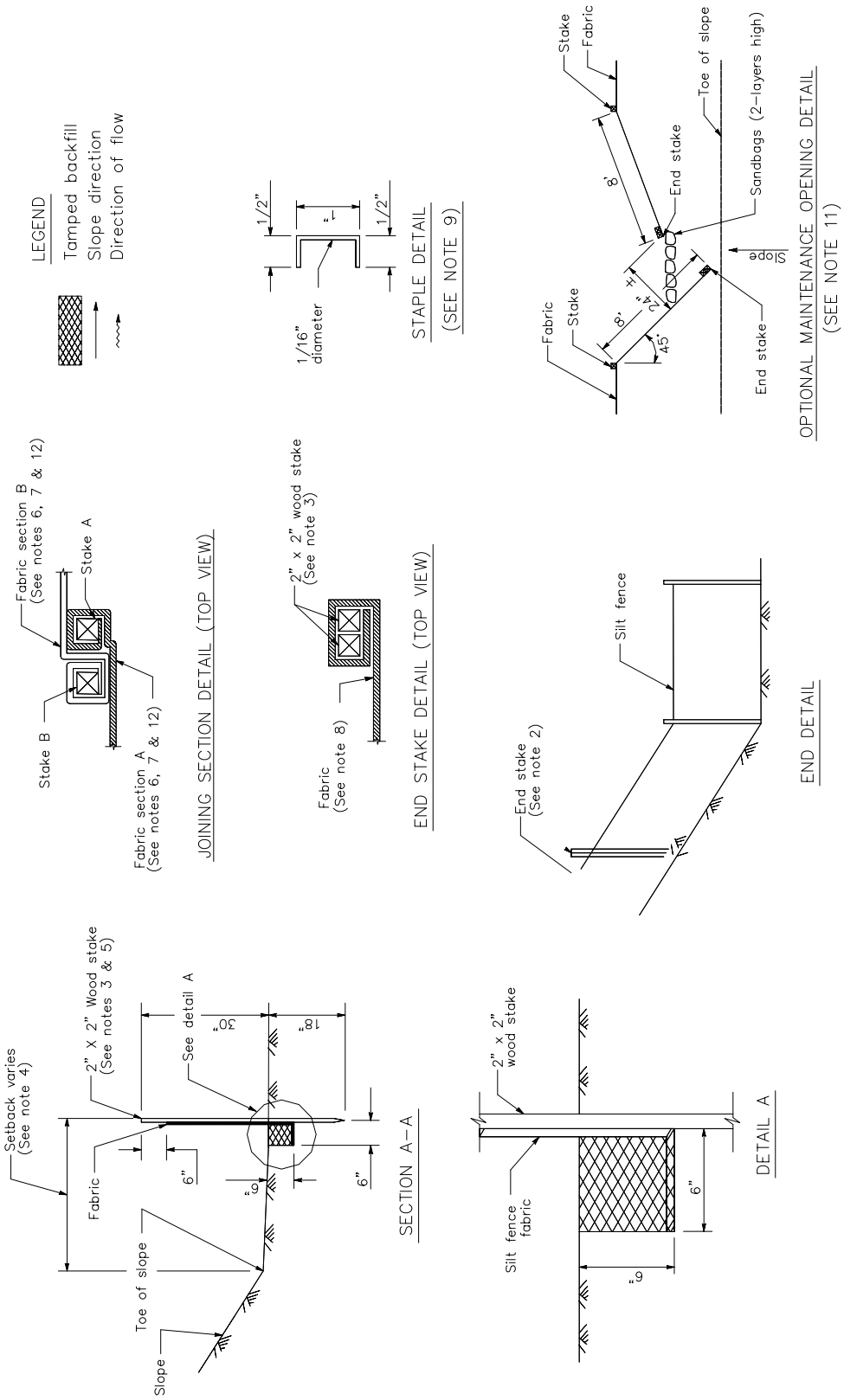




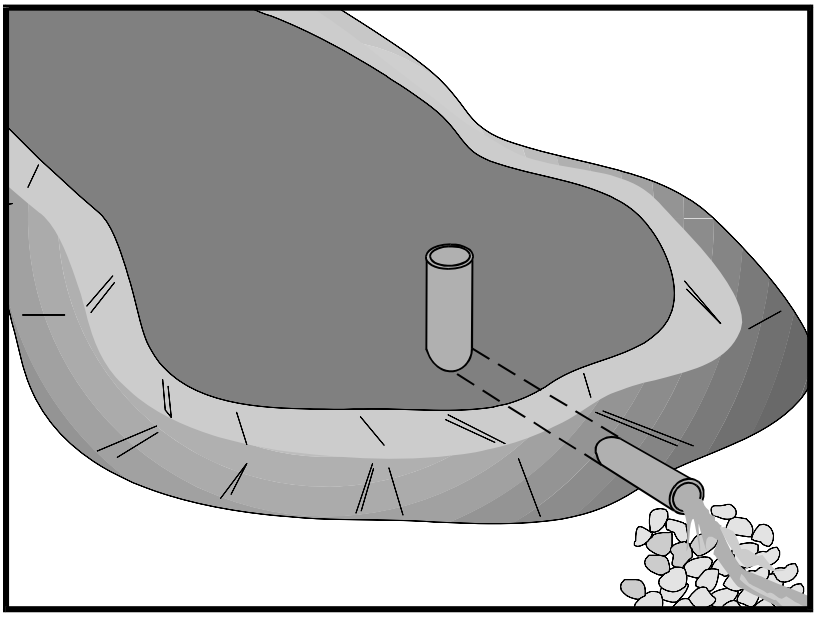


NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'–0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'–0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset, to eliminate gaps.
14. Add 3–4 bags to cross barrier on downgradient side of silt fence as needed to prevent bypass or undermining and as allowable based on site limits of disturbance.


LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
8'
End stake
Sandbags (2-layers high)
Slope
Fabric
Stake
8'
4"
45°
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A

Sediment Basin SE-2



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Sediment basin design guidance presented in this fact sheet is intended to provide options, methods, and techniques to optimize temporary sediment basin performance and basin sediment removal. Basin design guidance provided in this fact sheet is not intended to guarantee basin effluent compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment basins should be used in conjunction with a comprehensive system of BMPs that includes:

- Diverting runoff from undisturbed areas away from the basin
- Erosion control practices to minimize disturbed areas on-site
  and to provide temporary stabilization and interim sediment controls (e.g., stockpile perimeter control, check dams, perimeter controls around individual lots) to reduce the basin's influent sediment concentration.

At some sites, sediment basin design enhancements may be required to adequately remove sediment. Traditional

(aka "physical") enhancements such as alternative outlet configurations or flow deflection baffles increase detention time and other techniques such as outlet skimmers preferentially drain flows with lower sediment concentrations. These "physical" enhancement techniques are described in this fact sheet. To further enhance sediment removal particularly at sites with fine soils or turbidity sensitive receiving waters, some projects may need to consider implementing Active Treatment Systems (ATS) whereby coagulants and flocculants are used to enhance settling and removal of suspended sediments. Guidance on implementing ATS is provided in SE-11.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres and evaluated on a site by site basis
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- As a general guideline, sediment basins are suitable for drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres. However, the tributary area should be evaluated on a site by site basis.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this fact sheet are only effective in removing sediment down to about the silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical (or other appropriate method) treatment is used in addition to the sediment basin.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from California Department of Water Resources Division of Safety of Dams (http://www.water.ca.gov/damsafety/).

- Water that stands in sediment basins longer than 96 hours may become a source of mosquitoes (and midges), particularly along perimeter edges, in shallow zones, in scour or below-grade pools, around inlet pipes, along low-flow channels, and among protected habitats created by emergent or floating vegetation (e.g. cattails, water hyacinth), algal mats, riprap, etc.

- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure expected to be used during active construction in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to convey runoff to the basin inlet.

Many development projects in California are required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins if properly designed and maintained can trap a significant amount of the sediment that flows into them. However, traditional basins do not remove all inflowing sediment. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. Locations best suited for a sediment basin are generally in lower elevation areas of the site (or basin tributary area) where site drainage would not require significant diversion or other means to direct water to the basin but outside jurisdictional waterways. However, as necessary, drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). . The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Construct before clearing and grading work begins when feasible.

- Do not locate the basin in a jurisdictional stream.

- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft must obtain approval from the Division of Dam Safety. Local dam safety requirements may be more stringent.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

When designing a sediment basin, designers should evaluate the site constraints that could affect the efficiency of the BMP. Some of these constraints include: the relationship between basin capacity, anticipated sediment load, and freeboard, available footprint for the basin, maintenance frequency and access, and hydraulic capacity and efficiency of the temporary outlet infrastructure. Sediment basins should be designed to maximize sediment removal and to consider sediment load retained by the basin as it affects basin performance.

Three Basin Design Options (Part A) are presented below along with a Typical Sediment/Detention Basin Design Methodology (Part B). Regardless of the design option that is selected, designers also need to evaluate the sediment basin capacity with respect to sediment accumulation (See "*Step 3. Evaluate the Capacity of the Sediment Basin"),* and should incorporate approaches identified in "*Step 4. Other Design Considerations*" to enhance basin performance.

A) Basin Design Options:

Option 1:

Design sediment basin(s) using the standard equation:

$$A_s = \frac{1.2Q}{V_s} \qquad \text{(Eq. 1)}$$

Where:

A_s = Minimum surface area for trapping soil particles of a certain size

V_s = Settling velocity of the design particle size chosen (V_s = 0.00028 ft/s for a design particle size of 0.01 mm at 68°F)

1.2 = Factor of safety recommended by USEPA to account for the reduction in basin efficiency caused due to turbulence and other non ideal conditions.

$Q = CIA$ (Eq.2)

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient (unitless)

I = Peak rainfall intensity for the 10-year, 6-hour rain event (in/hr)

A = Area draining into the sediment basin in acres

The design particle size should be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the Vs used should be 100 percent of the calculated settling velocity.

This sizing basin method is dependent on the outlet structure design or the total basin length with an appropriate outlet. If the designer chooses to utilize the outlet structure to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a minimum of twice the basin width; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). If the designer chooses to utilize the basin length (with appropriate basin outlet) to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a specifically designed to capture 100% of the design particle size; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity).

The basin should be located on the site where it can be maintained on a year-round basis and should be maintained on a schedule to retain the 2 ft of capacity.

Option 2:

Design pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 1.

Option 3:

The use of an equivalent surface area design or equation provided that the design efficiency is as protective or more protective of water quality than Option 1.

B) Typical Sediment/Detention Basin Design Methodology:

Design of a sediment basin requires the designer to have an understanding of the site constraints, knowledge of the local soil (e.g., particle size distribution of potentially contributing soils), drainage area of the basin, and local hydrology. Designers should not assume that a sediment basin for location A is applicable to location B. Therefore, designers can use this factsheet as guidance but will need to apply professional judgment and knowledge of the site to design an effective and efficient sediment basin. The following provides a general overview of typical design methodologies:

Step 1. Hydrologic Design

- Evaluate the site constraints and assess the drainage area for the sediment basin. Designers should consider on- and off-site flows as well as changes in the drainage area associated with site construction/disturbance. To minimize additional construction during the course of the project, the designer should consider identifying the maximum drainage area when calculating the basin dimensions.

- If a local hydrology manual is not available it is recommended to follow standard rational method procedures to estimate discharge. The references section of this factsheet provides a reference to standard hydrology textbooks that can provide standard methodologies. If local rainfall depths are not available, values can be obtained from standard precipitation frequency maps from NOAA (downloaded from http://www.wrcc.dri.edu/pcpnfreq.html).

Step 2. Hydraulic Design

- Calculate the surface area required for the sediment basin using Equation 1. In which discharge is estimated for a 10-yr 6-hr event using rational method procedure listed in local hydrology manual and Vs is estimated using Stokes Law presented in Equation 3.

$$V_s = 2.81d^2 \qquad \text{(Eq.3)}$$

Where

V_s = Settling velocity in feet per second at 68˚F

d = diameter of sediment particle in millimeters (smallest soil grain size determined by wet sieve analysis or fine silt (0.01 mm [or 0.0004 in.])

- In general the basin outlet design requires an iterative trial and error approach that considered the maximum water surface elevation, the elevation versus volume (stage-storage) relationship, the elevation verses discharge (stage-discharge) relationship, and the estimated inflow hydrograph. To adequately design the basins to settle sediment, the outlet configuration and associated outflow rates can be estimated by numerous methodologies. The following provides some guidance for design the basin outlet:

  - An outlet should have more than one orifice.

  - An outlet design typically utilizes multiple horizontal rows of orifices (approximately 3 or more) with at least 2 orifices per row (see Figures 1 and 2 at the end of this fact sheet).

  - Orifices can vary in shape.

  - Select the appropriate orifice diameter and number of perforations per row with the objective of minimizing the number of rows while maximizing the detention time.

- The diameter of each orifice is typically a maximum of 3-4 inches and a minimum of 0.25-0.5 inches.
- If a rectangular orifice is used, it is recommended to have minimum height of 0.5 inches and a maximum height of 6 inches.
- Rows are typically spaced at three times the diameter center to center vertically with a minimum distance of approximately 4 inches on center and a maximum distance of 1 foot on center.
- To estimate the outflow rate, each row is calculated separately based on the flow through a single orifice then multiplied by the number of orifices in the row. This step is repeated for each of the rows. Once all of the orifices are estimated, the total outflow rate versus elevation (stage-discharge curve) is developed to evaluate the detention time within the basin.
- Flow through a single orifice can be estimated using an Equation 4:

$$Q = BC' A(2gH)^{0.5} \qquad \text{(Eq.4)}$$

Where
Q = Discharge in ft^3/s
C′ = Orifice coefficient (unitless)
A = Area of the orifice (ft^2)
g = acceleration due to gravity (ft^3/s)
H = Head above the orifice (ft)
B = Anticipated Blockage or clogging factor (unitless), It is dependent on anticipated sediment and debris load, trash rack configuration etc, so the value is dependent on design engineers professional judgment and/or local requirements (B is never greater than 1 and a value of 0.5 is generally used)

  - Care must be taken in the selection of orifice coefficient ("C′"); 0.60 is most often recommended and used. However, based on actual tests, Young and Graziano (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:
    - C′ = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or
    - C′ = 0.80 when the material is thicker than the orifice diameter
- If different sizes of orifices are used along the riser then they have to be sized such that not more than 50 percent of the design storm event drains in one-third of the drawdown time (to provide adequate settling time for events smaller than the design storm event) and the entire volume drains within 96 hours or as regulated by the local vector control agency. If a basin fails to drain within 96 hours, the basin must be pumped dry.

- Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

- Floating Outlet Skimmer: The floating skimmer (see Figure 3 at the end of this fact sheet is an alternative outlet configuration (patented) that drains water from upper portion of the water column. This configuration has been used for temporary and permanent basins and can improve basin performance by eliminating bottom orifices which have the potential of discharging solids. Some design considerations for this alternative outlet device includes the addition of a sand filter or perforated under drain at the low point in the basin and near the floating skimmer. These secondary drains allow the basin to fully drain. More detailed guidelines for sizing the skimmer can be downloaded from http://www.fairclothskimmer.com/.

- Hold and Release Valve: An ideal sediment/detention basin would hold all flows to the design storm level for sufficient time to settle solids, and then slowly release the storm water. Implementing a reliable valve system for releasing detention basins is critical to eliminate the potential for flooding in such a system. Some variations of hold and release valves include manual valves, bladder devices or electrically operated valves. When a precipitation event is forecast, the valve would be close for the duration of the storm and appropriate settling time. When the settling duration is met (approximately 24 or 48 hours), the valve would be opened and allow the stormwater to be discharged at a rate that does not resuspend settled solids and in a non-erosive manner. If this type of system is used the valve should be designed to empty the entire basin within 96 hours or as stipulated by local vector control regulations.

Step 3. Evaluate the Capacity of the Sediment Basin

- Typically, sediment basins do not perform as designed when they are not properly maintained or the sediment yield to the basin is larger than expected. As part of a good sediment basin design, designers should consider maintenance cycles, estimated soil loss and/or sediment yield, and basin sediment storage volume. The two equations below can be used to quantify the amount of soil entering the basin.

- The Revised Universal Soil Loss Equation (RUSLE, Eq.5) can be used to estimate annual soil loss and the Modified Universal Soil Equation (MUSLE, Eq.6) can be used to estimate sediment yield from a single storm event.

$$A = R \times K \times LS \times C \times P \qquad \text{(Eq.5)}$$

$$Y = 95\left(Q \times q_p\right)^{0.56} \times K \times LS \times C \times P \qquad \text{(Eq.6)}$$

Where:

A = annual soil loss, tons/acre-year

R = rainfall erosion index, in 100 ft.tons/acre.in/hr

K = soil erodibility factor, tons/acre per unit of R

LS = slope length and steepness factor (unitless)

C = vegetative cover factor (unitless)

P = erosion control practice factor (unitless)

Y = single storm sediment yield in tons

Q = runoff volume in acre-feet

q_p = peak flow in cfs

- Detailed descriptions and methodologies for estimating the soil loss can be obtained from standard hydrology text books (See References section).
- Determination of the appropriate equation should consider construction duration and local environmental factors (soils, hydrology, etc.). For example, if a basin is planned for a project duration of 1 year and the designer specifies one maintenance cycle, RUSLE could be used to estimate the soil loss and thereby the designer could indicate that the sediment storage volume would be half of the soil loss value estimated. As an example for use of MUSLE, a project may have a short construction duration thereby requiring fewer maintenance cycles and a reduced sediment storage volume. MUSLE would be used to estimate the anticipated soil loss based on a specific storm event to evaluate the sediment storage volume and appropriate maintenance frequency.
- The soil loss estimates are an essential step in the design and it is essential that the designer provide construction contractors with enough information to understand maintenance frequency and/or depths within the basin that would trigger maintenance. Providing maintenance methods, frequency and specification should be included in design bid documents such as the SWPPP Site Map.
- Once the designer has quantified the amount of soil entering the basin, the depth required for sediment storage can be determined by dividing the estimated sediment loss by the surface area of the basin.

Step 4. Other Design Considerations

- Consider designing the volume of the settling zone for the total storm volume associated with the 2-year event or other appropriate design storms specified by the local agency. This volume can be used as a guide for sizing the basin without iterative routing calculations. The depth of the settling zone can be estimated by dividing the estimated 2-yr storm volume by the surface area of the basin.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.
  - The basin depth must be no less than 3 ft (not including freeboard).
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 96 hours (also referred

to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 96-hour limit is specified to mitigate vector control concerns.

- Confirmation of the basin performance can be evaluated by routing the design storm (10-yr 6-hr, or as directed by local regulations) through the basin based on the basin volume (stage-storage curve) and the outlet design (stage-discharge curve based on the orifice configuration or equivalent outlet design).

- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.

  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap (or equivalent protection) on fill slopes.

  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.

- Rock, vegetation or appropriate erosion control should be used to protect the basin inlet, outlet, and slopes against erosion.

- The total depth of the sediment basin should include the depth required for sediment storage, depth required for settling zone and freeboard of at least 1 foot or as regulated by local flood control agency for a flood event specified by the local agency.

- The length to settling depth ratio (L/SD) should be less than 200.

- The basin alignment should be designed such that the length of the basin is more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet. If the site topography does not allow for this configuration baffles should be installed so that the ratio is satisfied. If a basin has more than one inflow point, any inflow point that conveys more than 30 percent of the total peak inflow rate has to meet the required length to width ratio.

- An alternative basin sizing method proposed by Fifield (2004) can be consulted to estimate an alternative length to width ratio and basin configuration. These methods can be considered as part of Option 3 which allows for alternative designs that are protective or more protective of water quality.

- Baffles (see Figure 4 at the end of this fact sheet) can be considered at project sites where the existing topography or site constraints limit the length to width ratio. Baffles should be constructed of earthen berms or other structural material within the basin to divert flow in the basin, thus increasing the effective flow length from the basin inlet to the outlet riser. Baffles also reduce the change of short circuiting and allows for settling throughout the basin.

- Baffles are typically constructed from the invert of the basin to the crest of the emergency spillway (i.e., design event flows are meant to flow around the baffles and flows greater than the design event would flow over the baffles to the emergency spillway).

- Use of other materials for construction of basin baffles (such as silt fence) may not be appropriate based on the material specifications and will require frequent maintenance (maintain after every storm event). Maintenance may not be feasible when required due to flooded conditions resulting from frequent (i.e., back to back) storm events. Use of alternative baffle materials should not deviate from the intended purpose of the material, as described by the manufacturer.
- Sediment basins are best used in conjunction with erosion controls.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.
- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen, although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

The cost of a sediment basin is highly variable and is dependent of the site configuration. To decrease basin construction costs, designers should consider using existing site features such as berms or depressed area to site the sediment basin. Designers should also consider potential savings associated with designing the basin to minimize the number of maintenance cycles and siting the basin in a location where a permanent BMP (e.g., extended detention basin) is required for the project site.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level and as required by local requirements. It is recommended that at a minimum, basins be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the basin must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance should be managed properly. The sediment should be appropriately evaluated and used or disposed of accordingly. Options include: incorporating sediment into earthwork on the site (only if there is no risk that sediment is contaminated); or off-site export/disposal at an appropriate location (e.g., sediment characterization and disposal to an appropriate landfill).
- Remove standing water from basin within 96 hours after accumulation.
- If the basin does not drain adequately (e.g., due to storms that are more frequent or larger than the design storm or other unforeseen site conditions), dewatering should be conducted in accordance with appropriate dewatering BMPs (see NS-2) and in accordance with local permits as applicable.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

References

A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zones, Metropolitan Washington Council of Governments, March 1992.

Draft-Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA. April 1990.

U.S. Environmental Protection Agency (USEPA). Erosion and Sediment Control, Surface Mining in the Eastern U.S., U.S. Environmental Protection Agency, Office of Water, Washington, DC,Washington, D.C., 1976.

Fifield, J.S. Designing for Effective Sediment and Erosion Control on Construction Sites. Forester Press, Santa Barbara, CA. 2004.

Goldman S.J., Jackson K. and Bursztynsky T.A. Erosion and Sediment Control Handbook. McGraw-Hill Book Company, 1986.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

Guidelines for the Design and Construction of Small Embankment Dams, Division of Safety of Dams, California Department of Water Resources, March 1986.

Haan C.T., Barfield B.J. and Hayes J.C. Design Hydrology and Sedimentology for Small Catchments. Academic Press. 1994.

Inlet/Outlet Alternatives for Extended Detention Basins. State of California Department of Transportation (Caltrans), 2001.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

McLean, J., 2000. Mosquitoes in Constructed Wetlands: A Management Bugaboo? In T.R. Schueler and H.K. Holland [eds.], The Practice of Watershed Protection. pp. 29-33. Center for Watershed Protection, Ellicott City, MD, 2000.

Metzger, M.E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Water, Work Group-Working Paper, USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Young, G.K. and Graziano, F., Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission, 1989.

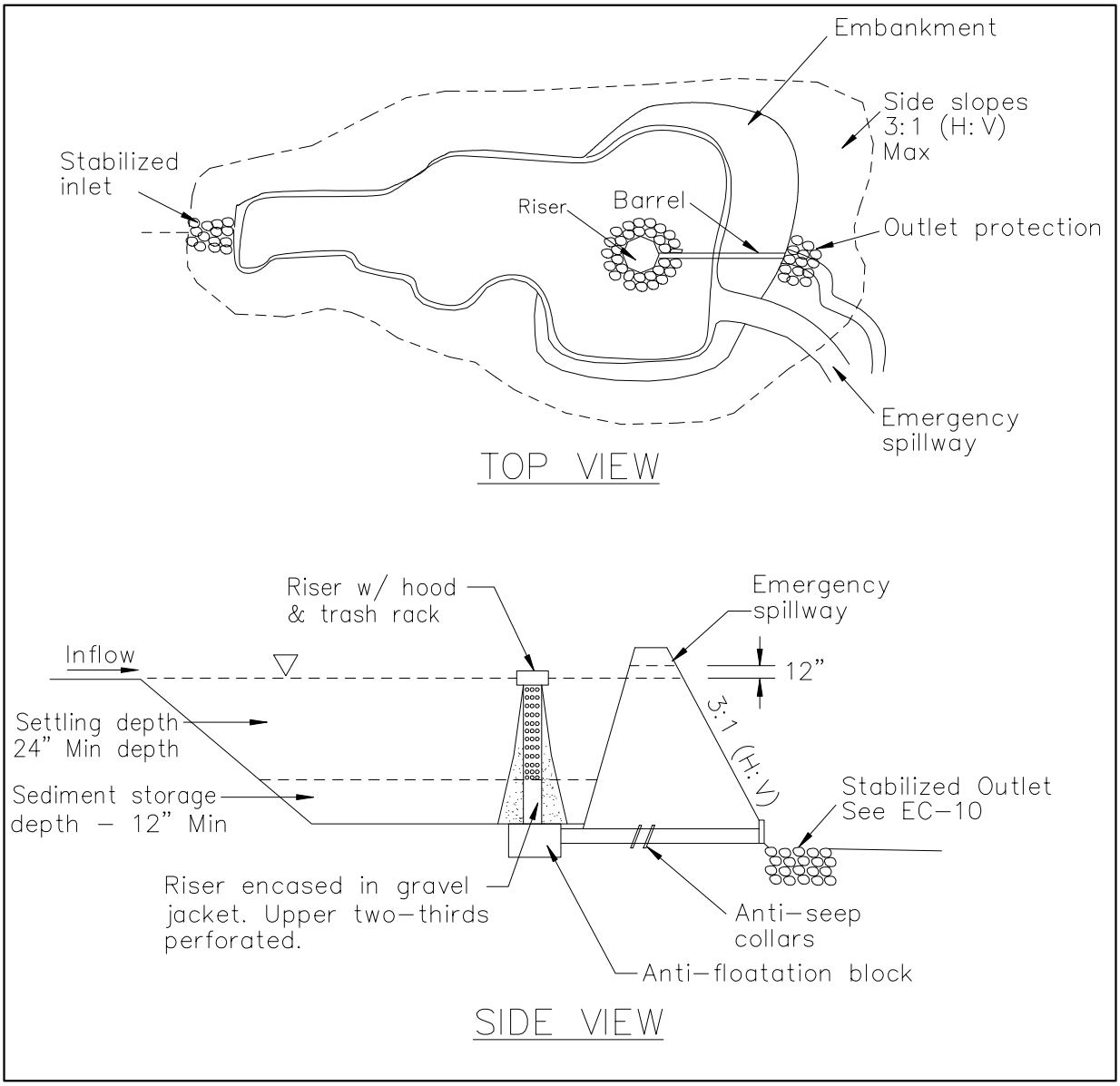


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

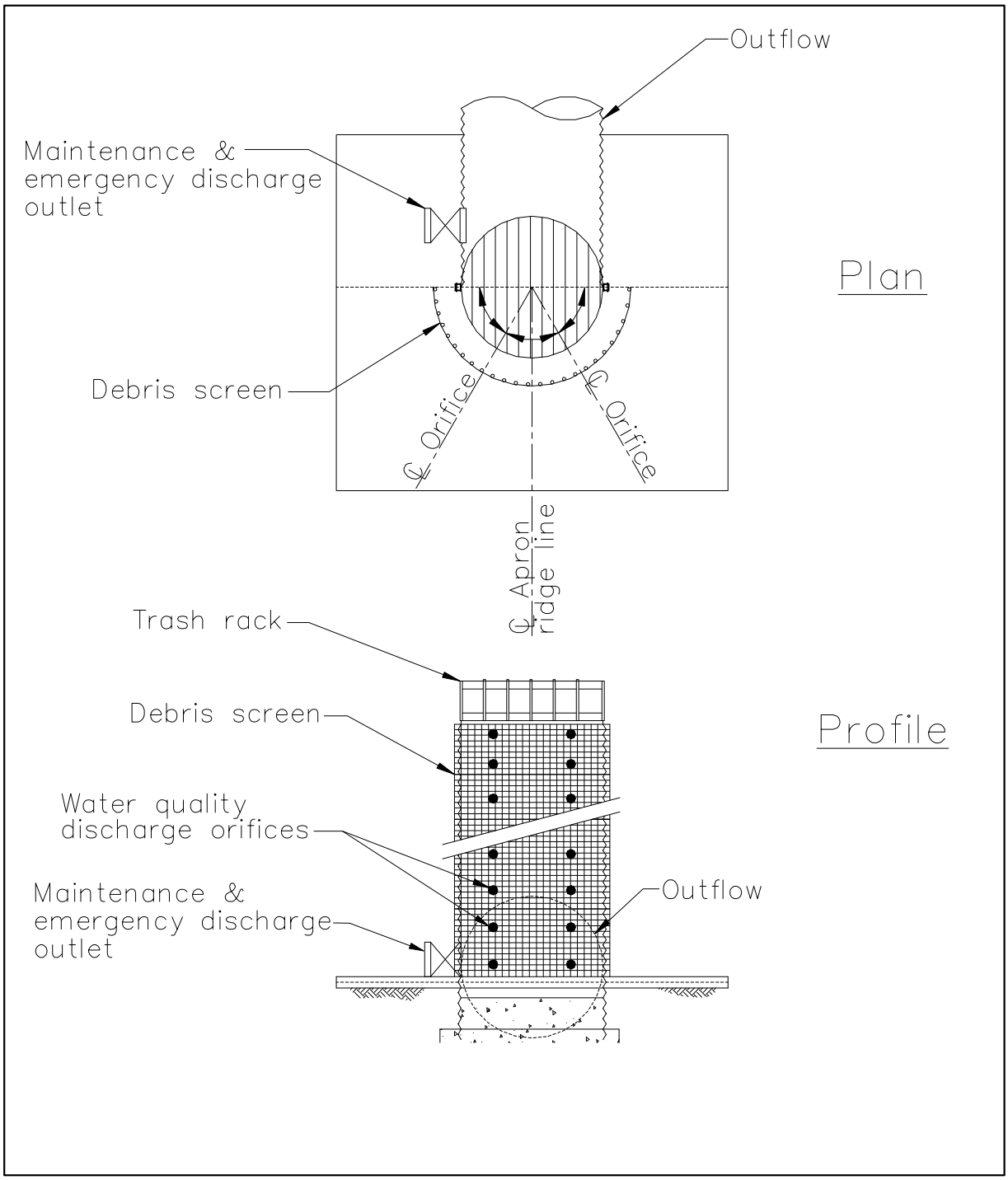


FIGURE 2: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

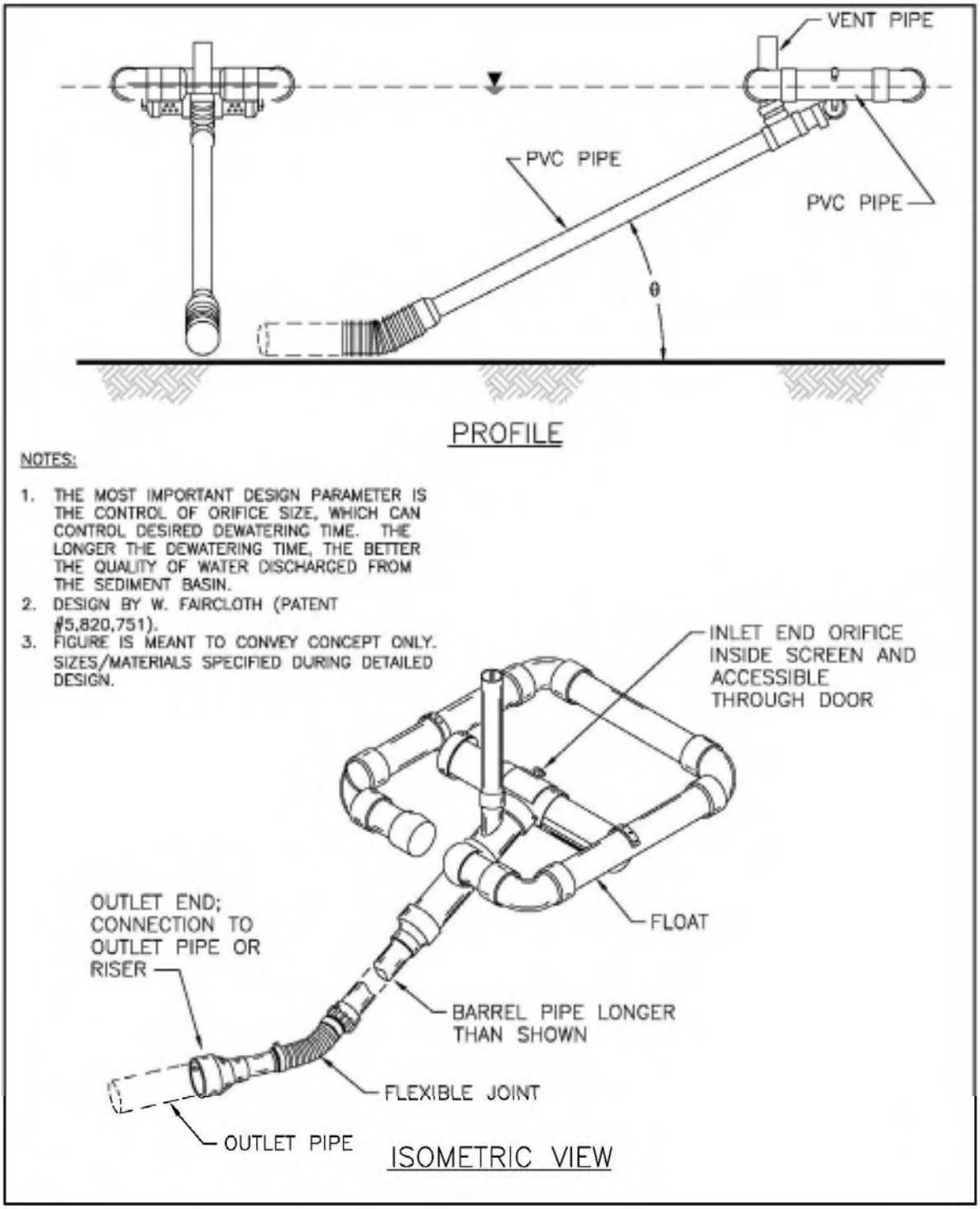


FIGURE 3: TYPICAL SKIMMER

NOT TO SCALE

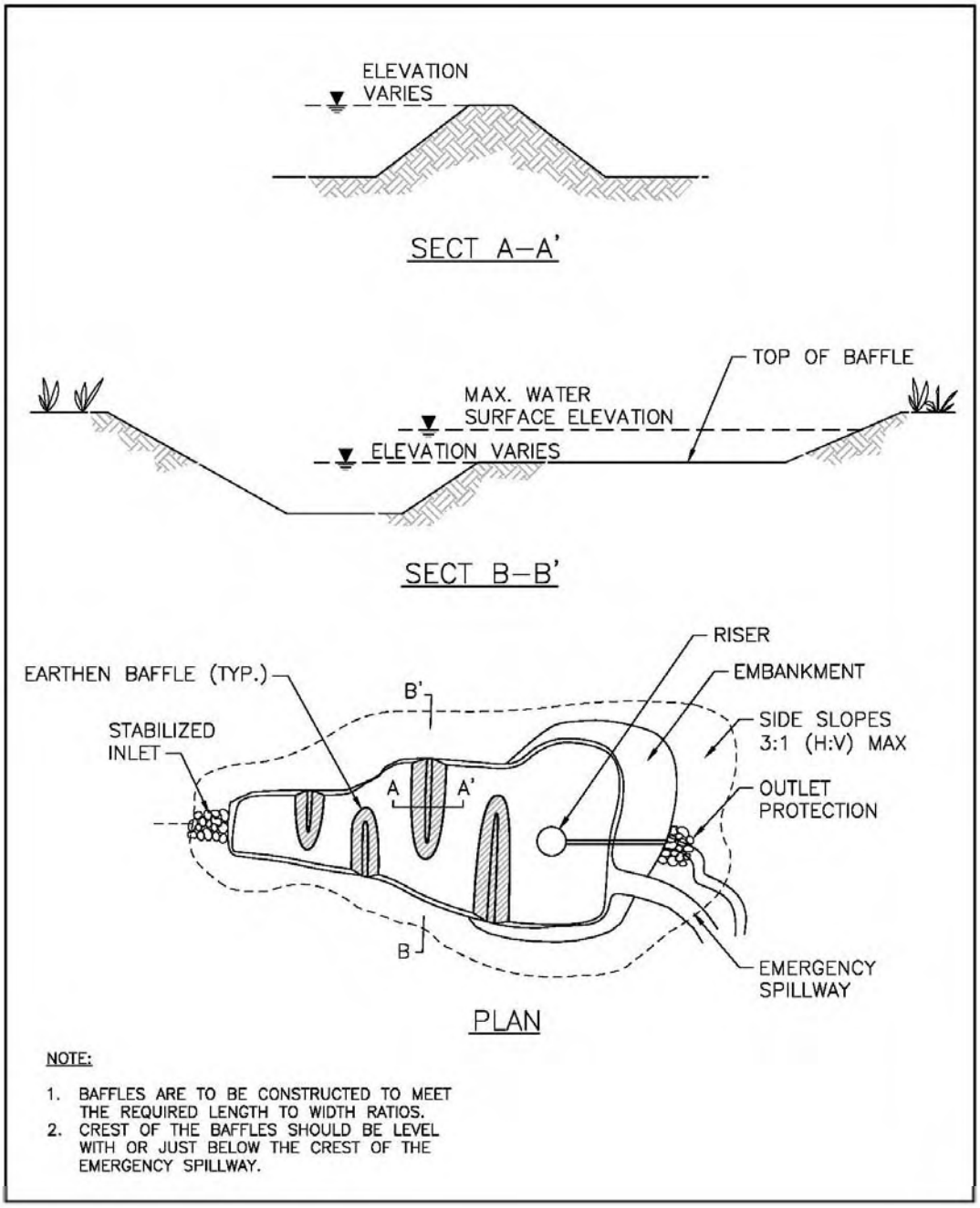
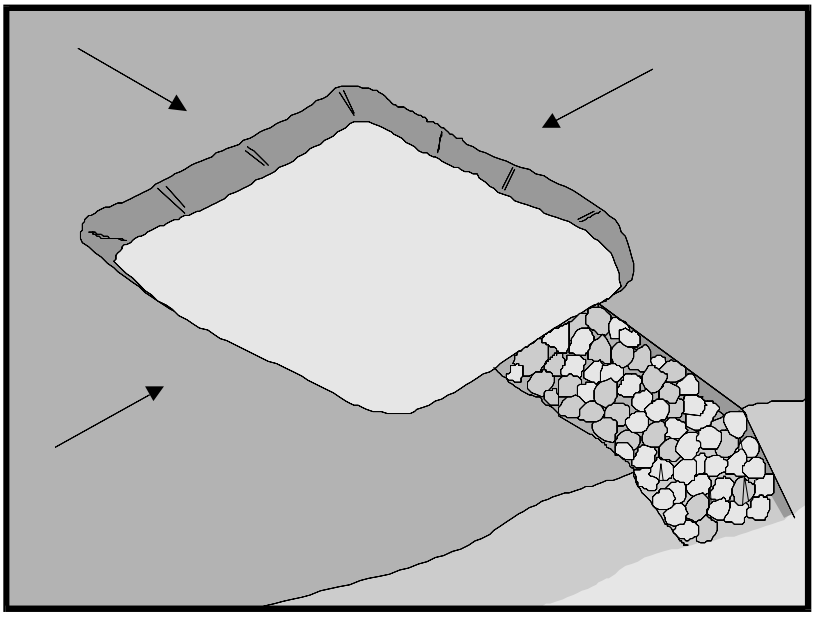


FIGURE 4: TYPICAL TEMPORARY SEDIMENT BASIN WITH BAFFLES

NOT TO SCALE

Sediment Trap SE-3



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged by gravity flow. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Trap design guidance provided in this fact sheet is not intended to guarantee compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment traps should be used in conjunction with a comprehensive system of BMPs.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be

placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.

- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume

the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.

- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.
- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 96 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs per NS-2 shall be implemented at all times during dewatering activities.

References

Brown, W., and T. Schueler. The Economics of Stormwater BMPs in the Mid-Atlantic Region. Prepared for Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD, 1997.

Draft – Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA, April 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Metzger, M.E., D.F. Messer, C.L. Beitia, C.M. Myers, and V.L. Kramer, The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

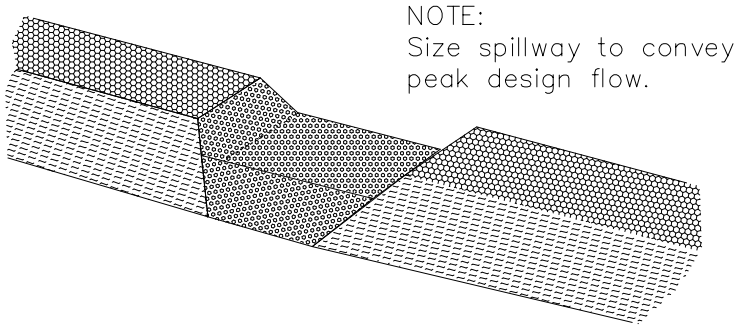
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

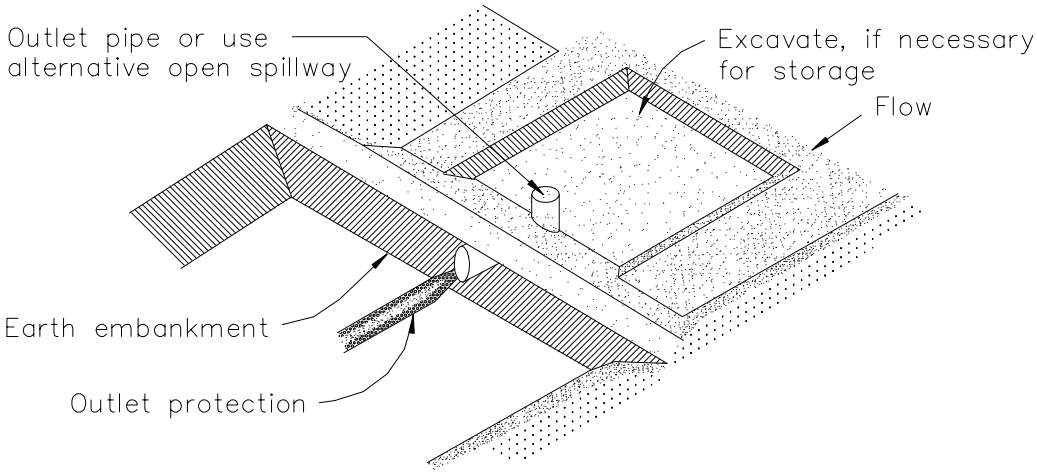
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

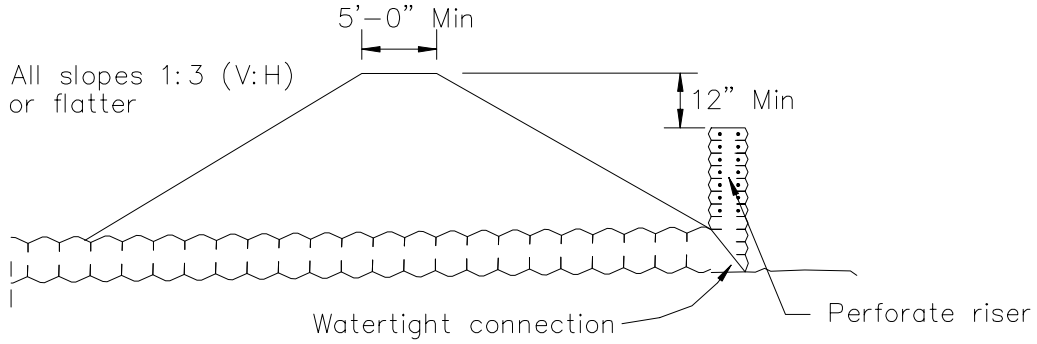
U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



TYPICAL OPEN SPILLWAY

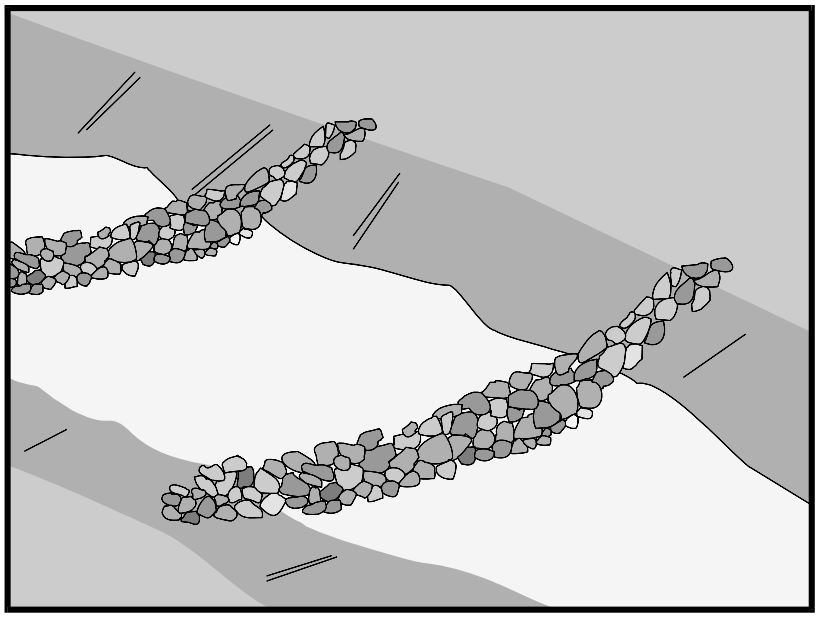




EMBANKMENT SECTION THRU RISER

TYPICAL SEDIMENT TRAP
NOT TO SCALE

Check Dams SE-4



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.
- To act as a grade control structure.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as as sediment controls. Note that use of 1-2 isolated check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, either:

- Don't use check dams. Consider alternative BMPs, or.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of

the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- For multiple check dam installation, backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap should be cleaned following each storm event.

- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms.
- Sandbags used for check dams should conform to SE-8, Sandbag Barrier.
- Fiber rolls used for check dams should conform to SE-5, Fiber Rolls.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

Costs

Cost consists of labor costs if materials are readily available (such as gravel on-site). If material must be imported, costs will increase. For other material and installation costs, see SE-5, SE-6, SE-8, SE-12, and SE-14.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.

- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

Draft – Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

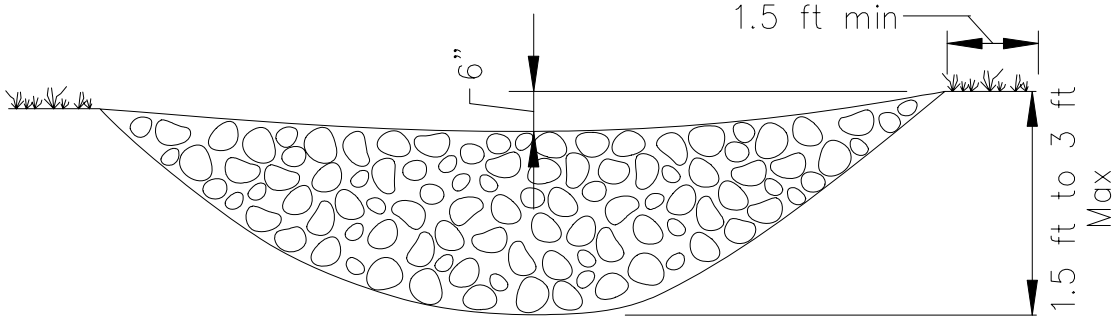
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

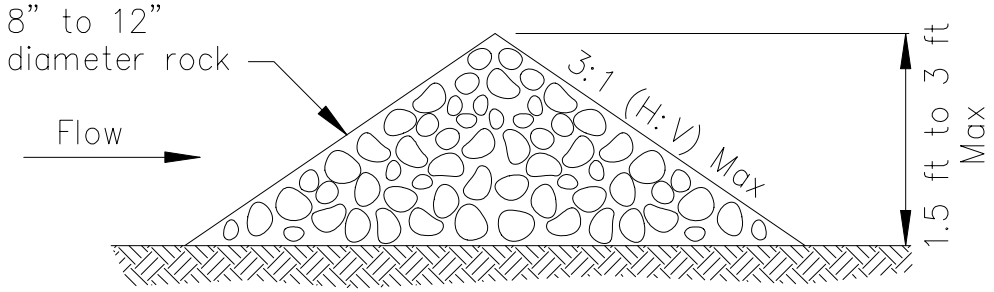
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

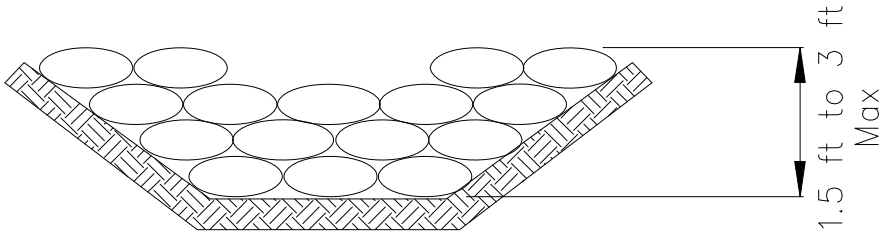


ELEVATION

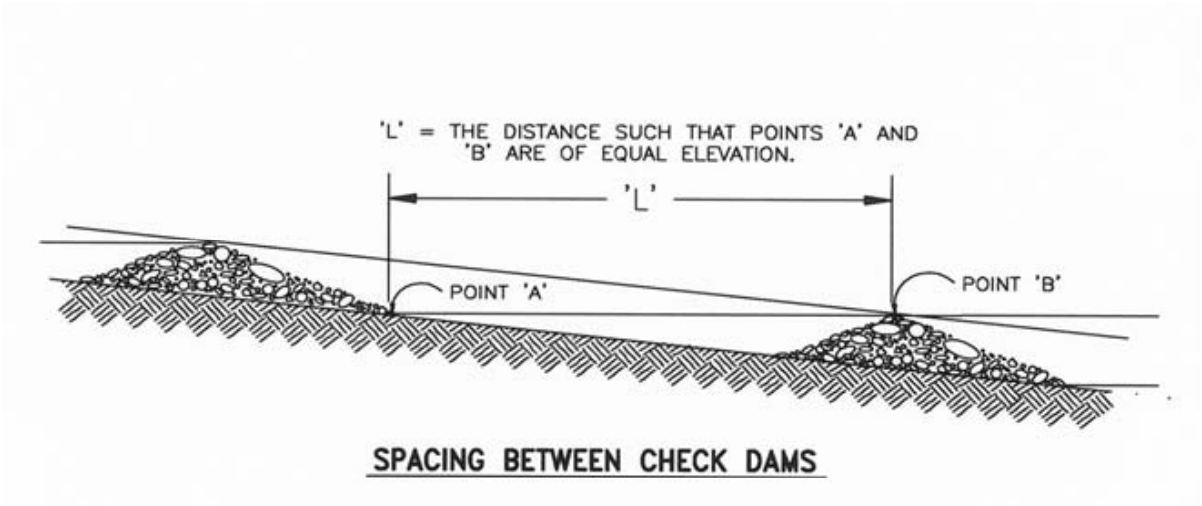


TYPICAL ROCK CHECK DAM SECTION

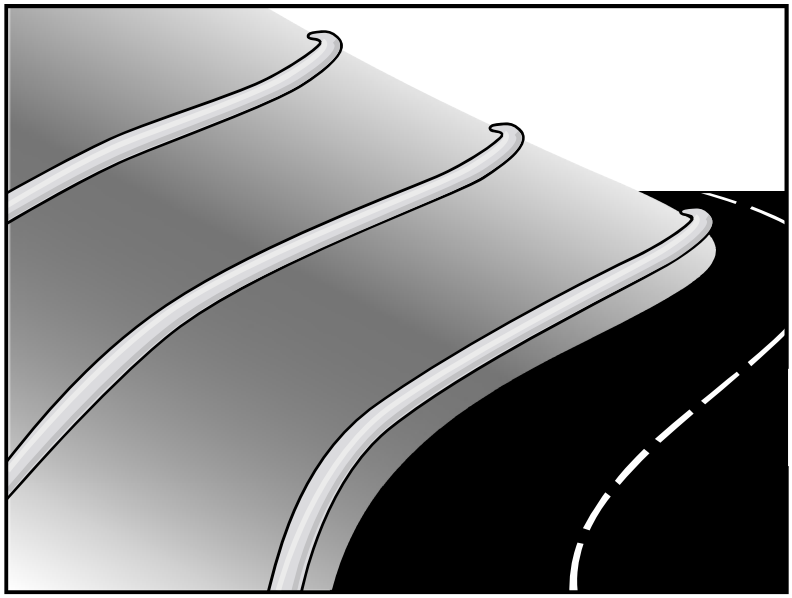
ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE


'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.
'L'
POINT 'A'
POINT 'B'
SPACING BETWEEN CHECK DAMS

Fiber Rolls SE-5



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A fiber roll consists of straw, coir, or other biodegradable materials bound into a tight tubular roll wrapped by netting, which can be photodegradable or natural. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight when staking the rolls are not feasible (such as use as inlet protection). When fiber rolls are placed at the toe and on the face of slopes along the contours, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches with minimal grade.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.

- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched in and staked.
- Not intended for use in high flow situations.
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.
- Rolls typically function for 12-24 months depending upon local conditions.

Implementation

Fiber Roll Materials

- Fiber rolls should be prefabricated.
- Fiber rolls may come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll. Fiber rolls impregnated with PAM provide additional sediment removal capabilities and should be used in areas with fine, clayey or silty soils to provide additional sediment removal capabilities. Monitoring may be required for these installations.
- Fiber rolls are made from weed free rice straw, flax, or a similar agricultural material bound into a tight tubular roll by netting.
- Typical fiber rolls vary in diameter from 9 in. to 20 in. Larger diameter rolls are available as well.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth should be ¼ to 1/3 of the thickness of the roll, and the width should equal the roll diameter, in order to provide area to backfill the trench.

- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- It is recommended that pilot holes be driven through the fiber roll. Use a straight bar to drive holes through the roll and into the soil for the wooden stakes.
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into the trench.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or removed depending on the type of fiber roll and application (temporary vs. permanent installation). Typically, fiber rolls encased with plastic netting are used for a temporary application because the netting does not biodegrade. Fiber rolls used in a permanent application are typically encased with a biodegradeable material and are left in place. Removal of a fiber roll used in a permanent application can result in greater disturbance.
- Temporary installations should only be removed when up gradient areas are stabilized per General Permit requirements, and/or pollutant sources no longer present a hazard. But, they should also be removed before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.

Costs

Material costs for regular fiber rolls range from $20 - $30 per 25 ft roll.

Material costs for PAM impregnated fiber rolls range between 7.00-$9.00 per linear foot, based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be periodically removed

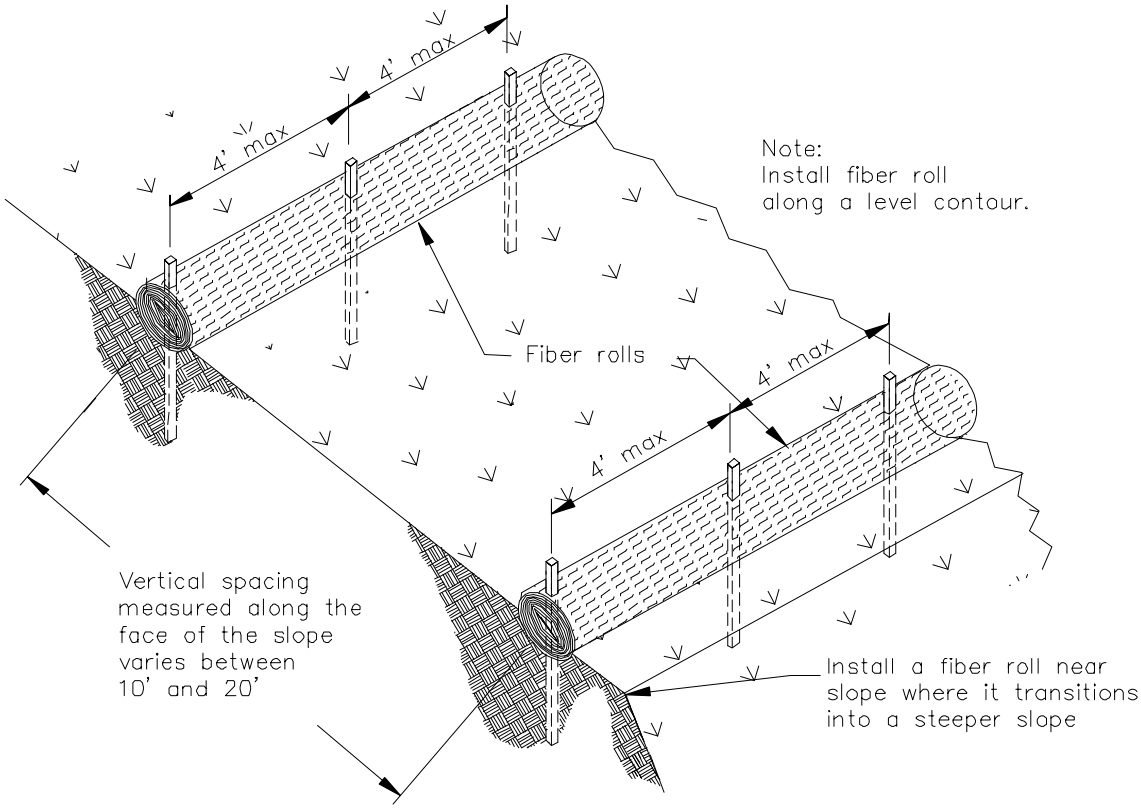
in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-third the designated sediment storage depth.

- If fiber rolls are used for erosion control, such as in a check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.
- Repair any rills or gullies promptly.

References

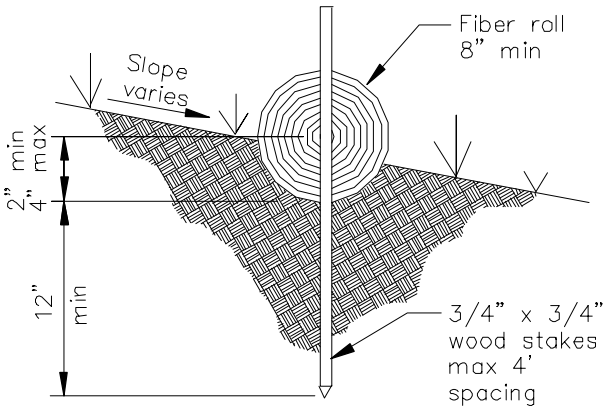
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



TYPICAL FIBER ROLL INSTALLATION

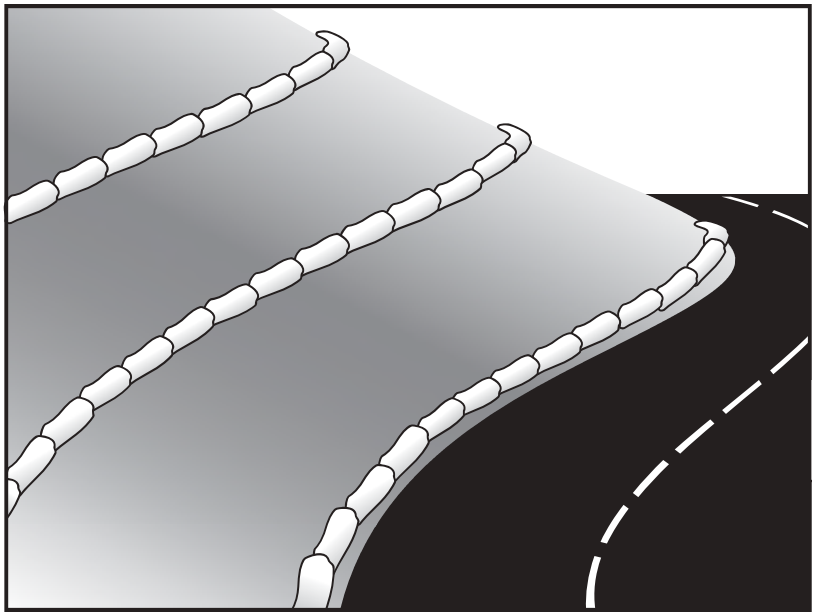
N.T.S.



ENTRENCHMENT DETAIL

N.T.S.

Gravel Bag Berm SE-6



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

- At the top of slopes to divert runoff away from disturbed slopes.
- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Material costs for gravel bags are average and are dependent upon material availability. $2.50-3.00 per filled gravel bag is standard based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

References

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Street Sweeping and Vacuuming SE-7

Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

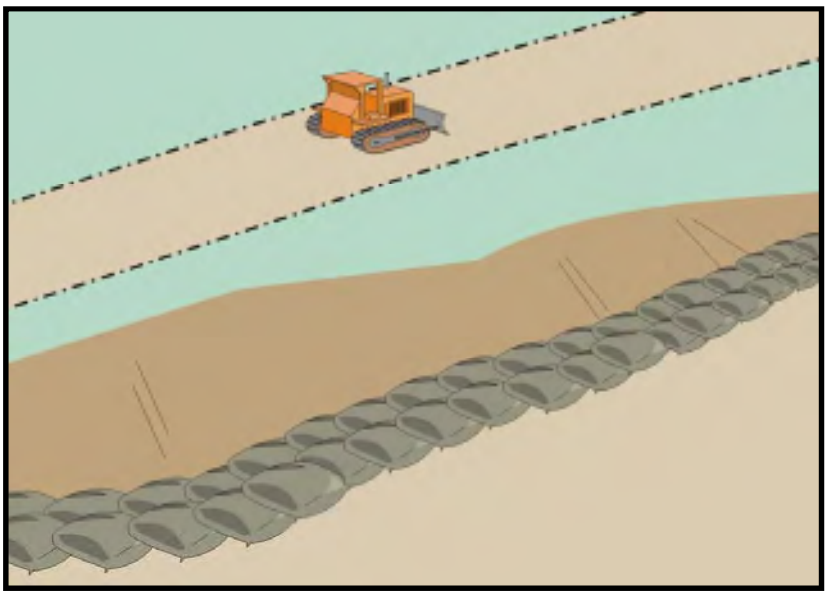
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Sandbag Barrier SE-8



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-14 Biofilter Bags

Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept or to divert sheet flows. Sandbag barriers placed on a level contour pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small cleared areas.
  - Along the perimeter of a site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment off paved areas.
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

- At the top of slopes to divert runoff away from disturbed slopes.
- As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Sandbags are not intended to be used as filtration devices.
- Easily damaged by construction equipment.
- Degraded sandbags may rupture when removed, spilling sand.
- Sand is easily transported by runoff if bag is damaged or ruptured.
- Installation can be labor intensive.
- Durability of sandbags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months. When used to detain concentrated flows, maintenance requirements increase.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. Sand-filled bags have limited porosity, which is further limited as the fine sand tends to quickly plug with sediment, limiting or completely blocking the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms or SE-14, Biofilter Bags. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to gravel bag berms, but less porous. Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate sandbag barriers on a level contour.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Sandbags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

    Slope inclination 2:1 (H:V) or greater: Sandbags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, sand bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the sand bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Stack sandbags at least three bags high.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Side slope = 2:1 (H:V) or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- See typical sandbag barrier installation details at the end of this fact sheet.

Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not an acceptable substitute, as sand can more easily mobilize out of burlap.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 3 (Caltrans Standard Specification, Section 25) permeable material free from clay and deleterious material, such as recycled concrete or asphalt..

Costs

Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Additional labor is required to fill the bags. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag. These costs are based upon vendor research.

Inspection and Maintenance

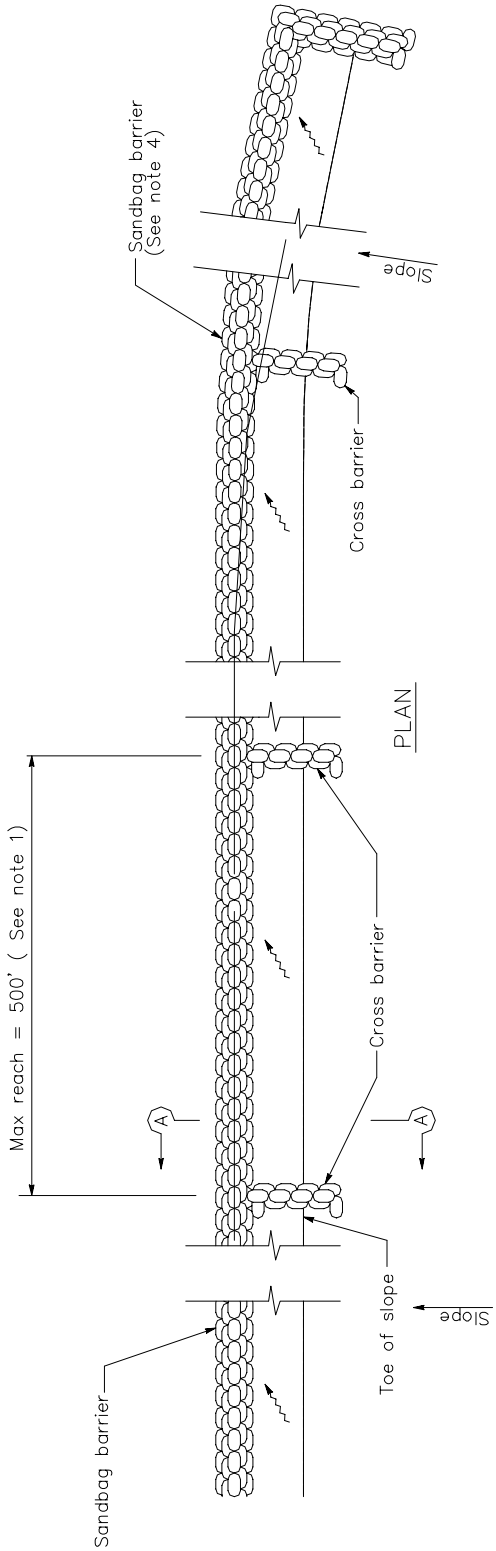
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove sandbags when no longer needed and recycle sand fill whenever possible and properly dispose of bag material. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

Standard Specifications for Construction of Local Streets and Roads, California Department of Transportation (Caltrans), July 2002.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

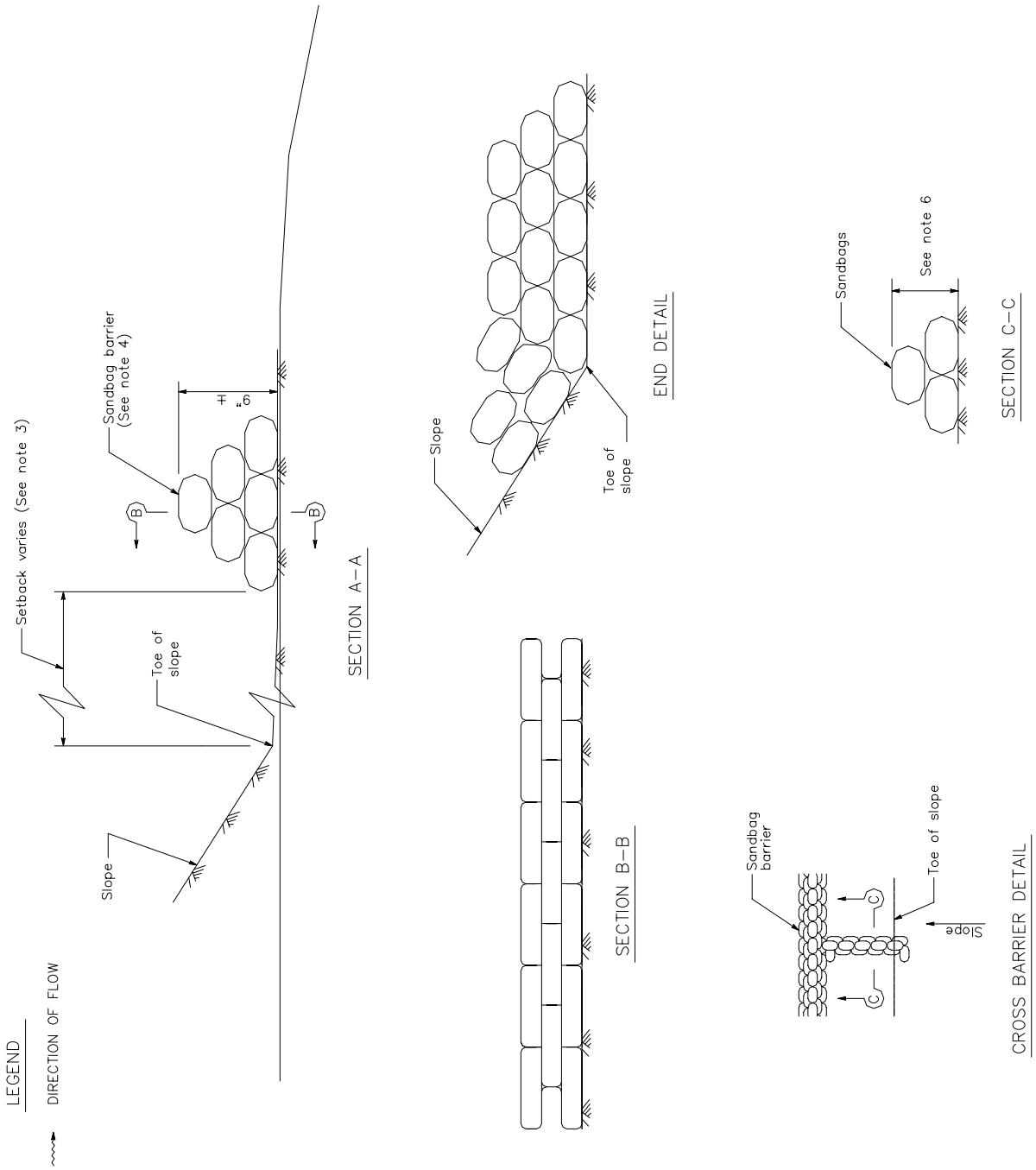
Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



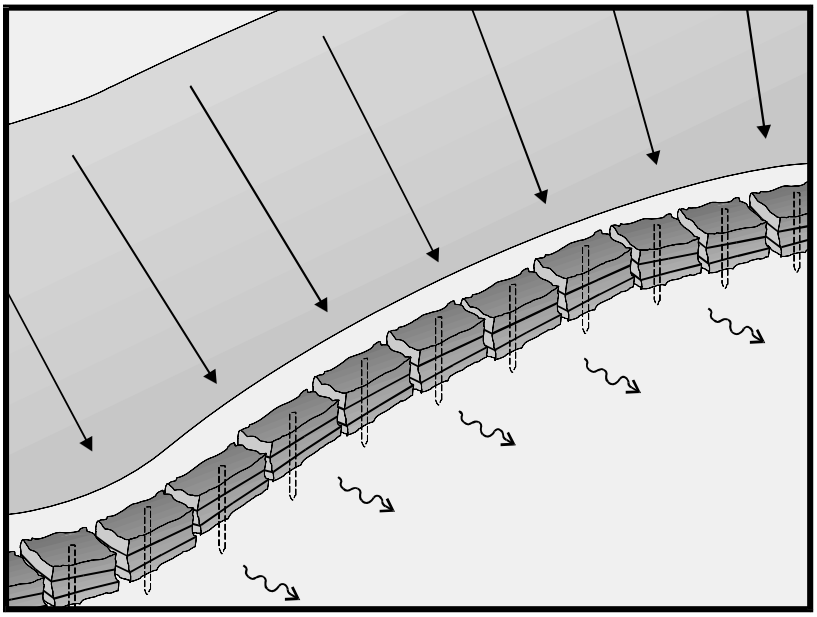
SANDBAG BARRIER

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.


LEGEND
DIRECTION OF FLOW
Setback varies (See note 3)
Sandbag barrier
(See note 4)
H
9"
B
B
Toe of
slope
Slope
SECTION A–A
Slope
Toe of
slope
END DETAIL
SECTION B–B
Sandbags
See note 6
SECTION C–C
Sandbag
barrier
Toe of slope
C
C
Slope
CROSS BARRIER DETAIL

Straw Bale Barrier SE-9



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Straw bale barriers pond sheet- flow runoff, allowing sediment to settle out.

Suitable Applications

Straw bale barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

Straw bale barriers:

- Are not to be used for extended periods of time because they tend to rot and fall apart
- Are suitable only for sheet flow on slopes of 10 % or flatter
- Are not appropriate for large drainage areas, limit to one acre or less
- May require constant maintenance due to rotting
- Are not recommended for concentrated flow, inlet protection, channel flow, and live streams
- Cannot be made of bale bindings of jute or cotton
- Require labor-intensive installation and maintenance
- Cannot be used on paved surfaces
- Should not to be used for drain inlet protection
- Should not be used on lined ditches
- May introduce undesirable non-native plants to the area

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bale barriers on a level contour.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the toe of slope.
  - Slopes greater than 10:1 (H:V): Not recommended.

- Turn the ends of the straw bale barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sand bags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should be limited to 100 ft.
- Straw bale barriers should consist of two parallel rows.
  - Butt ends of bales tightly
  - Stagger butt joints between front and back row
  - Each row of bales must be trenched in and firmly staked
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- ***Straw Bale Size:*** Each straw bale should be a minimum of 14 in. wide, 18 in. in height, 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- ***Bale Bindings:*** Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- ***Stakes:*** Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Costs

Straw bales cost $5 - $7 each. Adequate labor should be budgeted for installation and maintenance.

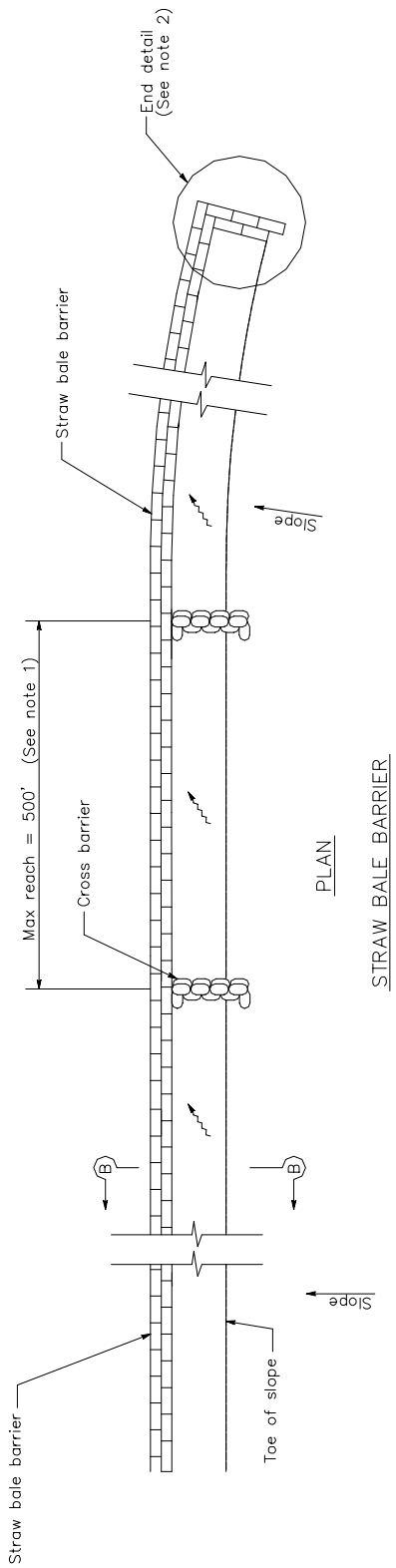
Inspection and Maintenance

Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damages as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



PLAN

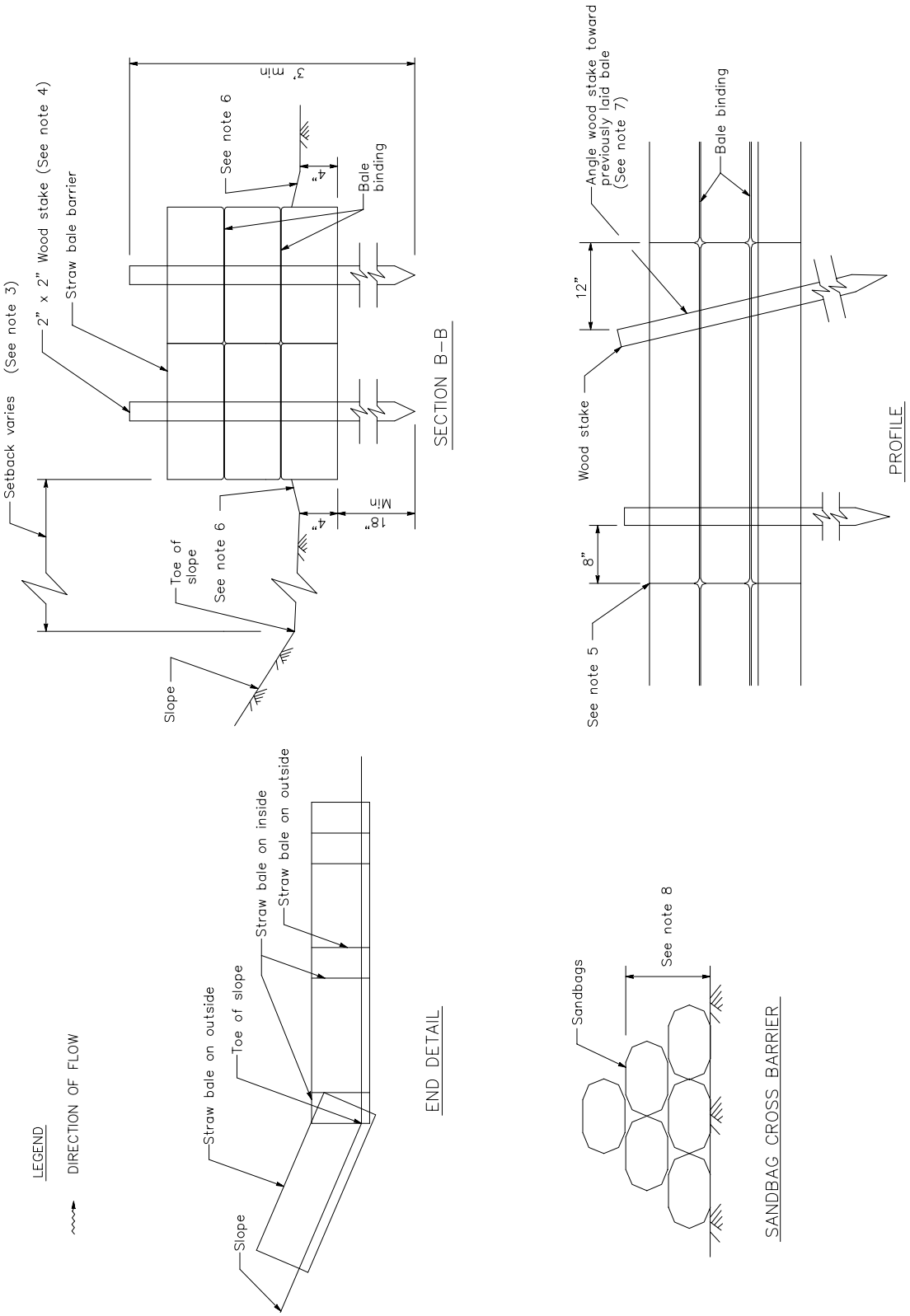
STRAW BALE BARRIER

LEGEND

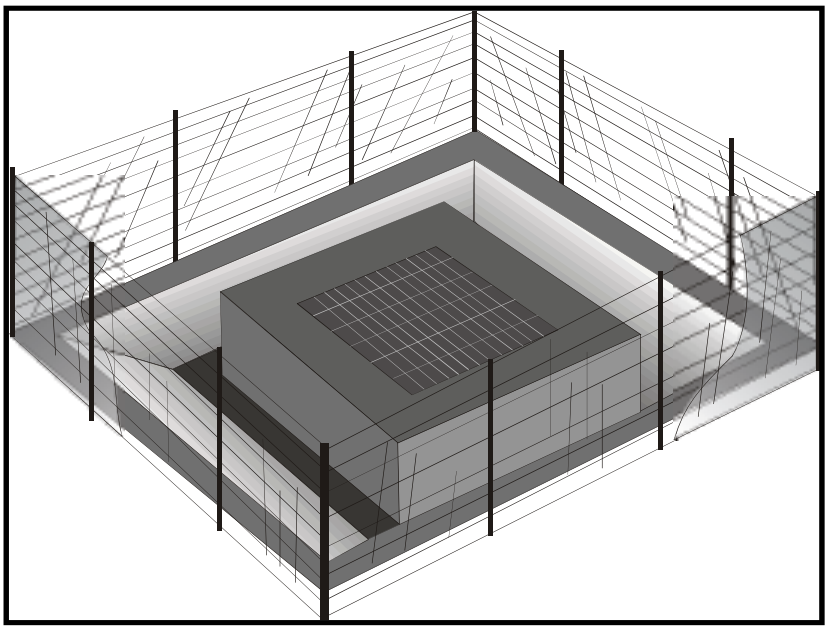
DIRECTION OF FLOW

NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The end of barrier shall be turned up slope.
3. Dimension may vary to fit field condition.
4. Stake dimensions are nominal.
5. Place straw bales tightly together.
6. Tamp embedment spoils against sides of installed bales.
7. Drive angled wood stake before vertical stake to ensure tight abutment to adjacent bale.
8. Sandbag cross barriers should be a min of 1/2 and a max of 2/3 the height of the linear barrier.
9. Sandbag rows and layers should be offset to eliminate gaps.


Setback varies (See note 3)
2" x 2" Wood stake (See note 4)
Straw bale barrier
3' min
See note 6
4"
Bale binding
Toe of slope
See note 6
4"
18" Min
Slope
SECTION B–B
Angle wood stake toward previously laid bale (See note 7)
Bale binding
12"
Wood stake
8"
See note 5
PROFILE
LEGEND
DIRECTION OF FLOW
Straw bale on outside
Toe of slope
Straw bale on inside
Straw bale on outside
Slope
END DETAIL
Sandbags
See note 8
SANDBAG CROSS BARRIER

Storm Drain Inlet Protection SE-10



Categories

EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area in, around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction. Temporary geotextile storm drain inserts attach underneath storm drain grates to capture and filter storm water.

Suitable Applications

Every storm drain inlet receiving runoff from unstabilized or otherwise active work areas should be protected. Inlet protection should be used in conjunction with other erosion and sediment controls to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.

Limitations

- Drainage area should not exceed 1 acre.
- In general straw bales should not be used as inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.

- Sediment removal may be inadequate to prevent sediment discharges in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.
- Limit drainage area to 1 acre maximum. For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap and/or used in conjunction with other drainage control, erosion control, and sediment control BMPs to protect the site. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Alternative methods are available in addition to the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- The key to successful and safe use of storm drain inlet protection devices is to know where runoff that is directed toward the inlet to be protected will pond or be diverted as a result of installing the protection device.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Six types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Silt Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
  - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  - Temporary Geotextile Storm drain Inserts: Different products provide different features. Refer to manufacturer details for targeted pollutants and additional features.
  - Biofilter Bag Barrier: Used to create a small retention area upstream of inlets and can be located on pavement or soil. Biofilter bags slowly filter runoff allowing sediment to settle out. Appropriate for flows under 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- ***DI Protection Type 1 - Silt Fence -*** Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced and water flow through the grate will be blocked resulting in flooding. See typical Type 1 installation details at the end of this fact sheet.

  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes should be at least 48 in.
  3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
  4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.

5. Backfill the trench with gravel or compacted earth all the way around.

- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap -*** Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area. See typical Type 2 installation details at the end of this fact sheet.

- ***DI Protection Type 3 - Gravel bag -*** Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability. See typical Type 3 installation details at the end of this fact sheet.

  1. Construct on gently sloping street.

  2. Leave room upstream of barrier for water to pond and sediment to settle.

  3. Place several layers of gravel bags – overlapping the bags and packing them tightly together.

  4. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- ***DI Protection Type 4 – Block and Gravel Filter -*** Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction. See typical Type 4 installation details at the end of this fact sheet.

  1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place woven geotextile over the wire mesh.

  2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.

  3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.

  4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

- ***DI Protection Type 5 – Temporary Geotextile Insert (proprietary)*** – Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside of a curb inlet and are fastened to the outside of the grate or curb. These inserts are removable and many can be cleaned and reused. Installation of these inserts differs between manufacturers. Please refer to manufacturer instruction for installation of proprietary devices.

- ***DI Protection Type 6 - Biofilter bags*** – Biofilter bags may be used as a substitute for gravel bags in low-flow situations. Biofilter bags should conform to specifications detailed in SE-14, Biofilter bags.

  1. Construct in a gently sloping area.
  2. Biofilter bags should be placed around inlets to intercept runoff flows.
  3. All bag joints should overlap by 6 in.
  4. Leave room upstream for water to pond and for sediment to settle out.
  5. Stake bags to the ground as described in the following detail. Stakes may be omitted if bags are placed on a paved surface.

Costs

- Average annual cost for installation and maintenance of DI Type 1-4 and 6 (one year useful life) is $200 per inlet.
- Temporary geotextile inserts are proprietary and cost varies by region. These inserts can often be reused and may have greater than 1 year of use if maintained and kept undamaged. Average cost per insert ranges from $50-75 plus installation, but costs can exceed $100. This cost does not include maintenance.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Silt Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes. At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height.
- Gravel Filters. If the gravel becomes clogged with sediment, it should be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Inspect and maintain temporary geotextile insert devices according to manufacturer's specifications.
- Remove storm drain inlet protection once the drainage area is stabilized.

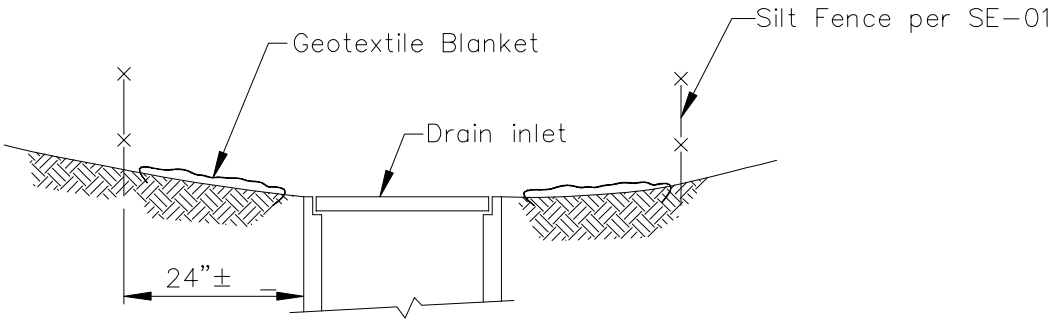
- Clean and regrade area around the inlet and clean the inside of the storm drain inlet, as it should be free of sediment and debris at the time of final inspection.

References

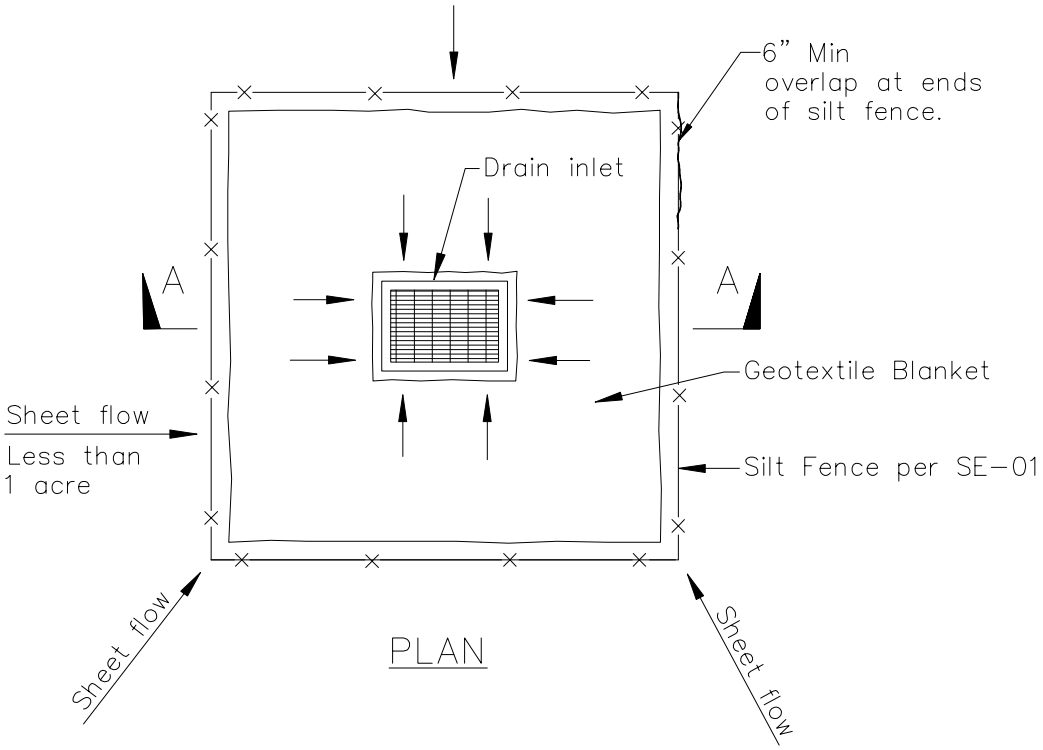
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



SECTION A–A

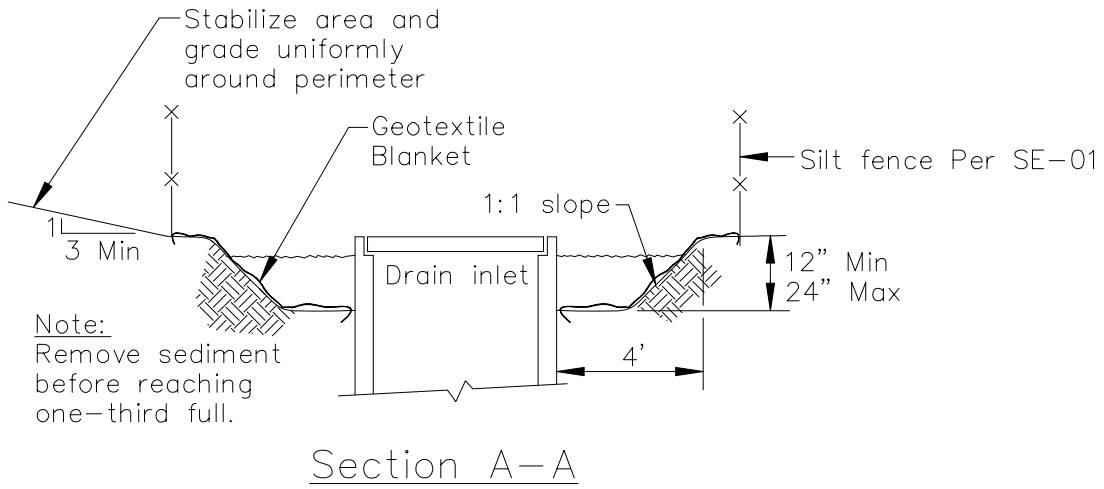


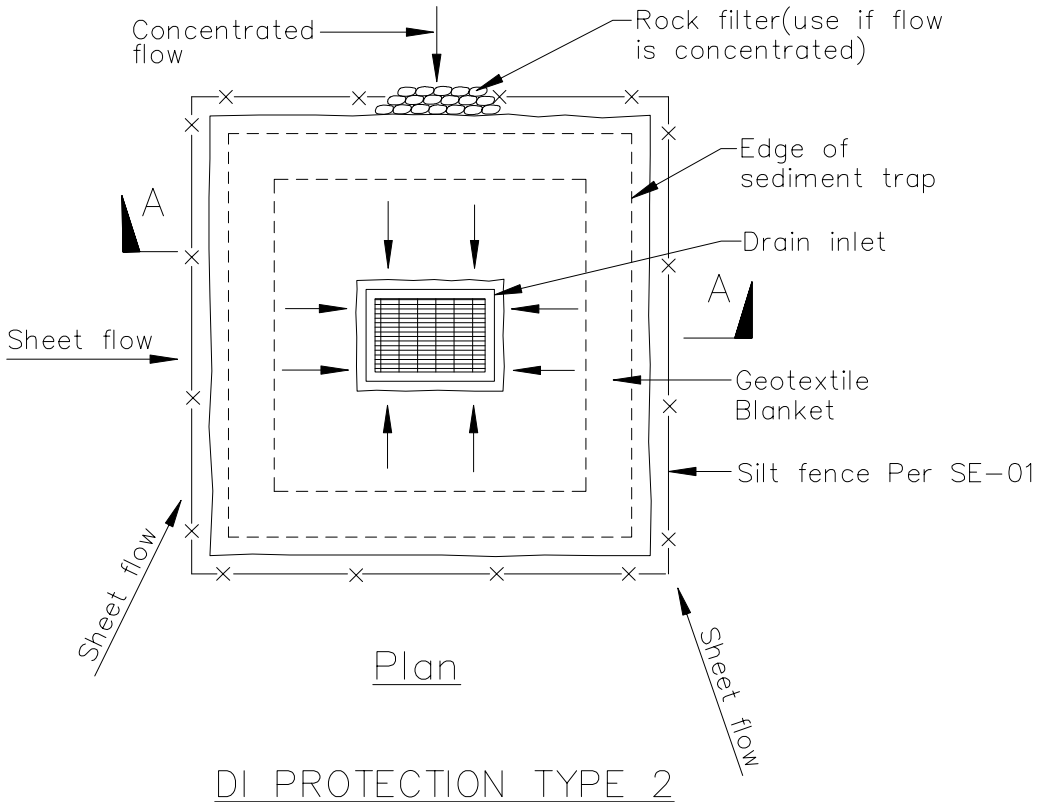
PLAN

DI PROTECTION TYPE 1
NOT TO SCALE

NOTES:

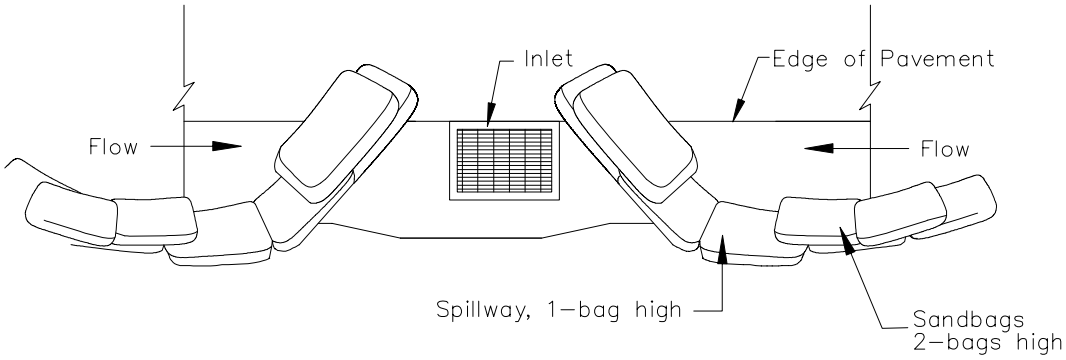
1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.



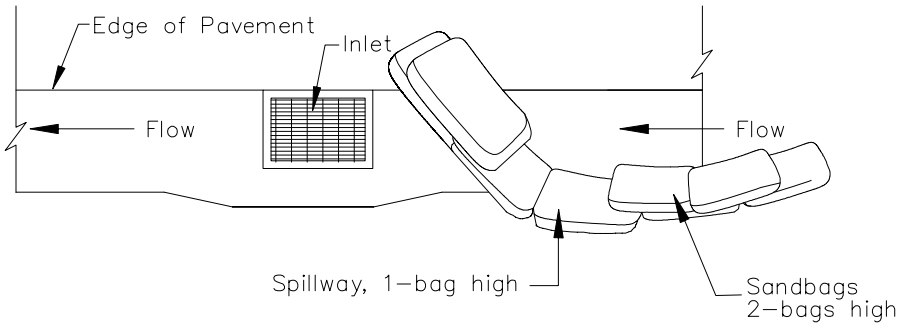


DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



TYPICAL PROTECTION FOR INLET ON SUMP

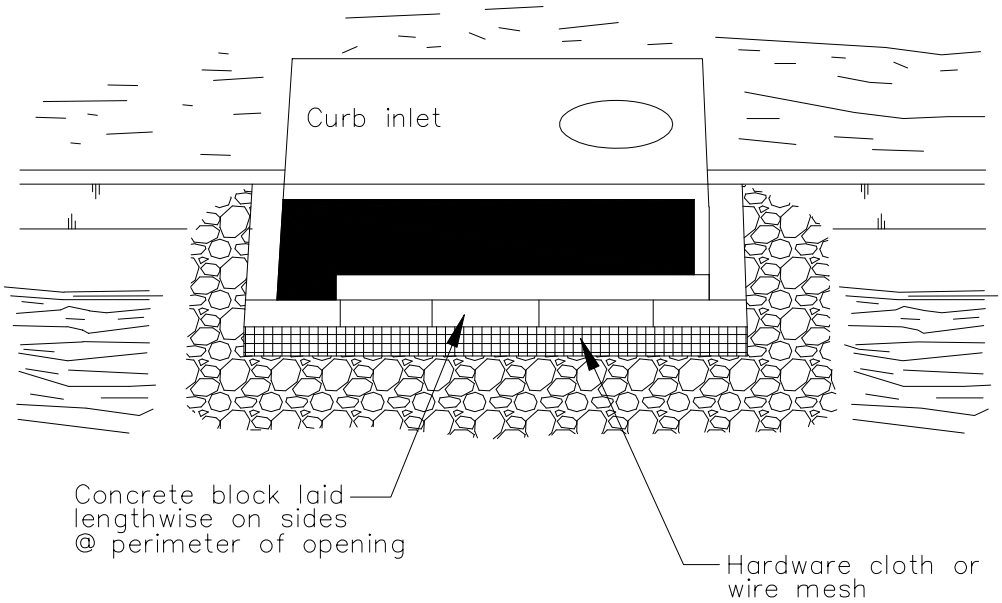


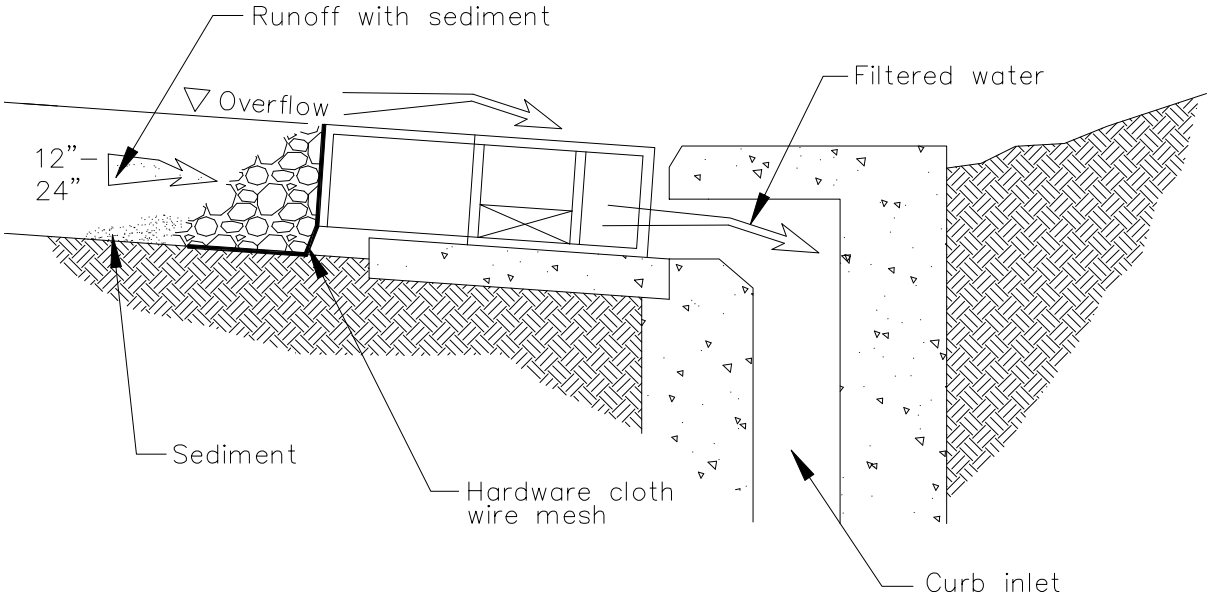
TYPICAL PROTECTION FOR INLET ON GRADE

NOTES:

1. Intended for short–term use.
2. Use to inhibit non–storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE

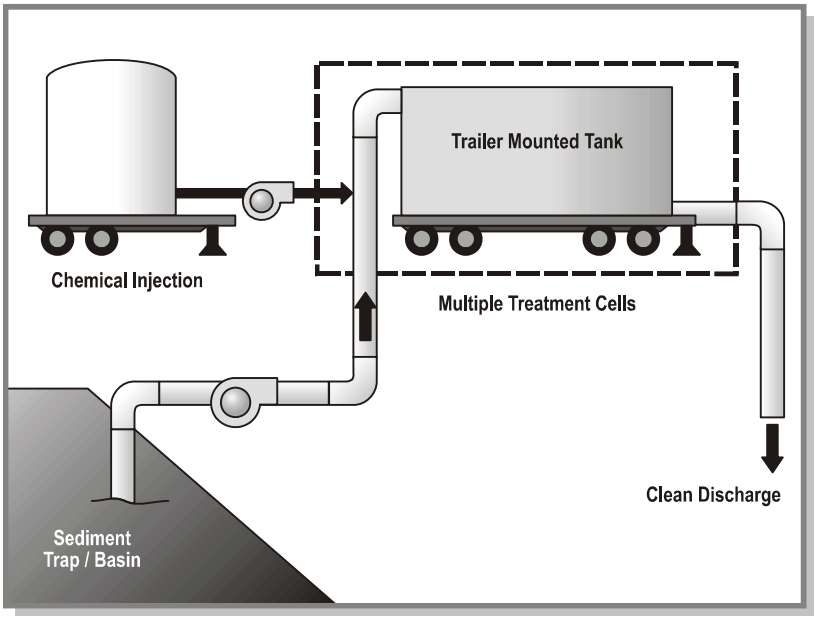




DI PROTECTION – TYPE 4

NOT TO SCALE

Active Treatment Systems SE-11



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Active Treatment Systems (ATS) reduce turbidity of construction site runoff by introducing chemicals to stormwater through direct dosing or an electrical current to enhance flocculation, coagulation, and settling of the suspended sediment. Coagulants and flocculants are used to enhance settling and removal of suspended sediments and generally include inorganic salts and polymers (USACE, 2001). The increased flocculation aids in sedimentation and ability to remove fine suspended sediments, thus reducing stormwater runoff turbidity and improving water quality.

Suitable Applications

ATS can reliably provide exceptional reductions of turbidity and associated pollutants and should be considered where turbid discharges to sediment and turbidity sensitive waters cannot be avoided using traditional BMPs. Additionally, it may be appropriate to use an ATS when site constraints inhibit the ability to construct a correctly sized sediment basin, when clay and/or highly erosive soils are present, or when the site has very steep or long slope lengths.

Limitations

Dischargers choosing to utilize chemical treatment in an ATS must follow all guidelines of the Construction General Permit Attachment F – Active Treatment System Requirements. General limitations are as follows:

- Numeric Effluent Limit (NEL) for all discharges (10 NTU daily flow-weighted average)
- Limited availability of chemical residual testing procedures that meet permit requirements for flow-through treatment
- Specific field and classroom ATS training required to operate equipment
- Batch treatment requires extensive toxicity testing of effluent
- Batch treatment requires large footprint to accommodate treatment cells
- Requires additional filtration to remove residual floc and treatment chemicals prior to discharge
- Petroleum based polymers should not be used
- Requires site-specific design and equipment
- Limited discharge rates depending on receiving water body
- Labor intensive operation and maintenance
- ATS costs are higher on a unit basis for smaller sites that would be expected to have a lower volume of treated runoff
- ATS costs are seasonably variable due to increases or decreases in rainfall volumes

Implementation

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). ATS may be used to reduce the turbidity of stormwater runoff. With an ATS, very high turbidities can be reduced to levels comparable to what is found in streams during dry weather.

Criteria for ATS Product Use

Chemically treated stormwater discharged from construction sites must be non-toxic to aquatic organisms. The following protocol should be used to evaluate chemicals proposed for stormwater treatment at construction sites. Authorization to use a chemical in the field based on this protocol does not relieve the applicant from responsibility for meeting all discharge and receiving water criteria applicable to a site.

- An ATS Plan, which includes an Operation and Maintenance component, a Monitoring, Sampling and Reporting component, a Health and Safety component, and a Spill Prevention component must be prepared and submitted to the Regional Water Quality Control Board (RWQCB).

- Treatment chemicals should be approved by EPA for potable water use or otherwise be demonstrated to be protective of human health and the environment. Chemical residual or whole effluent toxicity testing is required.

- Prior to field use of chemical treatment, jar tests are to be conducted to demonstrate that turbidity reduction necessary to meet the NELs and receiving water criteria can be achieved. Test conditions, including but not limited to raw water quality and jar test procedures, should be indicative of field conditions. Although these small-scale tests cannot be expected to reproduce performance under field conditions, they are indicative of treatment capability. A minimum of six site-specific jar tests must be conducted per chemical.

- The proposed maximum dosage should be at least a factor of five lower than the no observed effects concentration (NOEC).

- Effluent discharge from an ATS to a receiving water is conditional upon the favorable results of full-scale whole effluent bioassay/toxicity testing for batch treatment systems and upon chemical residuals testing for flow-through systems.

- Contact the RWQCB for a list of treatment chemicals that may be pre-approved for use.

Active Treatment System Design Considerations

The design and operation of an ATS should take into consideration the factors that determine optimum, cost-effective performance. While site characteristics will influence system design, it is important to recognize the following overriding considerations:

- The right chemical must be used at the right dosage. A dosage that is either too low or too high will not produce the lowest turbidity. There is an optimum dosage rate. This is a situation where the adage “adding more is always better” is not the case.

- The coagulant must be mixed rapidly into the water to insure proper dispersion.

- The mixing system for batch treatment must be sized to provide adequate mixing for the design storage volume. Lack of adequate mixing during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much mixing can rapidly destroy floc as it is formed.

- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The discharge should be directed through a filtration system such as sand, bag, or cartridge filter that would catch any unintended floc discharge.

- ATS is also regulated for pH of the discharge. A pH-adjusting chemical should be added into the treated water to control pH if the selected coagulant requires alteration of the pH of the discharge outside of the acceptable range.

Active Treatment System Design

ATS can be designed as batch treatment systems using either ponds or portable trailer-mounted tanks, or as flow-through systems using any number of proprietary designed systems.

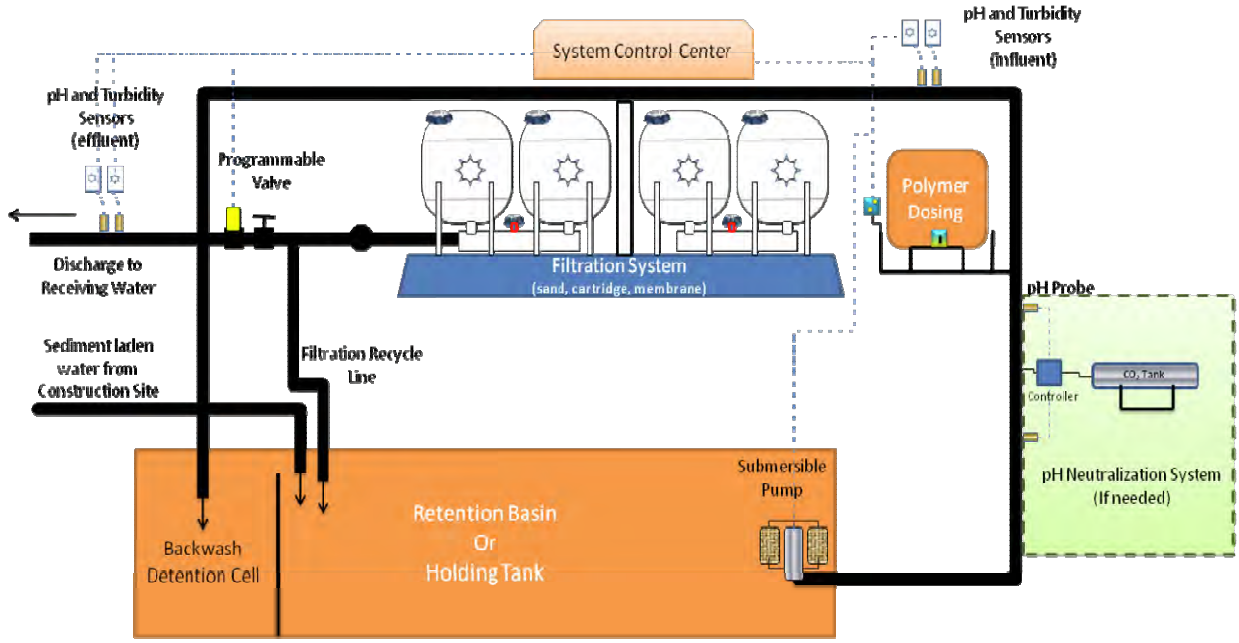


Figure has been adapted from Port of Seattle response to Washington Dept. of Ecology Action Order 2948

Batch Treatment

Batch Treatment systems consist of the stormwater collection system (either temporary diversion or the permanent site drainage system); a sediment basin, trap or holding tanks; pumps; a chemical feed system; treatment cells; and, interconnecting piping.

Batch treatment systems should use a minimum of two lined treatment cells. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be basins, traps, or tanks. Portable tanks may also be suitable for some sites.

The following equipment should be located in a secured, covered location:

- The chemical injector
- Secondary contaminant for acid, caustic, buffering compound, and treatment chemical
- Emergency shower and eyewash
- Monitoring equipment which consists of a pH meter and a turbidimeter (if not already within the instrumentation panel of the chemical injector)

Flow-through Treatment

At a minimum, a flow-through ATS system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond or holding tank, and a chemically enhanced filtration system.

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area.

The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

Stormwater is then pumped from the untreated stormwater storage pond to the chemically enhanced filtration system where polymer is added. Adjustments to pH may be necessary before chemical addition. The filtration system continually monitors the stormwater for turbidity and pH. If the discharge water is out of the acceptable turbidity or pH range, the water is recycled to the untreated stormwater pond (or holding tank) where it can be retreated. Flow through systems must ensure that:

- Cumulative flow volume shall be recorded daily. The data recording system shall have the capacity to record a minimum of seven days of continuous data.
- Instrumentation systems are interfaced with system control to provide auto shutoff or recirculation in the event that effluent measurements exceed turbidity or pH.
- Upon system upset, power failure, or other catastrophic event, the ATS will default to a recirculation mode or safe shut down.
- The instrumentation system provides a method for controlling coagulant dose, to prevent potential overdosing.

Sizing Criteria

An ATS shall be designed and approved by a Certified Professional in Erosion and Sediment Control (CPESC), a Certified Professional in Storm Water Quality (CPSWQ); a California registered civil engineer; or any other California registered engineer.

ATS must be designed to capture and treat (within 72 hours) runoff from the 10-year 24-hour storm event. The runoff volume of the watershed area to be treated from this size storm event is required to be calculated using the Rational Method with a runoff coefficient of 1.

If sediment basins are used to capture flow-through or batch treatment, see SE-2, Sediment Basin, for design criteria. Bypass should be provided around the ATS to accommodate extreme storm events. Primary settling should be encouraged in the sediment basin/storage pond. A forebay with access for maintenance may be beneficial.

The permissible discharge rate governed by potential downstream effect should be used to calculate the recommended size of the treatment cells. Local requirements related to Phase I or Phase II NPDES permit thresholds should be considered in developing maximum discharge rates the ATS Plan.

Costs

Costs for ATS may be significant due to equipment rental requirements and cost of chemicals. ATS cost is lower on a treated unit-basis for large construction sites with large volumes of runoff.

Inspection and Maintenance

ATS must be operated and maintained by individuals with experience in their use and trained in accordance with training requirements below. ATS should be monitored continuously while in

use. A designated responsible person shall be on site daily at all times during treatment operations. Daily on-site visual monitoring of the system for proper performance shall be conducted and recorded in the project data log. The name, phone number, and training documentation of the person responsible for system operation and monitoring shall be included in the project data log.

The following monitoring requirements and results should be recorded in the data log:

Operational and Compliance Monitoring

- Effluent flow rate and volume shall be continuously monitored and recorded at 15- minute or less intervals.
- Influent and effluent pH must be continuously monitored and recorded at 15-minute or less intervals.
- Influent and effluent turbidity (expressed in NTU) must be continuously monitored and recorded at 15-minute or less intervals.
- The type and amount of chemical used for pH adjustment, if any, shall be monitored and recorded.
- Dose rate of chemical used in the ATS system (expressed in mg/L) shall be monitored and reported 15-minutes after startup and every 8 hours of operation.
- Laboratory duplicates – monthly laboratory duplicates for residual coagulant analysis must be performed and records shall be maintained onsite.
- Effluent shall be monitored and recorded for residual chemical/additive levels.
- If a residual chemical/additive test does not exist and the ATS is operating in a batch treatment mode of operation refer to the toxicity monitoring requirements below.

Toxicity Monitoring

Batch Treatment

Toxicity testing for systems operated in batch treatment mode should be made in accordance with the following:

- Acute toxicity testing on effluent samples representing effluent from each batch prior to discharge shall be undertaken. All bioassays shall be sent to a laboratory certified by the Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP). The required field of testing number for Whole Effluent Toxicity (WET) testing is E113.
- Acute toxicity tests shall be conducted with the following species and protocols. The methods to be used in the acute toxicity testing shall be those outlined for a 96-hour acute test in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012" for Fathead minnow, *Pimephales promelas*. Rainbow trout, *Oncorhynchus mykiss,* may be used as a substitute for fathead minnow.

All toxicity tests shall meet quality assurance criteria and test acceptability criteria in the most recent versions of the EPA test method for WET testing.

Flow-through Treatment

Toxicity testing for systems operated in flow-through treatment mode should be made in accordance with the following:

- A residual chemical test method shall be used that has a method detection limit (MDL) of 10% or less than the maximum allowable threshold concentration (MATC) for the specific coagulant in use and for the most sensitive species of the chemical used. The MATC is equal to the geometric mean of the No Observed Effect Concentration (NOEC) and Lowest Observed Effect Concentration (LOEC) Acute and Chronic toxicity results for most sensitive species determined for the specific coagulant.
- The residual chemical test method shall produce a result within one hour of sampling.
- A California State certified laboratory shall validate the selected residual chemical test. Specifically the lab will review the test protocol, test parameters, and the detection limit of the coagulant. The discharger shall electronically submit this documentation as part of the ATS Plan.

Numeric Effluent Limit (NEL) Compliance:

All chemically treated stormwater must be sampled and tested for compliance with pH and turbidity limits. These limits have been established by the Construction General Permit. Sampling and testing for other pollutants may also be necessary at some sites. Turbidity limits have been set as 10 NTU as a daily flow-weighted average or 20 NTU from a single sample. pH must be within the range of 6.0 to 9.0 standard units. It is often possible to discharge treated stormwater that has a lower turbidity than the receiving water and that matches the pH.

Treated stormwater samples and measurements should be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water should not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training:

Operators shall have training specific to using an ATS and liquid coagulants for stormwater discharges in California. The training shall be in the form of a formal class with a certificate and requirements for testing and certificate renewal. Training shall include a minimum of eight hours classroom and 32 hours field training.

Standard BMPs:

Erosion and sediment control BMPs should be implemented throughout the site to prevent erosion and discharge of sediment to the ATS. Some types of chemical coagulation and flocculation are only achievable in water below a certain turbidity; therefore minimizing the amount of sediment reaching the system will increase the likelihood of meeting effluent limits and will potentially lower costs of chemical dosing.

Sediment Removal and Disposal

- Sediment shall be removed from the storage or treatment cells as necessary to ensure that the cells maintain their required water storage (i.e., volume) capability.
- Handling and disposal of all solids generated during ATS operations shall be done in accordance with all local, state, and federal laws and regulations.
- If sediment is determined to be non-toxic, it may be incorporated into the site away from drainages.

References

Engineering and Design – Precipitation/Coagulation/Flocculation. United States Army Corps of Engineers, EM 1110-1-4012, 2001.

Evaluation of Active Treatment Systems (ATS) for Construction Site Runoff. California Building and Industry Association (prepared by Geosyntec Consultants), 2008.

Stormwater Management Manual for Western Washington, Volume II – Construction Stormwater Pollution Prevention, Washington State Department of Ecology, August 2001.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Temporary Silt Dike SE-12

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

Temporary silt dikes are pre-manufactured devices that are typically specified and installed for semi-permanent drainage and sediment control on the perimeter of disturbed sites or stockpiles and as check dams within channels.

Suitable Applications

Temporary silt dikes are generally used in areas as a substitute for fiber rolls and silt fences to slow down runoff water, divert drainage or contain fines and sediment. A temporary silt dike typically consists of a triangular foam or recycled rubber core covered in geotextile fabric. Temporary silt dikes are a linear control and have a variety of profiles (triangular, round, and square). Temporary silt dikes may be suitable for:

- On paved surfaces for perimeter protection.
- As check structures in channels.
- Along the perimeter of disturbed sites in lieu of silt fence.
- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles or material/equipment storage areas.
- At the interface between graveled driveways and pavement.
- Along the toe of exposed and erodible slopes.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Limitations

- Temporary silt dikes require additional measures to adhere to asphalt in cold and windy climates, as glue may not adhere adequately to the pavement.
- Temporary silt dikes may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the barrier, possibly causing flooding or bypass if sufficient space does not exist to accommodate ponding.
- Temporary silt dikes may require frequent maintenance especially when used near vehicle traffic or to detain concentrated flows (e.g. check dams or inlet protection).
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

When appropriately placed, temporary silt dikes intercept and slow sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The core is porous, which allows the ponded runoff to flow slowly through the silt dike, releasing the runoff as sheet flows. Generally, temporary silt dikes should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control or as a non-stormwater perimeter control.

Design and Layout

- Temporary silt dikes used on soil should be attached to the ground per manufacturer specifications.
- Temporary silt dikes used on asphalt or concrete may be attached using a variety of methods, including nailing the dikes to the pavement, or using a high strength adhesive.
- Follow manufacturer specifications when installing temporary silt dikes.
- Allow sufficient space up slope from the silt dikes to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, temporary silt dike should be set back three feet from the slope toe to facilitate cleaning. Where site conditions do not allow set back, the silt dike may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Butt ends of temporary silt dike tightly. Overlaps should be sealed in accordance with the manufacturer's detail.

Materials

- Several manufactured products are available.

Costs

- Silt dike averages $35-45 per 7 ft. section.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Temporary silt dike exposed to sunlight will need to be replaced more frequently due to photo-degradation.
- Reshape or replace sections of damaged temporary silt dike as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove temporary silt dikes when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of properly.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Compost Socks and Berms SE-13

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☒
Bacteria	☒
Oil and Grease	☒
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

Compost socks and berms act as three-dimensional biodegradable filtering structures to intercept runoff where sheet flow occurs and are generally placed at the site perimeter or at intervals on sloped areas. Compost socks are generally a mesh sock containing compost and a compost berm is a dike of compost, trapezoidal in cross section. When employed to intercept sheet flow, both BMPs are placed perpendicular to the flow of runoff, allowing filtered runoff to pass through the compost and retaining sediment (and potentially other pollutants). A compost sock can be assembled on site by filling a mesh sock (e.g. with a pneumatic blower). The compost berm should be constructed using a backhoe or equivalent and/or a pneumatic delivery (blower) system and should be properly compacted. Compost socks and berms act as filters, reduce runoff velocities, and in some cases, aid in establishing vegetation.

Compost is organic, biodegradable, and renewable. Compost provides soil structure that allows water to infiltrate the compost medium which helps prevent rill erosion and the retained moisture promotes seed germination and vegetation growth, in addition to providing organic matter and nutrients important for fostering vegetation. Compost improves soil quality and productivity, as well as erosion and sediment control. The compost of the compost sock or berm can be selected that targets site specific objectives in capturing sediment and other pollutants, supporting vegetation, or additional erosion control.

Compost is typically derived from combinations of feedstocks, biosolids, leaf and yard trimmings, manure, wood, or mixed solid waste. Many types of compost are products of municipal recycle or "Greenwaste" programs. Compost is organic and biodegradable and can be left onsite. There are many types of compost with a variety of properties with specific functions, and accordingly compost selection is an important design consideration in the application of this type of erosion and sediment control.

Suitable Applications

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow (compost berms should only be used at the top of slopes or on slopes 4:1 (H:V) or flatter, all other slope applications should use compost socks)
- Along the perimeter of a project
- As check dams in unlined ditches (compost socks only)
- Down-slope of exposed soil areas
- At operational storm drains as a form of inlet protection (compost socks only)
- Around temporary stockpiles

Compost socks and berms do not require special trenching or BMP removal compared to other sediment control methods (e.g. silt fence or fiber rolls). Compost socks and berms can remain in place after earth disturbing activities are completed or the compost components can be spread over the site providing nutrients for plant growth and augmenting soil structure. BMPs that remain in place are particularly advantageous below embankments, especially adjacent streams, by limiting re-entry and the disturbance to sensitive areas.

Compost can be pre-seeded prior to application (recommended by the EPA for construction site stormwater runoff control and required for compost socks) or seeded after installation (for compost berms only). The compost medium can also remove pollutants in stormwater including heavy metals; oil and grease; and hydrocarbons.

Limitations

- Compost can potentially leach nutrients (dissolved phosphorus and nitrogen) into runoff and potentially impact water quality. Compost should not be used directly upstream from nutrient impaired waterbodies (Adams et. al, 2008).
- Compost may also contain other undesirable constituents that are detrimental to water quality. Compost should be obtained from a supplier certified by the California Integrated Waste Management Board or compost should otherwise meet the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7. Carefully consider the qualifications and experience of any compost producer/supplier.
- Application by hand is more time intensive and potentially costly. Using a pneumatic blower truck is the recommended cost effective method of assembly.
- Compost socks and berms should not be employed at the base of slopes greater than 2:1 (H:V). They can be employed with other erosion control methods for steeper slopes.

- Difficult to move once saturated.
- Compost berms should not be applied in areas of concentrated flows.
- Compost socks and berms are easy to fix; however, they are susceptible to damage by frequent traffic. Compost socks can be used around heavy machinery, but regular disturbance decreases sock performance.

Implementation

Compost Materials

- California Compost Regulations (Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7, Section 17868.3) define and require a quality of compost for application. Compost should comply with all physical and chemical requirements. Specific requirements are provided in Table 1, taken from Caltrans Standard Special Provision 10-1 (SSP 10-1), Erosion Control (Compost Blanket).
- The compost producer should be fully permitted as specified under the California Integrated Waste Management Board, Local Enforcement Agencies and any other State and Local Agencies that regulate Solid Waste Facilities. If exempt from State permitting requirements, the composting facility should certify that it follows guidelines and procedures for production of compost meeting the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7.
- The compost producer should be a participant in United States Composting Council's Seal of Testing Assurance program.
- Compost medium parameter specifications for compost socks and berms have been developed to assist in compost selection, such as those provided by the American Association of State Highway Transportation Officials (AASHTO).
- Particle size is important parameter for selecting compost. Well consolidated coarser grades of compost (e.g. small and large pieces) perform better for filtration objectives, while finer grades better support vegetation. Particle size of the compost should be selected based on site conditions, such as expected precipitation, and filtration goals and / or long term plant nutrients.
- Compost moisture should be considered for composition quality and application purposes. A range of 30-50% is typical. Compost that is too dry is hard to apply and compost that is too wet is more difficult (and more expensive) to transport. For arid or semi-arid areas, or for application during the dry season, use compost with greater moisture content than areas with wetter climates. For wetter or more humid climates or for application during the wet season, drier composts can be used as the compost will absorb moisture from the ambient air.
- If vegetation establishment is a desired function of the compost, a compost sample should be inspected by a qualified individual. Vegetation has different nutrient and moisture needs.
- Organic content of the compost is also important and should range from 30 to 65% depending on site conditions.

- Compost should not be derived from mixed municipal solid waste and should be reasonably free of visible contaminates.
- Compost should not contain paint, petroleum products, pesticides or any other chemical residues harmful to animal life or plant growth. Metal concentrations in compost should not exceed the maximum metal concentrations listed under Title 14, California Code of Regulations, Division 7, Chapter 3.1, Section 17868.2.
- Compost should not possess objectionable odors.
- Compost should be weed free.

Table 1. Physical/Chemical Requirements of Compost
Reference - Caltrans SSP-10 Erosion Control Blanket (Compost)

Property	Test Method	Requirement
pH	*TMECC 04.11-A Elastometric pH 1:5 Slurry Method pH Units	6.0–8.0
Soluble Salts	TMECC 04.10-A Electrical Conductivity 1:5 Slurry Method dS/m (mmhos/cm)	0-10.0
Moisture Content	TMECC 03.09-A Total Solids & Moisture at 70+/- 5 deg C % Wet Weight Basis	30-60
Organic Matter Content	TMECC 05.07-A Loss-On-Ignition Organic Matter Method (LOI) % Dry Weight Basis	30–65
Maturity	TMECC 05.05-A Germination and Vigor Seed Emergence Seedling Vigor % Relative to Positive Control	80 or Above 80 or Above
Stability	TMECC 05.08-B Carbon Dioxide Evolution Rate mg CO_2-C/g OM per day	8 or below
Particle Size	TMECC 02.02-B Sample Sieving for Aggregate Size Classification % Dry Weight Basis	100% Passing, 3 inch 90-100% Passing, 1 inch 65-100% Passing, 3/4 inch 0 - 75% Passing, 1/4 inch Maximum length 6 inches
Pathogen	TMECC 07.01-B Fecal Coliform Bacteria < 1000 MPN/gram dry wt.	Pass
Pathogen	TMECC 07.01-B Salmonella < 3 MPN/4 grams dry wt.	Pass
Physical Contaminants	TMECC 02.02-C Man Made Inert Removal and Classification: Plastic, Glass and Metal % > 4mm fraction	Combined Total: < 1.0
Physical Contaminants	TMECC 02.02-C Man Made Inert Removal and Classification: Sharps (Sewing needles, straight pins and hypodermic needles) % > 4mm fraction	None Detected

*TMECC refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).

Installation

- Prior to application, prepare locations for socks and berms by removing brush and thick vegetation. The compost of the sock and/or berm should be allowed to come in full contact with the ground surface.

- Select method to apply the compost sock or berm. A pneumatic blower is most cost effective and most adaptive in applying compost to steep, rough terrain, and hard to reach locations.

- The compost of the berm should be distributed evenly to the surface, compacted, and shaped trapezoidal in cross section. Berm design is generally consists of a base two times the height. AASHTO specification MP 9-03 provides compost berm dimensions based on anticipated site precipitation (AASHTO, 2003 and USEPA, 2009). State agencies, such as Oregon

Department of Environmental Quality (ODEQ) have developed berm dimension based on slope steepness and length (ODEQ, 2004).

- Compost socks can be assembled on site by filling mesh socks with the selected compost. Mesh socks can be tied at one end, filled, and then tied at the other end. The ends of socks can be interlocked until the desired length is achieved. The sock diameter is a function of slope steepness and length. Again, ASSHTO provides specifications for various parameters. Compost socks range from 8" to 18", but are typically 12" to 18" in diameter.

- Compost socks are typically placed in contours perpendicular to sheet flow. They can also be placed in V formation on a slope. Compost socks need to be anchored, typically stakes, through the center of the sock. To prevent water flowing around them, the ends of compost socks should be placed upslope.

- Locate compost socks and berms on level contours spaced as follows:

  - Slope inclination of 4:1 (H:V) or flatter: Socks and/or berms should be placed at a maximum interval of 20 ft.

  - Slope inclination between 4:1 and 2:1 (H:V): Socks should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).

  - Slope inclination 2:1 (H:V) or greater: Socks should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).

- Place perimeter socks and berms using a j-hook installation. Use of vegetation will also provide additional anchoring.

- Compost socks and berms can be placed around the perimeter of an affected area, like a silt fence, if the area is flat or on a contour. Do not place these socks and berms where ponded water could become an issue.

- If used at the toe of slopes, the compost sock or berm should at a minimum of 5 to 10 feet away.

- Use additional anchoring and erosion control BMPS in conjunction of the compost socks and berms as needed.

- Consider using compost berms or socks as necessary at the top and/or bottom of the slope for additional erosion control performance.

- Compost socks and berms can also be effective over rocky and frozen ground if installed properly.

- It is recommended that the drainage areas of these compost BMPs do not exceed 0.25 acre per 100 feet placement interval and runoff does not exceed 1 cubic foot per second.

Costs

Recently obtained vendor costs indicated $3.50 per linear foot for compost berm application and $2.00 per linear foot for 8" socks and $2.50 per linear foot for 12"socks. Costs do not include final compost sock or berm functions at the end of construction activities, including spreading or removal, if required. ODEQ estimates that compost berms cost 30 percent less than silt fences to install.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Once damage is identified, mend or reapply the sock or berm as needed. Washed out areas should be replaced. If the sock or berm height is breached during a storm, an additional sock can be stacked to increase the sock height and similarly the berm dimensions can be increased, as applicable. An additional sock or berm may be installed upslope, as needed. It may be necessary to apply an additional type of stormwater BMP, such as a compost blanket.

- Sediment contained by the sock or berm should be removed prior reaching 1/3 of the exposed height of the BMP. The sediment can be stabilized with the compost sock or berm with vegetation at the end of construction activities.

- Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.

- Limit traffic to minimize damage to BMPs or impede vegetation establishment.

References

An analysis of Composting as an Environmental Remediation Technology, U.S. Environmental Protection Agency (USEPA), Solid Waste and Emergency Response (5305W), EPA530-R-8-008, 1998.

Characteristics of Compost: Moisture Holding and Water Quality Improvement, Center for Research in Water Resources, Kirchoff, C., Malina, J., and Barrett, M., 2003.

Compost Utilization for Erosion Control, The University of Georgia College of Agricultural and Environmental Sciences, pubs.caes.uga.edu/caespubs/pubcd/B1200.htm, Faucette, B. and Risse, M., 2001.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Standard Special Provision 10-1, Erosion Control (Compost Blanket), State of California Department of Transportation (Caltrans). 2007 Update.

Evaluation of Environmental Benefits and Impacts of Compost and Industry Standard Erosion and Sediment Controls Measures Used in Construction Activities, Dissertation, Institute of Ecology, University of Georgia, Faucette, B., 2004.

National Pollutant Discharge Elimination System (NPDES), Compost Blankets, U.S. Environmental Protection Agency (USEPA). http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=118, 2009.

Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Designation MP-9, Compost for Erosion/Sediment Control (Filter Berms), Provisional, American Association of State Highway Transportation Officials (AASHTO), 2003.

Stormwater Best Management Practices (BMPs) Field Trials of Erosion Control Compost in Reclamation of Rock Quarry Operations, Nonpoint Source Protection Program CWA §319(h), Texas Commission on Environmental Quality, Adams, T., McFarland, A., Hauck, L., Barrett, M., and Eck, B., 2008.

Biofilter Bags SE-14

Categories

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-4 Check Dams

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-10 Storm Drain Inlet Protection

Description and Purpose

Biofilter bags, or bio-bags, are a multi-purpose sediment control BMP consisting of a plastic mesh bag filled with 100% recycled wood product waste. Biofilter bags come in a variety of sizes (30" X 18" and 30" X 9" being common) and generally have between 1-2 cubic yards of recycled wood waste (or wood chips). Biofilter bags work by detaining flow and allowing a slow rate of discharge through the wood media. This action removes suspended sediment through gravity settling of the detained water and filtration within the bag.

Suitable Applications

Biofilter bags are a short-term BMP that can be rapidly deployed, maintained, and replaced. Biofilter bags can be an effective short-term solution to place in developed rills to prevent further erosion until permanent measures can be established. Suitable short-term applications include:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - Below other small cleared areas
  - Along the perimeter of a site (with low-expected flow)
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas

- Along streams and channels

- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
  - At the top of slopes to divert runoff away from disturbed slopes
  - As check dams across mildly sloped construction roads
- Inlet Protection (See SE-10)
- Supplement to silt fences or other sediment control devices

Limitations

- Short life-span (2-3 months); regular maintenance and replacement required to ensure effectiveness. Bags will rapidly fill with sediment and reduce permeability.
- Easily damaged by construction vehicles.
- If not properly staked, will fail on slope applications.
- If improperly installed can allow undercutting or side-cutting flow.
- Not effective where water velocities or volumes are high.
- Potentially buoyant and easily displaced if not properly installed.

Implementation

General

Biofilter bags are a relatively low cost temporary BMP that are easily deployed and have a simple installation that can be performed by hand. Without proper installation, however, biofilter bags can fail due to their light weight, potential displacement, and multiple joint locations. One of the benefits of utilizing biofilter bags is that the media (wood-product) can be recycled or used onsite when no longer needed (where acceptable).

Design and Layout – Linear control

- Locate biofilter bags on level contours.
  - Slopes between 20:1 and 4:1 (H:V): Biofilter bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slopes between 4:1 and 2:1 (H:V): Biofilter bags should be placed at a maximum interval of 15 ft, with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Biofilter bags should be placed at a maximum interval of 10 ft., with the first row placed the slope toe.

- Turn the ends of the biofilter bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the biofilter bag berm to allow ponding, and to provide room for sediment storage.
- Stake biofilter bags into a 1 to 2 in. deep trench with a width equal to the bag.
  - Drive one stake at each end of the bag.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- Biofilter bags should be overlapped (6 in.), not abutted.

Costs

Pre-filled biofilter bags cost approximately $2.50-$3.50 per bag, dependent upon size.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Biofilter bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.
- Reshape or replace biofilter bags as needed.
- Repair washouts or other damage as needed.
- Sediment that is retained by the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove biofilter bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Biofilter media may be used on-site, if allowed.

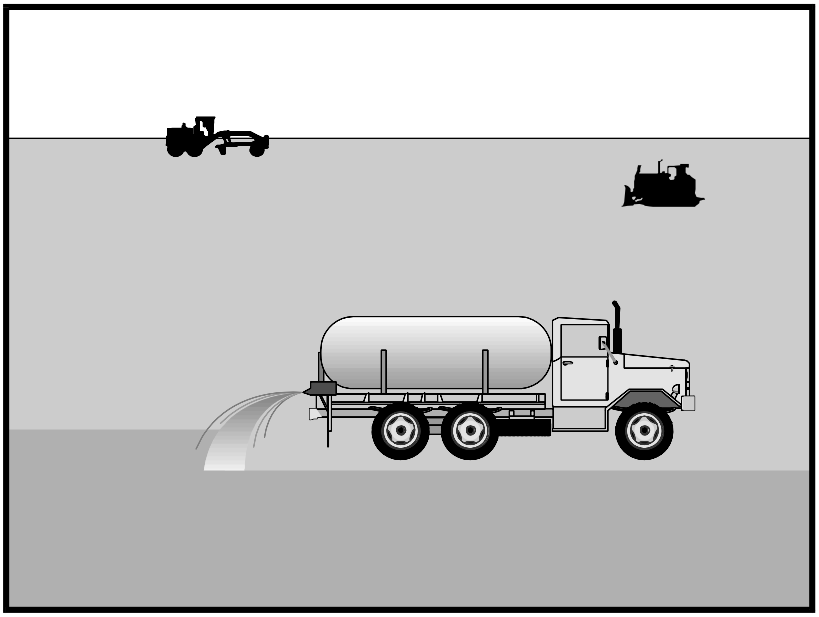
References

Catalog of Stormwater Best Management Practices for Idaho Cities and Counties. Volume 2, Section 7, BMP 34 – Biofilter Bags, Idaho Department of Environmental Quality, 2005.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Wind Erosion Control WE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-5 Soil Binders

Description and Purpose

Wind erosion or dust control consists of applying water or other chemical dust suppressants as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

California's Mediterranean climate, with a short "wet" season and a typically long, hot "dry" season, allows the soils to thoroughly dry out. During the dry season, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment. Site conditions and climate can make dust control more of an erosion problem than water based erosion. Additionally, many local agencies, including Air Quality Management Districts, require dust control and/or dust control permits in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. Wind erosion control is required to be implemented at all construction sites greater than 1 acre by the General Permit.

Suitable Applications

Most BMPs that provide protection against water-based erosion will also protect against wind-based erosion and dust control requirements required by other agencies will generally meet wind erosion control requirements for water quality protection. Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period (generally less than a few hours) and should be applied daily (or more often) to be effective.
- Over watering may cause erosion and track-out.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Chemical dust suppression agents may have potential environmental impacts. Selected chemical dust control agents should be environmentally benign.
- Effectiveness of controls depends on soil, temperature, humidity, wind velocity and traffic.
- Chemical dust suppression agents should not be used within 100 feet of wetlands or water bodies.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.
- If the soil surface has minimal natural moisture, the affected area may need to be pre-wetted so that chemical dust control agents can uniformly penetrate the soil surface.

Implementation

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table presents dust control practices that can be applied to varying site conditions that could potentially cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph or less, and controlling the number and activity of vehicles on a site at any given time.

Chemical dust suppressants include: mulch and fiber based dust palliatives (e.g. paper mulch with gypsum binder), salts and brines (e.g. calcium chloride, magnesium chloride), non-petroleum based organics (e.g. vegetable oil, lignosulfonate), petroleum based organics (e.g. asphalt emulsion, dust oils, petroleum resins), synthetic polymers (e.g. polyvinyl acetate, vinyls, acrylic), clay additives (e.g. bentonite, montimorillonite) and electrochemical products (e.g. enzymes, ionic products).

Site Condition	Dust Control Practices							
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Temporary Gravel Construction Entrances/Equipment Wash Down	Synthetic Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X			X
Disturbed Areas Subject to Traffic			X	X	X	X		X
Material Stockpiles		X	X	X			X	X
Demolition			X			X	X	
Clearing/ Excavation			X	X				X
Truck Traffic on Unpaved Roads			X	X	X	X	X	
Tracking					X	X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (see EC-1, Scheduling).
- Quickly treat exposed soils using water, mulching, chemical dust suppressants, or stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Restrict construction traffic to stabilized roadways within the project site, as practicable.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality

Control Board (RWQCB) requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and wheel wash areas.
- Stabilize inactive areas of construction sites using temporary vegetation or chemical stabilization methods.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater and should meet all applicable regulatory requirements.

Costs

Installation costs for water and chemical dust suppression vary based on the method used and the length of effectiveness. Annual costs may be high since some of these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check areas protected to ensure coverage.
- Most water-based dust control measures require frequent application, often daily or even multiple times per day. Obtain vendor or independent information on longevity of chemical dust suppressants.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

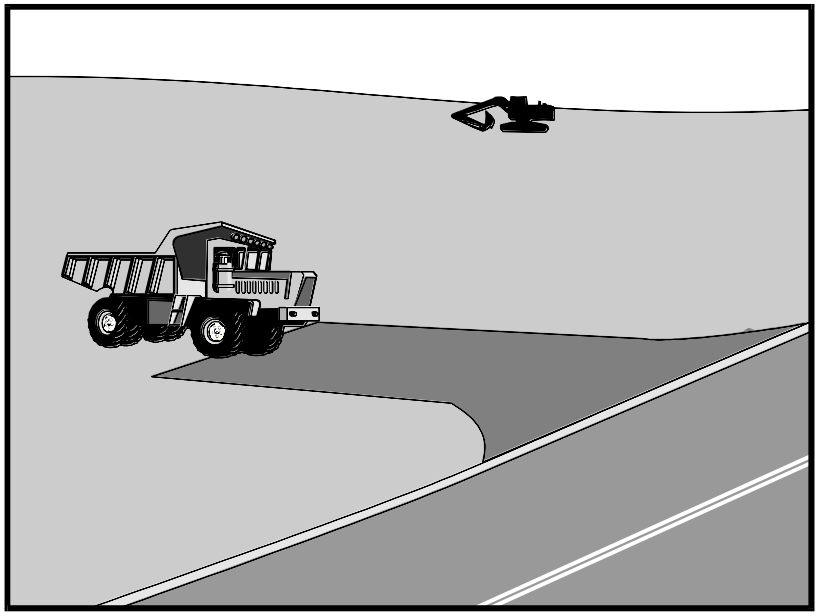
California Air Pollution Control Laws, California Air Resources Board, updated annually.

Construction Manual, Chapter 4, Section 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative", California Department of Transportation (Caltrans), July 2001.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stabilized Construction Entrance/Exit TC-1



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft or maximum site will allow, and 10 ft minimum width or to accommodate traffic.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.

- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

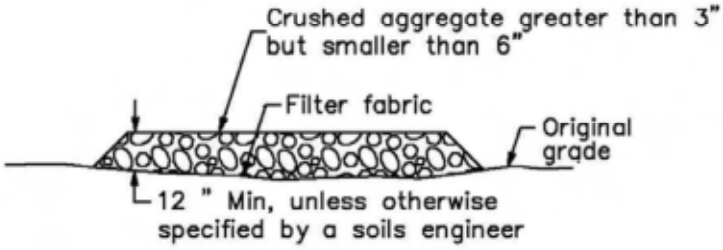
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

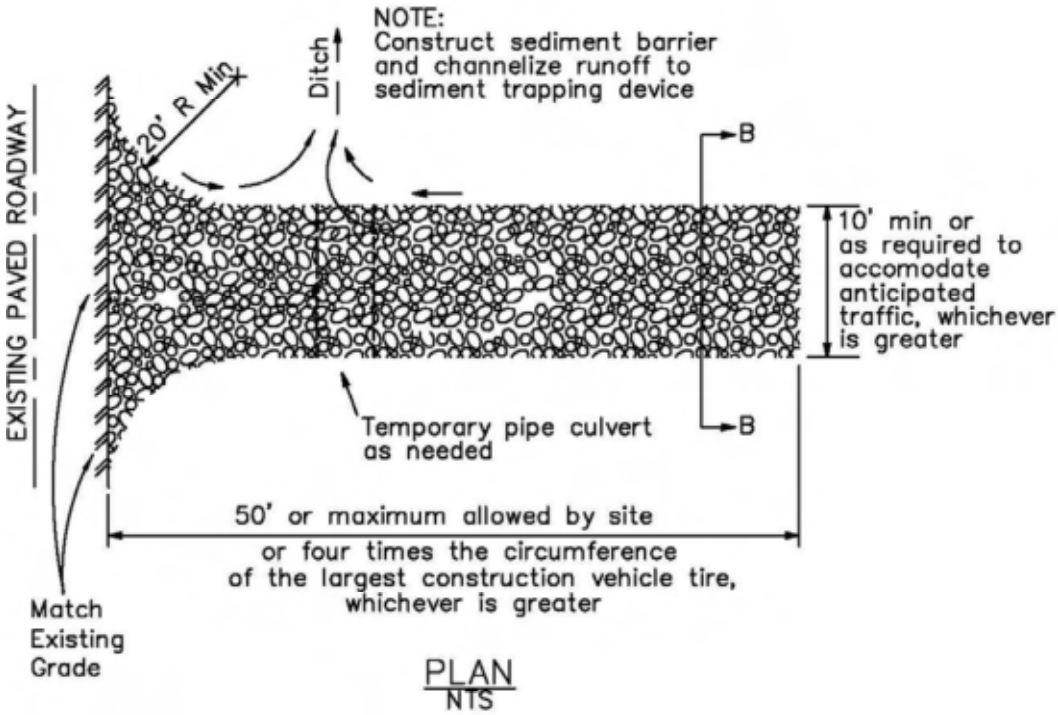
Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Stabilized Construction Entrance/Exit TC-1

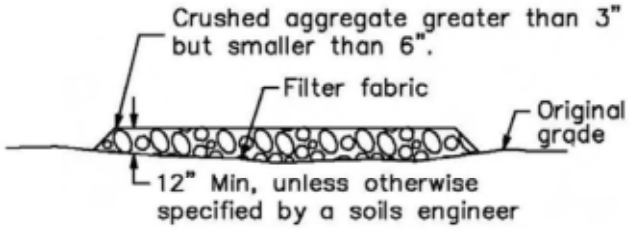


SECTION B–B
NTS

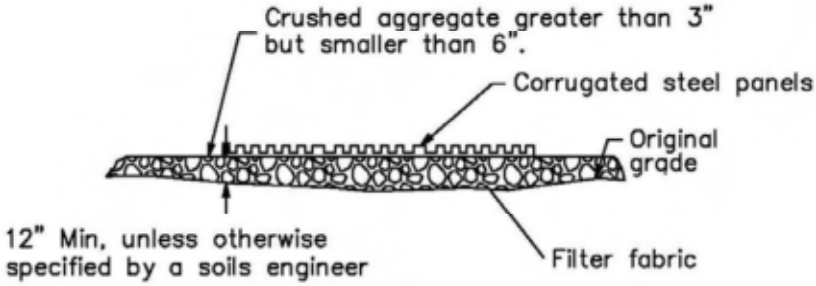


PLAN
NTS

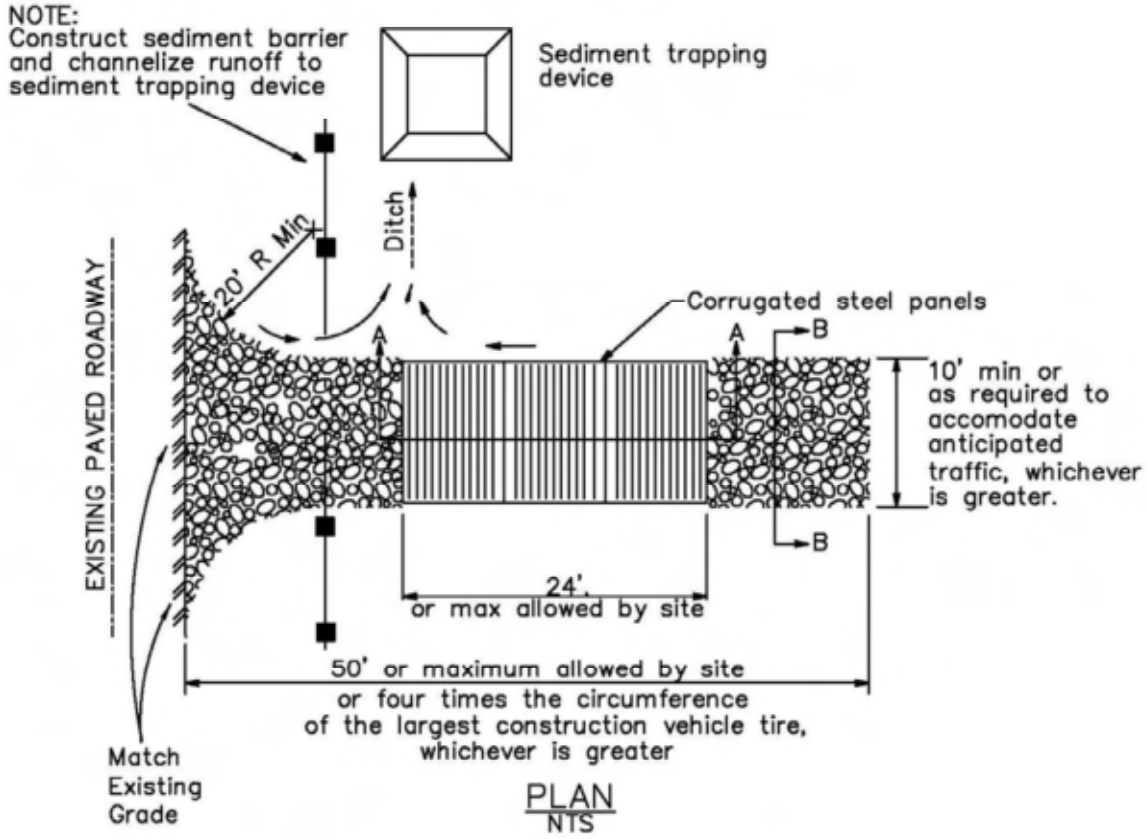
Stabilized Construction Entrance/Exit TC-1



SECTION B–B
NTS

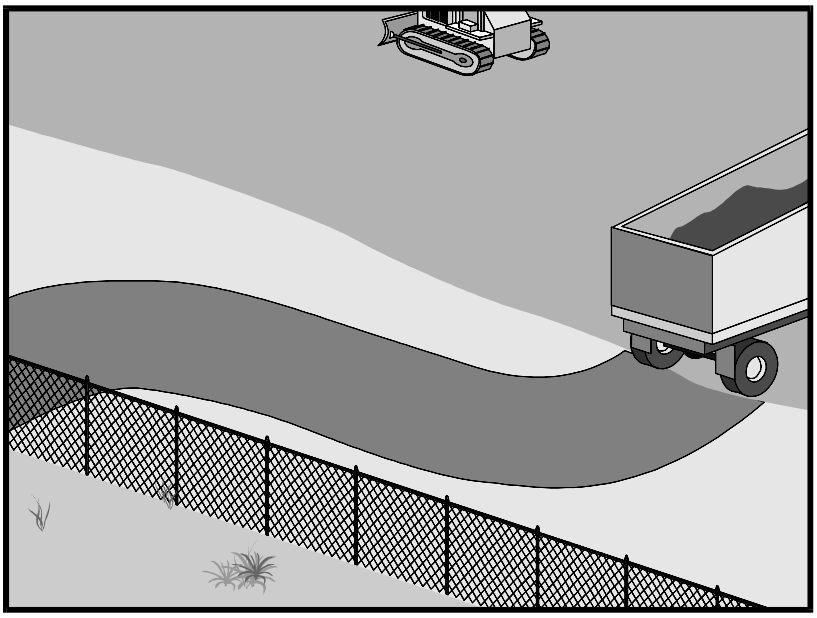


SECTION A–A
NOT TO SCALE



PLAN
NTS

Stabilized Construction Roadway TC-2



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.

- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.
- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

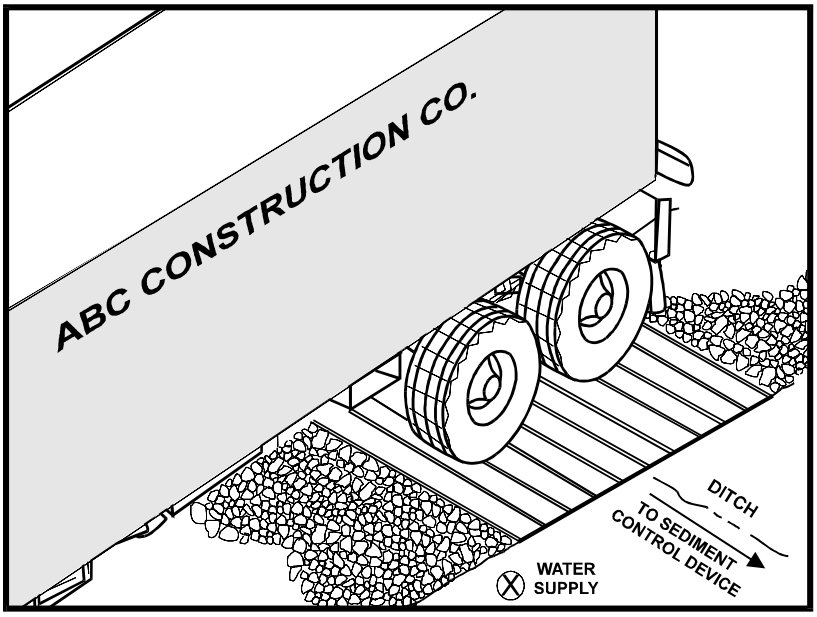
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Entrance/Outlet Tire Wash TC-3



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TC-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement SC-7, Street Sweeping and Vacuuming, as needed.

Costs

Costs are low for installation of wash rack.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

References

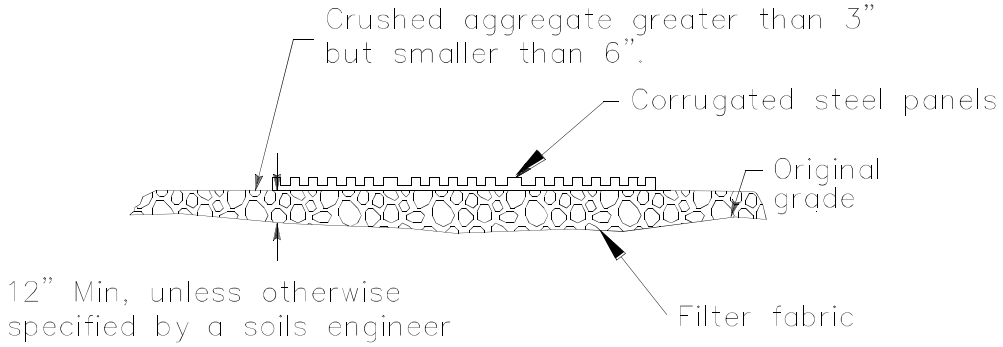
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

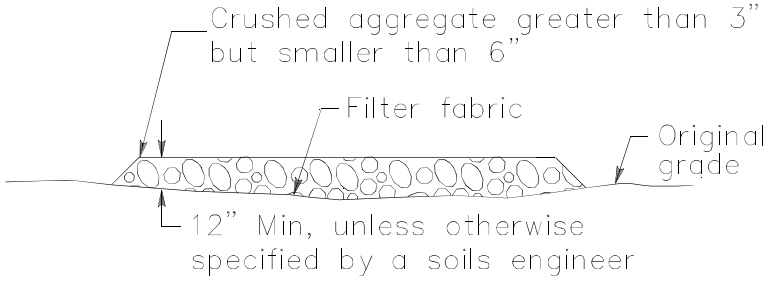
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

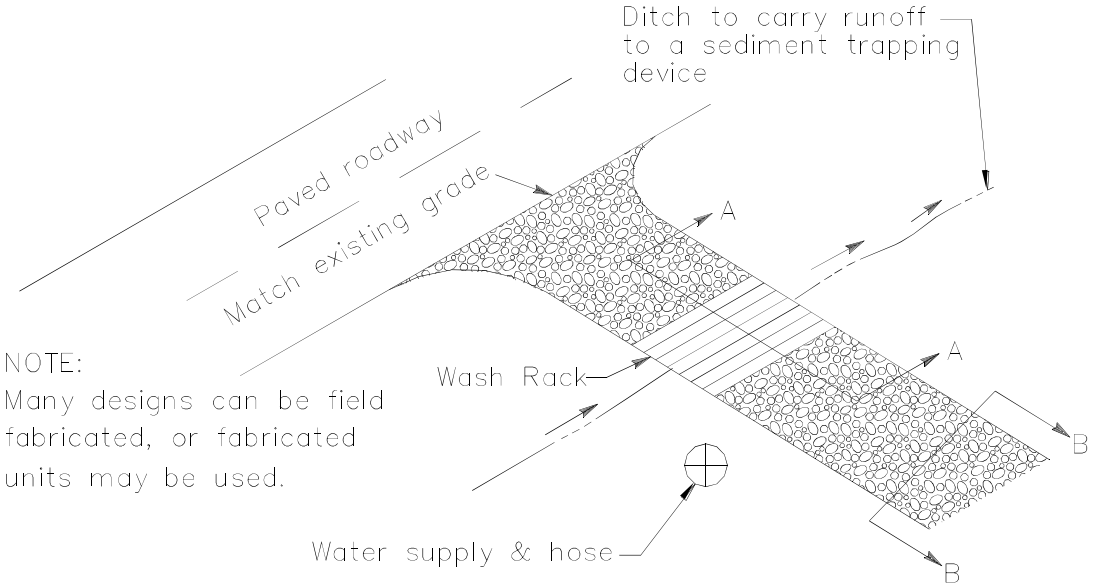
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



SECTION A–A
NOT TO SCALE



SECTION B–B
NTS



TYPICAL TIRE WASH
NOT TO SCALE

Section 4
Non-Stormwater Management and Material Management BMPs

4.1 Non-Stormwater Management BMPs

The discharge of materials other than stormwater and authorized non-stormwater discharges is prohibited by NPDES regulations as well as other local codes and ordinances. It is recognized that certain authorized non-stormwater discharges may be necessary for the completion of construction projects. Such discharges include but are not limited to irrigation of vegetative erosion control measures, and pipe flushing and testing.

Non-stormwater management BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source or eliminating off-site discharge. These practices involve day-to-day operations of the construction site and are usually under the control of the contractor. These BMPs are also referred to as "good housekeeping practices" which involve keeping a clean, orderly construction site.

Non-stormwater management BMPs also include procedures and practices designed to minimize or eliminate the discharge of pollutants from vehicle and equipment cleaning, fueling, and maintenance operations to stormwater drainage systems or to watercourses.

Table 4-1 Non-Stormwater Management BMPs

BMP#	BMP Name
NS-1	Water Conservation Practices[2]
NS-2	Dewatering Operations[1]
NS-3	Paving and Grinding Operations[1]
NS-4	Temporary Stream Crossing[1]
NS-5	Clear Water Diversion[1]
NS-6	Illicit Connection/Discharge[1]
NS-7	Potable Water/Irrigation[1]
NS-8	Vehicle and Equipment Cleaning[1]
NS-9	Vehicle and Equipment Fueling[1]
NS-10	Vehicle and Equipment Maintenance[1]
NS-11	Pile Driving Operations[1]
NS-12	Concrete Curing[1]
NS-13	Concrete Finishing[1]
NS-14	Material Over Water[1]
NS-15	Demolition Adjacent to Water[1]
NS-16	Temporary Batch Plants[1]

1) BMP fact sheet updated in 2009
2) BMP fact sheet updated in 2011

Table 4-1 lists the non-stormwater management BMPs. All these BMPs must be implemented depending on the conditions and applicability of deployment described as part of the BMP. The key to implementing these BMPs is to maintain a clean site and keep water, runoff, and run-on away from potential pollutants, including bare soil. In general, conduct construction activities so that: potential pollutants are not discharged directly to drainage systems; generation of potential pollutants is limited; and pollutants that are generated are contained and cleaned up immediately and are therefore not available for later discharge. These BMPs are fundamental to water quality protection and all sites must implement non-stormwater BMPs appropriate for the construction activities being performed.

It is recommended that owners and contractors be vigilant regarding implementation of these BMPs, including making their implementation a condition of continued employment, and part of all prime and subcontract agreements. By doing so, the chance of inadvertent violation by an uncaring individual can be prevented, potentially saving thousands of dollars in fines and project delays. Also, if procedures are not properly implemented and/or if BMPs are compromised then the discharge may be subject to additional sampling and analysis requirements for non-visible pollutants contained in the General Permit. (See section 2.5.5 of this handbook.)

4.2 Waste Management & Materials Pollution Control BMPs

Waste management and materials pollution control BMPs, like non-stormwater management BMPs, are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with stormwater. These BMPs also involve day-to-day operations of the construction site, and are under the control of the contractor, and are additional "good housekeeping practices" which involve keeping a clean, orderly construction site. These BMPs are fundamental to water quality protection and all sites must implement waste management and/or materials pollution control non-stormwater BMPs appropriate for the construction activities being performed.

Table 4-2 Waste Management & Materials Pollution Control BMPs

BMP#	BMP Name
WM-1	Material Delivery and Storage[1]
WM-2	Material Use[1]
WM-3	Stockpile Management[1]
WM-4	Spill Prevention and Control[1]
WM-5	Solid Waste Management[1]
WM-6	Hazardous Waste Management[1]
WM-7	Contaminated Soil Management[1]
WM-8	Concrete Waste Management[1]
WM-9	Sanitary/ Septic Waste Management[1]
WM-10	Liquid Waste Management[1]

1) BMP fact sheet updated in 2009
2) BMP fact sheet updated in 2011

Waste management consists of implementing procedural and structural BMPs for handling, storing, and disposing of wastes generated by a construction project to prevent the release of waste materials into stormwater runoff or discharges through proper management of the following types of wastes:

- Solid
- Sanitary
- Concrete
- Hazardous
- Equipment-related wastes

Materials pollution control (also called materials handling) consists of implementing procedural and structural BMPs in the handling of, storing, and the using of construction materials. The BMPs are intended to prevent the release of pollutants during stormwater and non-stormwater discharges. The objective is to prevent or reduce the opportunity for contamination of

stormwater runoff from construction materials by covering and/or providing secondary containment of storage areas and/or by taking adequate precautions when handling materials. These controls must be implemented for all applicable activities, material usage, and site conditions. The discharge of construction materials or wastes from a site is prohibited.

Table 4-2 lists the waste management and materials pollution control BMPs. It is important to note that these BMPs should be implemented depending on the conditions/applicability of deployment described as part of the BMP.

4.3 Fact Sheet Format

A BMP fact sheet is a short document that presents detailed information about a particular BMP. Typically each fact sheet contains the information outlined in Figure 4-1. Completed fact sheets for each of the above activities are provided in Section 4.4.

The fact sheets also contain side bar presentations with information on BMP categories, targeted constituents, removal effectiveness, and potential alternatives.

NS-xx Example Fact Sheet

Description and Purpose

Suitable Applications

Limitations

Implementation

Costs

Inspection and Maintenance

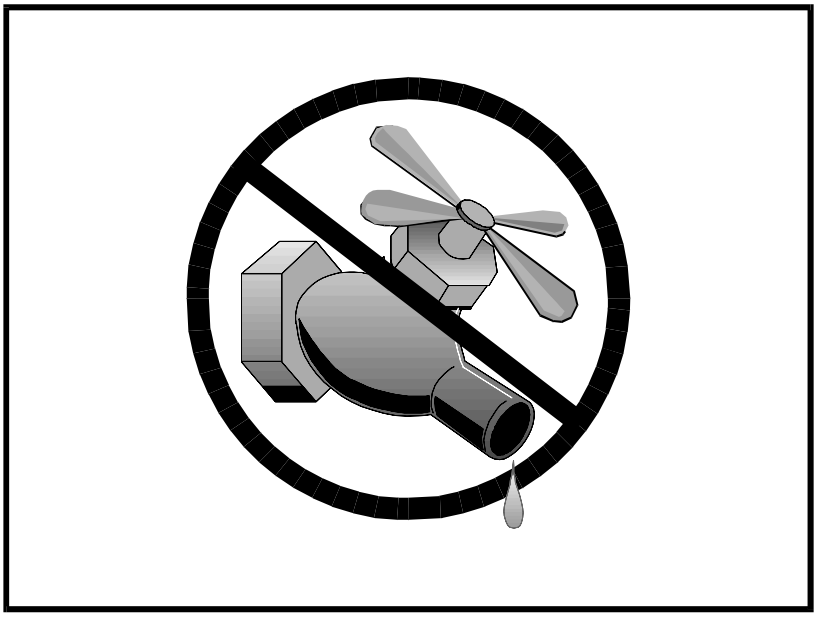
References

Figure 4-1
Example Fact Sheet

4.4 BMP Fact Sheets

BMP Fact Sheets for non-stormwater management and waste management and materials pollution control follow. The BMP fact sheets are individually page numbered and are suitable for inclusions in SWPPPs. Copies of the fact sheets can be individually downloaded from the CASQA BMP Handbook Portal at http://www.casqa.org.

Water Conservation Practices NS-1



Categories		
EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.
- Direct construction water runoff to areas where it can soak

into the ground or be collected and reused.

- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

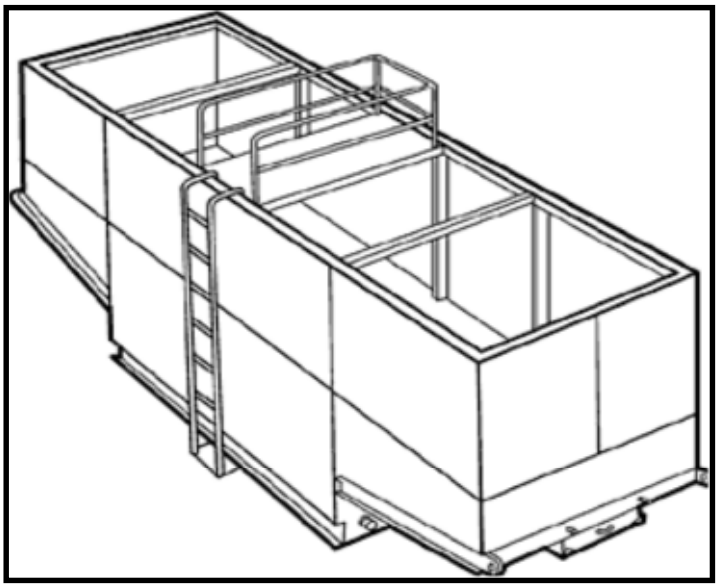
Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Dewatering Operations NS-2



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

SE-5: Fiber Roll

SE-6: Gravel Bag Berm

Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-stormwater and accumulated precipitation (stormwater) must be removed from a work location to proceed with construction work or to provide vector control.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for turbidity (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Discharges from dewatering operations can contain high levels of fine sediment and other pollutants that, if not properly treated, could lead to exceedences of the General Permit requirements or Basin Plan standards.

Suitable Applications

These practices are implemented for discharges of non-stormwater from construction sites. Non-stormwaters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area to facilitate construction.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.

Stormwater mixed with non-stormwater should be managed as non-stormwater.

Limitations

- Dewatering operations will require, and should comply with applicable local and project-specific permits and regulations. In some areas, all dewatering activities, regardless of the discharge volume, require a dewatering permit.
- Site conditions will dictate design and use of dewatering operations.
- The controls discussed in this fact sheet primarily address sediment. Other secondary pollutant removal benefits are discussed where applicable.
- The controls detailed in this fact sheet only allow for minimal settling time for sediment particles. Use only when site conditions restrict the use of the other control methods.
- Avoid dewatering discharges where possible by using the water for dust control.

Implementation

- A Construction Site Monitoring Plan (CSMP) should be included in the project Stormwater Pollution Prevention Plan (SWPPP).
- Regional Water Quality Control Board (RWQCB) Regions may require notification and approval prior to any discharge of water from construction sites.
- The destination of discharge from dewatering activities will typically determine the type of permit required by the discharger. For example, when discharging to a water of the U.S., a dewatering permit may be required from the site's governing RWQCB. When discharging to a sanitary sewer or Municipal Separate Storm Sewer System (MS4), a permit may need to be obtained through the owner of the sanitary sewer or MS4 in addition to obtaining an RWQCB dewatering permit. Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.
- Dewatering discharges should not cause erosion at the discharge point. Appropriate BMPs should be implemented to maintain compliance with all applicable permits.
- Maintain dewatering records in accordance with all local and project-specific permits and regulations.

Sediment Treatment

A variety of methods can be used to treat water during dewatering operations. Several devices are presented below and provide options to achieve sediment removal. The sediment particle size and permit or receiving water limitations on sediment or turbidity are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate. Use of other enhanced treatment methods (i.e., introduction of chemicals or electric current to enhance flocculation and removal of sediment) must comply with: 1) for storm drain or surface water discharges, the requirements for Active Treatment Systems (see SE-11); or 2) for sanitary sewer discharges, the requirements of applicable sanitary sewer discharge permits.

Sediment Basin (see also SE-2)

Description:

- A sediment basin is a temporary basin with a controlled release structure that is formed by excavation or construction of an embankment to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment basins are generally larger than Sediment Traps (SE-3) and have a designed outlet structure.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, silt, some metals that settle out with the sediment.

Implementation:

- Excavation and construction of related facilities is required.
- Temporary sediment basins should be fenced if safety is a concern.
- Outlet protection is required to prevent erosion at the outfall location.

Maintenance:

- Maintenance is required for safety fencing, vegetation, embankment, inlet and outlet, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Sediment Trap (See also SE-3)

Description:

- A sediment trap is a temporary basin formed by excavation and/or construction of an earthen embankment across a waterway or low drainage area to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment traps are generally smaller than Sediment Basins (SE-2) and do not have a designed outlet (but do have a spillway or overflow).

Appropriate Applications:

Effective for the removal of large and medium sized particles (sand and gravel) and some metals that settle out with the sediment.

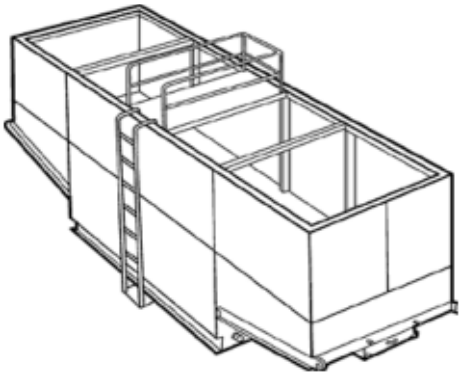
Implementation:

- Excavation and construction of related facilities is required.
- Trap inlets should be located to maximize the travel distance to the trap outlet.
- Use rock or vegetation to protect the trap outlets against erosion.

Maintenance:

- Maintenance is required for vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Weir Tanks



Description:

- A weir tank separates water and waste by using weirs. The configuration of the weirs (over and under weirs) maximizes the residence time in the tank and determines the waste to be removed from the water, such as oil, grease, and sediments.

Appropriate Applications:

- The tank removes trash, some settleable solids (gravel, sand, and silt), some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.
- Treatment capacity (i.e., volume and number of tanks) should provide at a minimum the required volume for discrete particle settling for treatment design flows.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal should be conducted by a licensed waste disposal company.

Dewatering Tanks

Description:

- A dewatering tank removes debris and sediment. Flow enters the tank through the top, passes through a fabric filter, and is discharged through the bottom of the tank. The filter separates the solids from the liquids.

Appropriate Applications:

- The tank removes trash, gravel, sand, and silt, some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

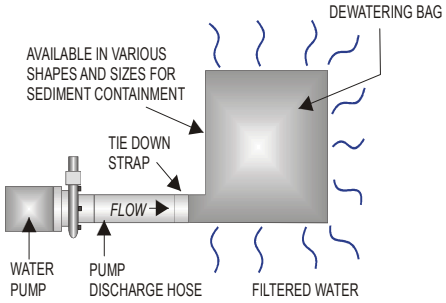
Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal should be conducted by licensed waste disposal company.

Gravity Bag Filter



Description:

- A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects gravel, sand, silt, and fines.

Appropriate Applications:

- Effective for the removal of sediments (gravel, sand, silt, and fines). Some metals are removed with the sediment.

Implementation:

- Water is pumped into one side of the bag and seeps through the top, bottom, and sides of the bag.
- Place filter bag on pavement or a gravel bed or paved surface. Avoid placing a dewatering bag on unprotected bare soil. If placing the bag on bare soil is unavoidable, a secondary barrier should be used, such as a rock filter bed placed beneath and beyond the edges of the bag to, prevent erosion and capture sediments that escape the bag.
- Perimeter control around the downstream end of the bag should be implemented. Secondary sediment controls are important especially in the initial stages of discharge, which tend to allow fines to pass through the bag.

Maintenance:

- Inspection of the flow conditions, bag condition, bag capacity, and the secondary barrier (as applicable) is required.
- Replace the bag when it no longer filters sediment or passes water at a reasonable rate.
- Caution should be taken when removing and disposing of the bag, to prevent the release of captured sediment
- Properly dispose of the bag offsite. If sediment is removed from the bag prior to disposal (bags can potentially be reused depending upon their condition), dispose of sediment in accordance with the general maintenance procedures described at the end of this BMP Fact Sheet.

Sand Media Particulate Filter

Description:

- Water is treated by passing it through canisters filled with sand media. Generally, sand filters provide a final level of treatment. They are often used as a secondary or higher level of treatment after a significant amount of sediment and other pollutants have been removed using other methods.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, and silt and some metals, as well as the reduction of biochemical oxygen demand (BOD) and turbidity.
- Sand filters can be used for stand-alone treatment or in conjunction with bag and cartridge filtration if further treatment is required.
- Sand filters can also be used to provide additional treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filters require regular service to monitor and maintain the level of the sand media. If subjected to high loading rates, filters can plug quickly.
- Venders generally provide data on maximum head loss through the filter. The filter should be monitored daily while in use, and cleaned when head loss reaches target levels.
- If cleaned by backwashing, the backwash water may need to be hauled away for disposal, or returned to the upper end of the treatment train for another pass through the series of dewatering BMPs.

Pressurized Bag Filter

Pressurized Bag Filter

Description:

- A pressurized bag filter is a unit composed of single filter bags made from polyester felt material. The water filters through the unit and is discharged through a header. Vendors provide bag filters in a variety of configurations. Some units include a combination of bag filters and cartridge filters for enhanced contaminant removal.

Appropriate Applications:

- Effective for the removal of sediment (sand and silt) and some metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Oil absorbent bags are available for hydrocarbon removal.

- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filter bags require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Cartridge Filter

Description:

- Cartridge filters provide a high degree of pollutant removal by utilizing a number of individual cartridges as part of a larger filtering unit. They are often used as a secondary or higher (polishing) level of treatment after a significant amount of sediment and other pollutants are removed. Units come with various cartridge configurations (for use in series with bag filters) or with a larger single cartridge filtration unit (with multiple filters within).

Appropriate Applications:

- Effective for the removal of sediment (sand, silt, and some clays) and metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Hydrocarbons can effectively be removed with special resin cartridges.

- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance.

Maintenance:

- The cartridges require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Costs

- Sediment control costs vary considerably depending on the dewatering and sediment treatment system that is selected. Pressurized filters tend to be more expensive than gravity settling, but are often more effective. Simple tanks are generally rented on a long-term basis (one or more months) and can range from $360 per month for a 1,000 gallon tank to $2,660 per month for a 10,000 gallon tank. Mobilization and demobilization costs vary considerably.

Inspection and Maintenance

- Inspect and verify that dewatering BMPs are in place and functioning prior to the commencement of activities requiring dewatering.

- Inspect dewatering BMPs daily while dewatering activities are being conducted.

- Inspect all equipment before use. Monitor dewatering operations to ensure they do not cause offsite discharge or erosion.
- Sample dewatering discharges as required by the General Permit.
- Unit-specific maintenance requirements are included with the description of each unit.
- Sediment removed during the maintenance of a dewatering device may be either spread onsite and stabilized, or disposed of at a disposal site as approved by the owner.
- Sediment that is commingled with other pollutants should be disposed of in accordance with all applicable laws and regulations and as approved by the owner.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

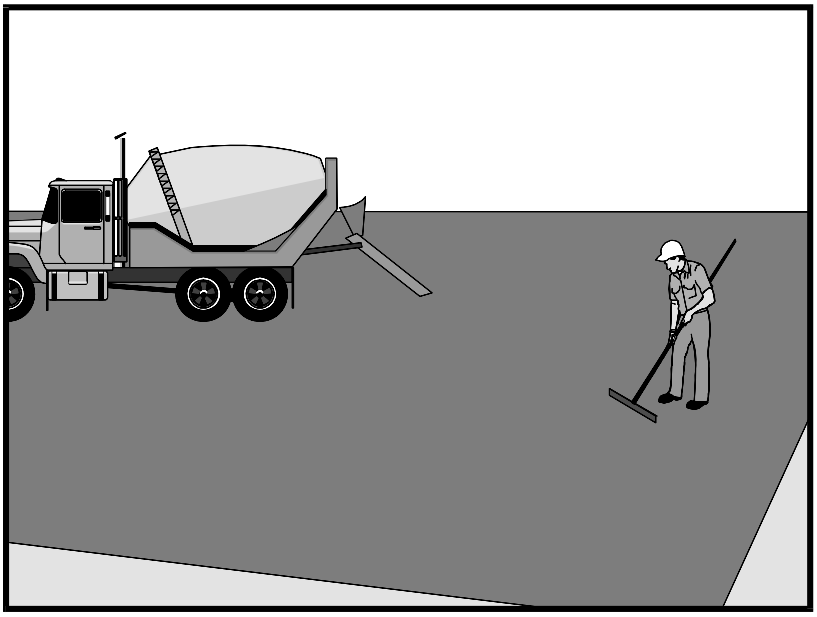
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003; Updated March 2004.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Labor Surcharge & Equipment Rental Rates, April 1, 2002 through March 31, 2003, California Department of Transportation (Caltrans).

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Paving and Grinding Operations NS-3



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☒

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH and turbidity (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials associated with paving and grinding operations, including mortar, concrete, and cement and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Paving opportunities may be limited during wet weather.
- Discharges of freshly paved surfaces may raise pH to environmentally harmful levels and trigger permit violations.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is forecasted.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses. These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC (Portland cement concrete) and AC (asphalt concrete) waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing should not be allowed to enter any storm drains or watercourses. Install inlet protection and perimeter controls until area is stabilized (i.e. cutting, grinding or other removal activities are complete and loose material has been properly removed and disposed of)or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-9, Earth Dikes and Drainage Swales; SE-1, Silt Fence; SE-5, Fiber Rolls, or SE-13 Compost Socks and Berms
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt should be recycled or disposed of properly.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by a vacuum attachment to the grinding machine, or by sweeping, should not be allowed to flow across the pavement, and should not be left on the surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.
- Pavement removal activities should not be conducted in the rain.
- Collect removed pavement material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.

- If removed pavement material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management.
  - Old asphalt should be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect waste materials by dry methods, such as sweeping or shoveling, and return to aggregate base stockpile or dispose of properly. Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if authorized by the local wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate should not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized (i.e. all sealing operations are complete and cured and loose materials have been properly removed and disposed).
- Inlet protection (SE-10, Storm Drain Inlet Protection) should be used during application of seal coat, tack coat, slurry seal, and fog seal.
- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials and dispose of in accordance with the applicable regulations. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.
- Substances used to coat asphalt transport trucks and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.
- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.
- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the stormwater drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move.
- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the stormwater drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

Costs

- All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of paving and grinding operations.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sample stormwater runoff required by the General Permit.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

References

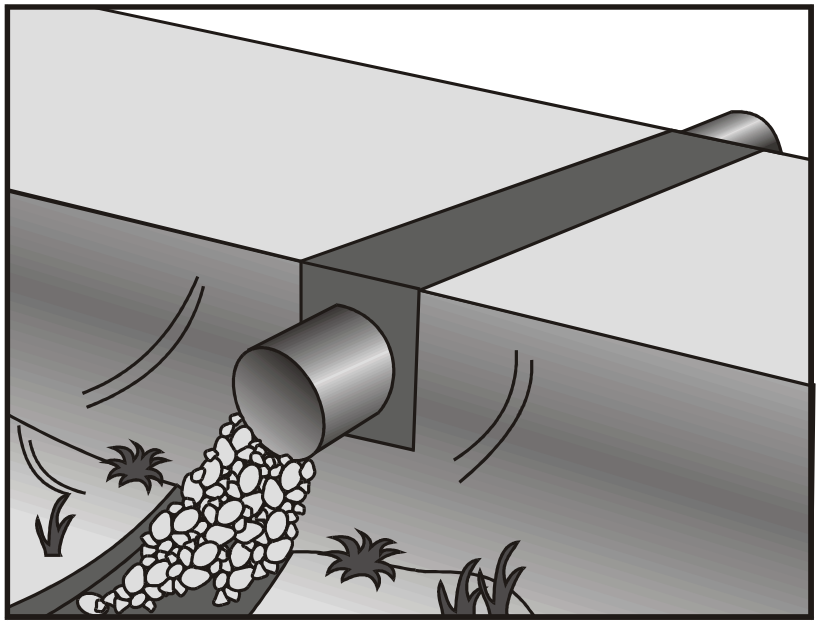
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Temporary Stream Crossing NS-4



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A temporary stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

Suitable Applications

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels that may be significantly eroded by construction traffic.

Temporary streams crossings are installed at sites:

- Where appropriate permits have been secured (404 Permits, and 401 Certifications)
- Where construction equipment or vehicles need to frequently cross a waterway
- When alternate access routes impose significant constraints
- When crossing perennial streams or waterways causes significant erosion
- Where construction activities will not last longer than one year
- Where appropriate permits have been obtained for the

stream crossing

Limitations

The following limitations may apply:

- Installation and removal will usually disturb the waterway.
- Installation may require Regional Water Quality Control Board (RWQCB) 401 Certification, U.S. Army Corps of Engineers 404 permit and approval by California Department of Fish and Game. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Installation may require dewatering or temporary diversion of the stream. See NS-2, Dewatering Operations and NS-5, Clear Water Diversion.
- Installation may cause a constriction in the waterway, which can obstruct flood flow and cause flow backups or washouts. If improperly designed, flow backups can increase the pollutant load through washouts and scouring.
- Use of natural or other gravel in the stream for construction of Cellular Confinement System (CCS) ford crossing will be contingent upon approval by fisheries agencies.
- Ford crossings may degrade water quality due to contact with vehicles and equipment.
- May be expensive for a temporary improvement.
- Requires other BMPs to minimize soil disturbance during installation and removal.
- Fords should only be used in dry weather.

Implementation

General

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in California. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light–duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Location of the temporary stream crossing should address:

- Site selection where erosion potential is low.

- Areas where the side slopes from site runoff will not spill into the side slopes of the crossing.

The following types of temporary stream crossings should be considered:

- **Culverts –** A temporary culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.

- **Fords** - Appropriate during the dry season in arid areas. Used on dry washes and ephemeral streams, and low-flow perennial streams. CCS, a type of ford crossing, is also appropriate for use in streams that would benefit from an influx of gravels. A temporary ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate during the dry ice season and in arid areas of California.

- **Bridges** - Appropriate for streams with high flow velocities, steep gradients and where temporary restrictions in the channel are not allowed.

Design

During the long summer construction season in much of California, rainfall is infrequent and many streams are dry. Under these conditions, a temporary ford may be sufficient. A ford is not appropriate if construction will continue through the winter rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary culverts and bridges should then be considered and, if used, should be sized to pass a significant design storm (i.e., at least a 10-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing.

Design and installation requires knowledge of stream flows and soil strength. Designs should be prepared under direction of, and approved by, a registered civil engineer and for bridges, a registered structural engineer. Both hydraulic and construction loading requirements should be considered with the following:

- Comply with any special requirements for culvert and bridge crossings, particularly if the temporary stream crossing will remain through the rainy season.

- Provide stability in the crossing and adjacent areas to withstand the design flow. The design flow and safety factor should be selected based on careful evaluation of the risks due to over topping, flow backups, or washout.

- Install sediment traps immediately downstream of crossings to capture sediments. See SE-3, Sediment Trap.

- Avoid oil or other potentially hazardous materials for surface treatment.

- Culverts are relatively easy to construct and able to support heavy equipment loads.

- Fords are the least expensive of the crossings, with maximum load limits.

- CCS crossing structures consist of clean, washed gravel and cellular confinement system blocks. CCS are appropriate for streams that would benefit from an influx of gravel; for example, salmonid streams, streams or rivers below reservoirs, and urban, channelized streams. Many urban stream systems are gravel-deprived due to human influences, such as dams, gravel mines, and concrete channels.
- CCS allow designers to use either angular or naturally occurring rounded gravel, because the cells provide the necessary structure and stability. In fact, natural gravel is optimal for this technique, because of the habitat improvement it will provide after removal of the CCS.
- A gravel depth of 6 to 12 in. for a CCS structure is sufficient to support most construction equipment.
- An advantage of a CCS crossing structure is that relatively little rock or gravel is needed, because the CCS provides the stability.
- Bridges are generally more expensive to design and construct, but provide the least disturbance of the streambed and constriction of the waterway flows.

Construction and Use

- Stabilize construction roadways, adjacent work area, and stream bottom against erosion.
- Construct during dry periods to minimize stream disturbance and reduce costs.
- Construct at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.
- Install temporary erosion control BMPs in accordance with erosion control BMP fact sheets to minimize erosion of embankment into flow lines.
- Any temporary artificial obstruction placed within flowing water should only be built from material, such as clean gravel or sandbags, that will not introduce sediment or silt into the watercourse.
- Temporary water body crossings and encroachments should be constructed to minimize scour. Cobbles used for temporary water body crossings or encroachments should be clean, rounded river cobble.
- Vehicles and equipment should not be driven, operated, fueled, cleaned, maintained, or stored in the wet or dry portions of a water body where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed.
- The exterior of vehicles and equipment that will encroach on the water body within the project should be maintained free of grease, oil, fuel, and residues.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than one hour.

- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate soil stabilization measures.

- Riparian vegetation, when removed pursuant to the provisions of the work, should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble must be removed upon completion of project activities.

- Conceptual temporary stream crossings are shown in the attached figures.

Costs

Caltrans Construction Cost index for temporary bridge crossings is $45-$95/ft^2.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Check for blockage in the channel, sediment buildup or trapped debris in culverts, blockage behind fords or under bridges.

- Check for erosion of abutments, channel scour, riprap displacement, or piping in the soil.

- Check for structural weakening of the temporary crossings, such as cracks, and undermining of foundations and abutments.

- Remove sediment that collects behind fords, in culverts, and under bridges periodically.

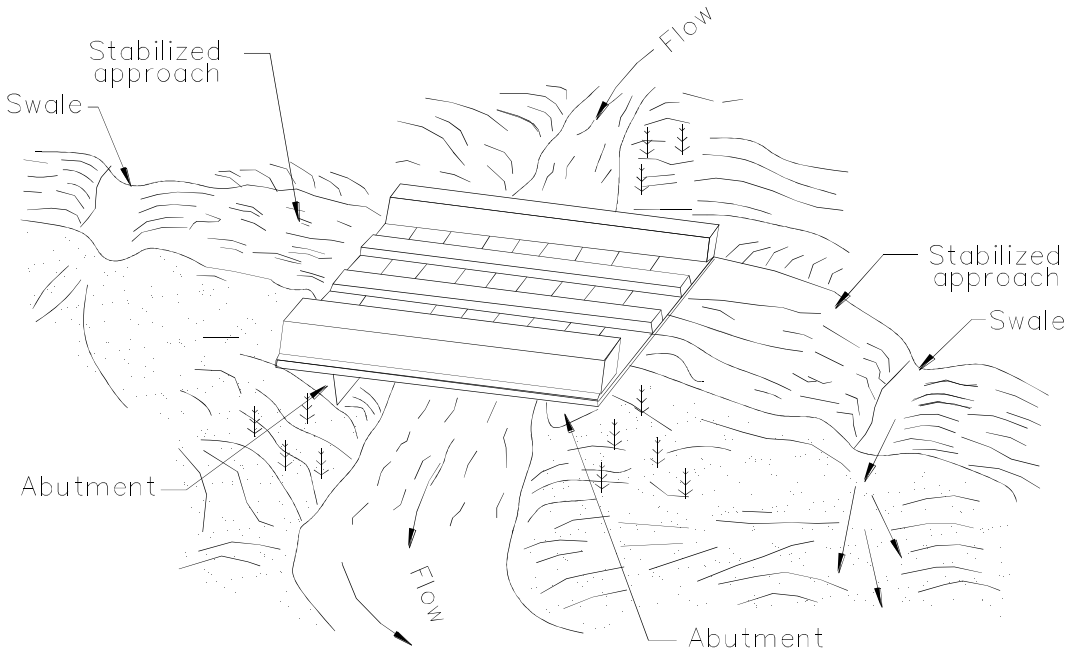
- Replace lost or displaced aggregate from inlets and outlets of culverts and cellular confinement systems.

- Remove temporary crossing promptly when it is no longer needed.

References

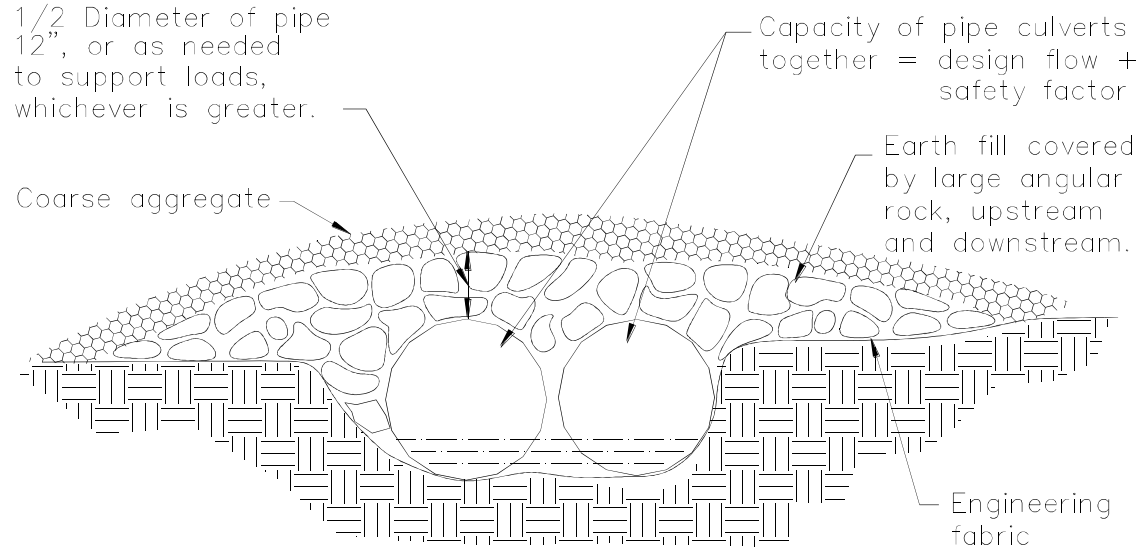
California Bank and Shore Rock Slope Protection Design – Practitioners Guide and Field Evaluations of Riprap Methods, Caltrans Study No. F90TL03, October 2000.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

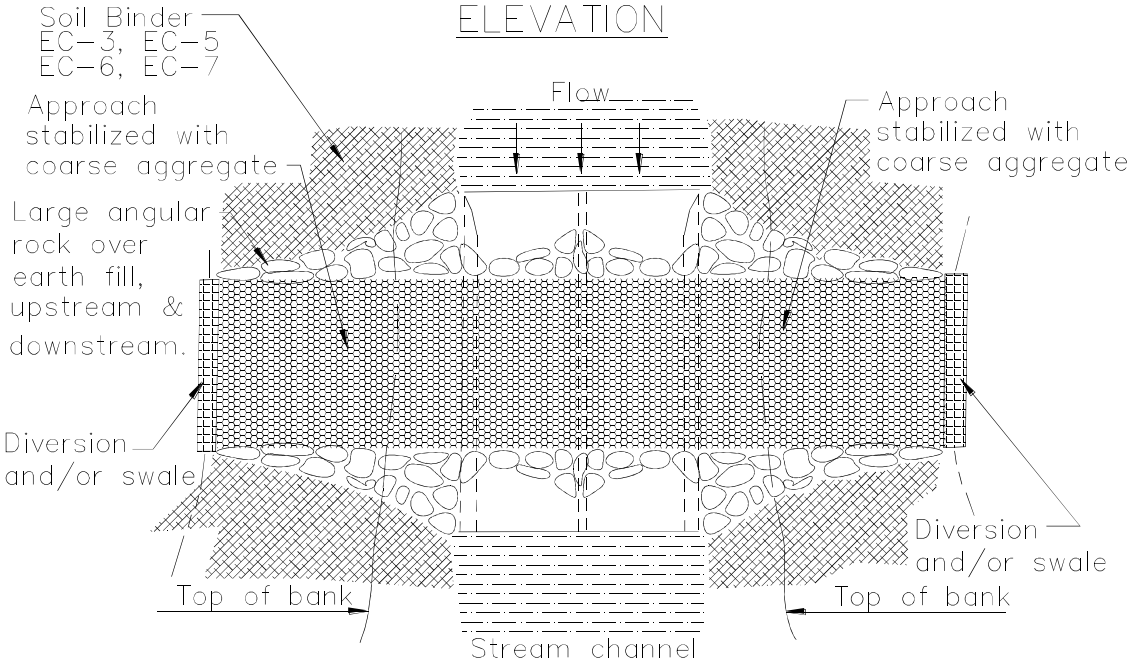


NOTE:
Surface flow of road diverted by swale and/or dike.

TYPICAL BRIDGE CROSSING
NOT TO SCALE



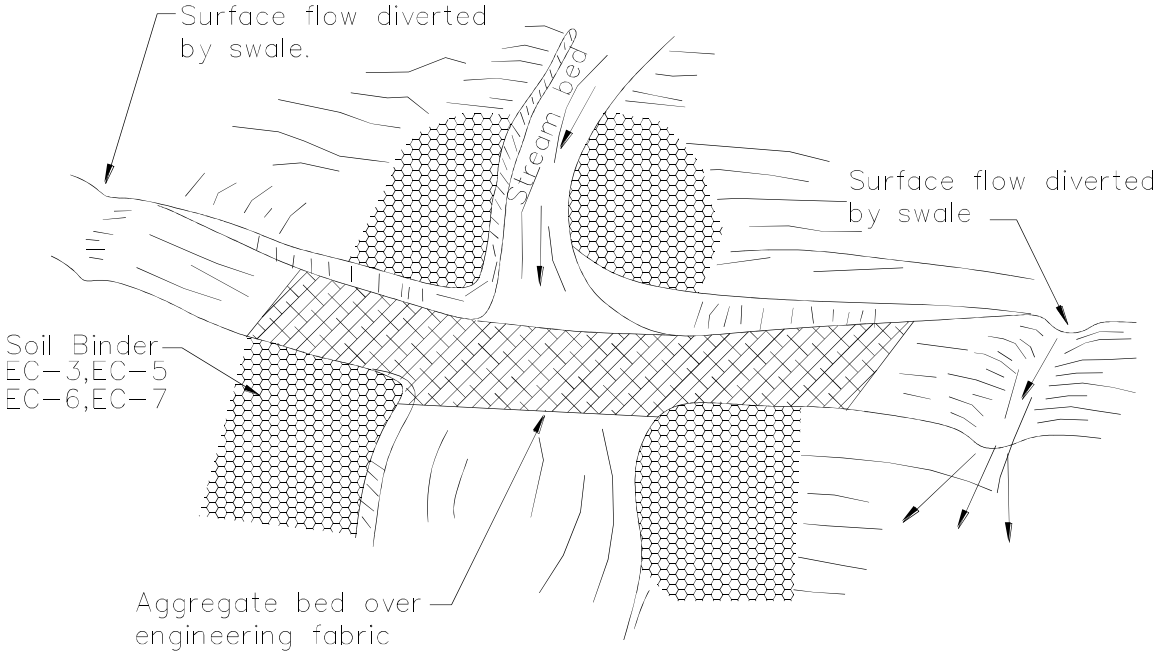
ELEVATION



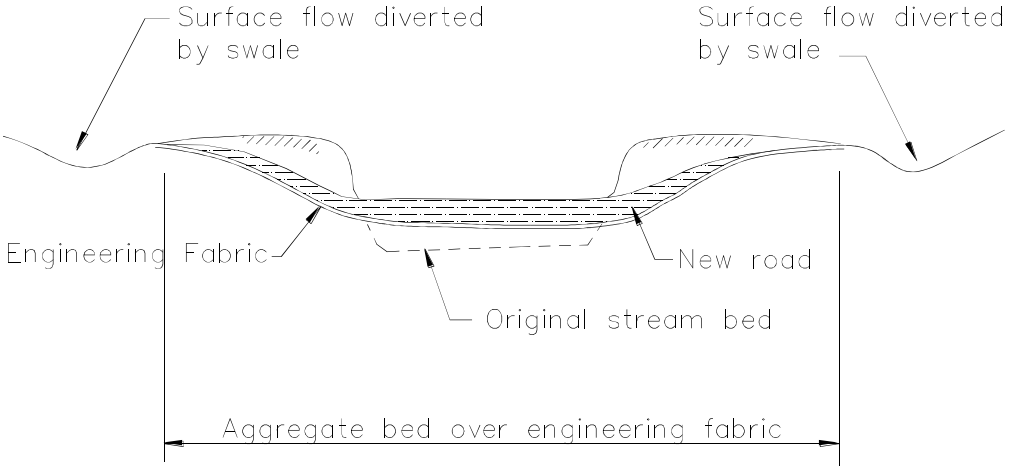
PLAN VIEW

TYPICAL CULVERT CROSSING

NOT TO SCALE

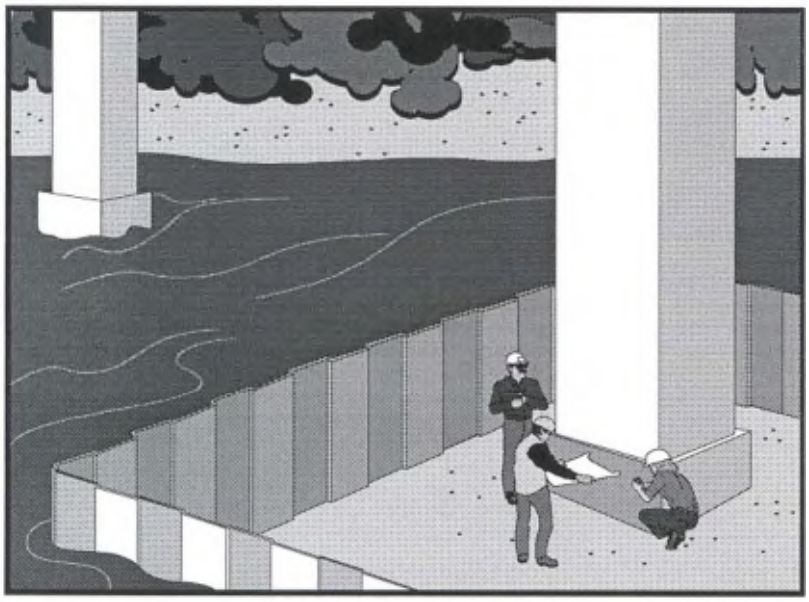


Aggregate approch
1:5 (V:H) Maximum slope on road



TYPICAL FORD CROSSING
NOT TO SCALE

Clear Water Diversion NS-5



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a project, transport it around the work area, and discharge it downstream with minimal water quality degradation from either the project construction operations or the construction of the diversion. Clear water diversions are used in a waterway to enclose a construction area and reduce sediment pollution from construction work occurring in or adjacent to water. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, rock, gravel bags, wood, aqua barriers, cofferdams, filter fabric or turbidity curtains, drainage and interceptor swales, pipes, or flumes.

Suitable Applications

A clear water diversion is typically implemented where appropriate permits (1601 Agreement) have been secured and work must be performed in a flowing stream or water body.

- Clear water diversions are appropriate for isolating construction activities occurring within or near a water body such as streambank stabilization, or culvert, bridge, pier or abutment installation. They may also be used in combination with other methods, such as clear water bypasses and/or pumps.
- Pumped diversions are suitable for intermittent and low flow streams.
- Excavation of a temporary bypass channel, or passing the

flow through a heavy pipe (called a "flume") with a trench excavated under it, is appropriate for the diversion of streams less than 20 ft wide, with flow rates less than 100 cfs.

- Clear water diversions incorporating clean washed gravel may be appropriate for use in salmonid spawning streams.

Limitations

- Diversion and encroachment activities will usually disturb the waterway during installation and removal of diversion structures.
- Installation may require Regional Water Quality Control Board (RWQCB) 401 Certification, U.S. Army Corps of Engineers 404 permit and approval by California Department of Fish and Game. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Diversion and encroachment activities may constrict the waterway, which can obstruct flood flows and cause flooding or washouts. Diversion structures should not be installed without identifying potential impacts to the stream channel.
- Diversion or isolation activities are not appropriate in channels where there is insufficient stream flow to support aquatic species in the area dewatered as a result of the diversion.
- Diversion or isolation activities are inappropriate in deep water unless designed or reviewed by an engineer registered in California.
- Diversion or isolation activities should not completely dam stream flow.
- Dewatering and removal may require additional sediment control or water treatment. See NS-2, Dewatering Operations.
- Not appropriate if installation, maintenance, and removal of the structures will disturb sensitive aquatic species of concern.

Implementation

General

- Implement guidelines presented in NS-17, Streambank Stabilization to minimize impacts to streambanks.
- Where working areas encroach on flowing streams, barriers adequate to prevent the flow of muddy water into streams should be constructed and maintained between working areas and streams. During construction of the barriers, muddying of streams should be held to a minimum.
- Diversion structures must be adequately designed to accommodate fluctuations in water depth or flow volume due to tides, storms, flash floods, etc.
- Heavy equipment driven in wet portions of a water body to accomplish work should be completely clean of petroleum residue, and water levels should be below the fuel tanks, gearboxes, and axles of the equipment unless lubricants and fuels are sealed such that inundation by water will not result in discharges of fuels, oils, greases, or hydraulic fluids.

- Excavation equipment buckets may reach out into the water for the purpose of removing or placing fill materials. Only the bucket of the crane/ excavator/backhoe may operate in a water body. The main body of the crane/excavator/backhoe should not enter the water body except as necessary to cross the stream to access the work site.
- Stationary equipment such as motors and pumps located within or adjacent to a water body, should be positioned over drip pans.
- When any artificial obstruction is being constructed, maintained, or placed in operation, sufficient water should, at all times, be allowed to pass downstream to maintain aquatic life.
- Equipment should not be parked below the high water mark unless allowed by a permit.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate erosion control measures.
- Riparian vegetation approved for trimming as part of the project should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble should be removed upon completion of project activities.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- Where possible, avoid or minimize diversion and encroachment impacts by scheduling construction during periods of low flow or when the stream is dry. Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Construct diversion structures with materials free of potential pollutants such as soil, silt, sand, clay, grease, or oil.

Temporary Diversions and Encroachments

- Construct diversion channels in accordance with EC-9, Earth Dikes and Drainage Swales.
- In high flow velocity areas, stabilize slopes of embankments and diversion ditches using an appropriate liner, in accordance with EC-7, Geotextiles and Mats, or use rock slope protection.
- Where appropriate, use natural streambed materials such as large cobbles and boulders for temporary embankment and slope protection, or other temporary soil stabilization methods.
- Provide for velocity dissipation at transitions in the diversion, such as the point where the stream is diverted to the channel and the point where the diverted stream is returned to its natural channel. See also EC-10, Velocity Dissipation Devices.

Temporary Dry Construction Areas

- When dewatering behind temporary structures to create a temporary dry construction area, such as cofferdams, pass pumped water through a sediment-settling device, such as a portable tank or settling basin, before returning water to the water body. See also NS-2, Dewatering Operations.

- Any substance used to assemble or maintain diversion structures, such as form oil, should be non-toxic and non-hazardous.

- Any material used to minimize seepage underneath diversion structures, such as grout, should be non-toxic, non-hazardous, and as close to a neutral pH as possible.

Comparison of Diversion and Isolation Techniques:

- Gravel bags are relatively inexpensive, but installation and removal can be labor intensive. It is also difficult to dewater the isolated area. Sandbags should not be used for this technique in rivers or streams, as sand should never be put into or adjacent to a stream, even if encapsulated in geotextile.

- Gravel Bag Berms (SE-6) used in conjunction with an impermeable membrane are cost effective, and can be dewatered relatively easily. If spawning gravel is used, the impermeable membrane can be removed from the stream, and the gravel can be spread out and left as salmonid spawning habitat if approved in the permit. Only clean, washed gravel should be used for both the gravel bag and gravel berm techniques.

- Cofferdams are relatively expensive, but frequently allow full dewatering. Also, many options now available are relatively easy to install.

- Sheet pile enclosures are a much more expensive solution, but do allow full dewatering. This technique is not well suited to small streams, but can be effective on large rivers or lakes, and where staging and heavy equipment access areas are available.

- K-rails are an isolation method that does not allow full dewatering, but can be used in small to large watercourses, and in fast-water situations.

- A relatively inexpensive isolation method is filter fabric isolation. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place. This method should be used in relatively calm water, and can be used in smaller streams. Note that this is not a dewatering method, but rather a sediment isolation method.

- Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They can also be used for in-stream construction, when dewatering an area is not required.

- When used in watercourses or streams, cofferdams must be used in accordance with permit requirements.

- Manufactured diversion structures should be installed following manufacturer's specifications.

- Filter fabric and turbidity curtain isolation installation methods can be found in the specific technique descriptions that follow.

Filter Fabric Isolation Technique

Definition and Purpose

A filter fabric isolation structure is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. This structure is composed of filter fabric, gravel bags, and steel t-posts.

Appropriate Applications

- Filter fabric may be used for construction activities such as streambank stabilization, or culvert, bridge, pier or abutment installation. It may also be used in combination with other methods, such as clean water bypasses and/or pumps.
- Filter fabric isolation is relatively inexpensive. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place.
- If spawning gravel is used, all other components of the isolation can be removed from the stream, and the gravel may be spread out and left as salmonid spawning habitat if approved in the permit. Whether spawning gravel or other types of gravel are used, only clean washed gravel should be used as infill for the gravel bags or continuous berm.
- This method should be used in relatively calm water, and can be used in smaller streams. This is not a dewatering method, but rather a sediment isolation method.
- Water levels inside and outside the fabric curtain must be about the same, as differential heads will cause the curtain to collapse.

Limitations

- Do not use if the installation, maintenance and removal of the structures will disturb sensitive aquatic species of concern.
- Filter fabrics are not appropriate for projects where dewatering is necessary.
- Filter fabrics are not appropriate to completely dam stream flow.

Design and Installation

- For the filter fabric isolation method, a non-woven or heavy-duty fabric is recommended over standard silt fence. Using rolled geotextiles allows non-standard widths to be used.
- Anchor filter fabric with gravel bags filled with clean, washed gravel. Do not use sand. If a bag should split open, the gravel can be left in the stream, where it can provide aquatic habitat benefits. If a sandbag splits open in a watercourse, the sand could cause a decrease in water quality, and could bury sensitive aquatic habitat.
- Another anchor alternative is a continuous berm, made with the Continuous Berm Machine. This is a gravel-filled bag that can be made in very long segments. The length of the berms is usually limited to 18 ft for ease of handling (otherwise, it gets too heavy to move).

- Place the fabric on the bottom of the stream, and place either a bag of clean, washed gravel or a continuous berm over the bottom of the silt fence fabric, such that a bag-width of fabric lies on the stream bottom. The bag should be placed on what will be the outside of the isolation area.
- Pull the fabric up, and place a metal t-post immediately behind the fabric, on the inside of the isolation area; attach the silt fence to the post with three diagonal nylon ties.
- Continue placing fabric as described above until the entire work area has been isolated, staking the fabric at least every 6 ft.

Inspection and Maintenance

- Immediately repair any gaps, holes or scour.
- Remove and properly dispose of sediment buildup.
- Remove BMP upon completion of construction activity. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

Turbidity Curtain Isolation Technique

Definition and Purpose

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out.

Appropriate Applications

Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They are used when construction activities adjoin quiescent waters, such as lakes, ponds, and slow flowing rivers. The curtains are designed to deflect and contain sediment within a limited area and provide sufficient retention time so that the sediment particles will fall out of suspension.

Limitations

- Turbidity curtains should not be used in flowing water; they are best suited for use in ponds, lakes, and very slow-moving rivers.
- Turbidity curtains should not be placed across the width of a channel.
- Removing sediment that has been deflected and settled out by the curtain may create a discharge problem through the resuspension of particles and by accidental dumping by the removal equipment.

Design and Installation

- Turbidity curtains should be oriented parallel to the direction of flow.
- The curtain should extend the entire depth of the watercourse in calm-water situations.
- In wave conditions, the curtain should extend to within 1 ft of the bottom of the watercourse, such that the curtain does not stir up sediment by hitting the bottom repeatedly. If it is

desirable for the curtain to reach the bottom in an active-water situation, a pervious filter fabric may be used for the bottom 1 ft.

- The top of the curtain should consist of flexible flotation buoys, and the bottom should be held down by a load line incorporated into the curtain fabric. The fabric should be a brightly colored impervious mesh.
- The curtain should be held in place by anchors placed at least every 100 ft.
- First, place the anchors, then tow the fabric out in a furled condition, and connect to the anchors. The anchors should be connected to the flotation devices, and not to the bottom of the curtain. Once in place, cut the furling lines, and allow the bottom of the curtain to sink.
- Consideration must be given to the probable outcome of the removal procedure. It must be determined if it will create more of a sediment problem through re-suspension of the particles or by accidental dumping of material during removal. It is recommended that the soil particles trapped by the turbidity curtain only be removed if there has been a significant change in the original contours of the affected area in the watercourse.
- Particles should always be allowed to settle for a minimum of 6 to 12 hours prior to their removal or prior to removal of the turbidity curtain.

Maintenance and Inspection:

- The curtain should be inspected for holes or other problems, and any repairs needed should be made promptly.
- Allow sediment to settle for 6 to 12 hours prior to removal of sediment or curtain. This means that after removing sediment, wait an additional 6 to 12 hours before removing the curtain.
- To remove, install furling lines along the curtain, detach from anchors, and tow out of the water.

K-rail River Isolation

Definition and Purpose

This temporary sediment control or stream isolation method uses K-rails to form the sediment deposition area, or to isolate the in-stream or near-bank construction area.

Barriers are placed end-to-end in a pre-designed configuration and gravel-filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

Appropriate Applications

The K-rail isolation can be used in streams with higher water velocities than many other isolation techniques.

- This technique is also useful at the toe of embankments, and cut or fill slopes.

Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight.

Design and Installation

- To create a floor for the K-rail, move large rocks and obstructions. Place washed gravel and gravel-filled bags to create a level surface for K-rails to sit. Washed gravel should always be used.
- Place the bottom two K-rails adjacent to each other, and parallel to the direction of flow; fill the center portion with gravel bags. Then place the third K-rail on top of the bottom two. There should be sufficient gravel bags between the bottom K-rails such that the top rail is supported by the gravel. Place plastic sheeting around the K-rails, and secure at the bottom with gravel bags.
- Further support can be added by pinning and cabling the K-rails together. Also, large riprap and boulders can be used to support either side of the K-rail, especially where there is strong current.

Inspection and Maintenance:

- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Sediment should be allowed to settle for at least 6 to 12 hours prior to removal of sediment, and for 6 to 12 hours prior to removal of the barrier.

Stream Diversions

The selection of which stream diversion technique to use will depend upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

Advantages of a Pumped Diversion

- Downstream sediment transport can be nearly eliminated.
- Dewatering of the work area is possible.
- Pipes can be moved around to allow construction operations.
- The dams can serve as temporary access to the site.
- Increased flows can be managed by adding more pumping capacity.

Disadvantages of a Pumped Diversion

- Flow volume is limited by pump capacity.
- A pumped diversion requires 24 hour monitoring of pumps.
- Sudden rain could overtop dams.
- Erosion at the outlet.

- Minor in-stream disturbance is required to install and remove dams.

Advantages of Excavated Channels and Flumes

- Excavated channels isolate work from water flow and allow dewatering.
- Excavated channels can handle larger flows than pumps.

Disadvantages of Excavated Channels and Flumes

- Bypass channel or flume must be sized to handle flows, including possible floods.
- Channels must be protected from erosion.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment.

Design and Installation

- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Pump capacity must be sufficient for design flow.
- A standby pump is required in case a primary pump fails.
- Dam materials used to create dams upstream and downstream of diversion should be erosion resistant; materials such as steel plate, sheet pile, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.

When constructing a diversion channel, begin excavation of the channel at the proposed downstream end, and work upstream. Once the watercourse to be diverted is reached and the excavated channel is stable, breach the upstream end and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.

Inspection and Maintenance

- Pumped diversions require 24 hour monitoring of pumps.
- Inspect embankments and diversion channels for damage to the linings, accumulating debris, sediment buildup, and adequacy of the slope protection. Remove debris and repair linings and slope protection as required. Remove holes, gaps, or scour.
- Upon completion of work, the diversion or isolation structure should be removed and flow should be redirected through the new culvert or back into the original stream channel. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

Costs

Costs of clear water diversion vary considerably and can be very high.

Inspection and Maintenance

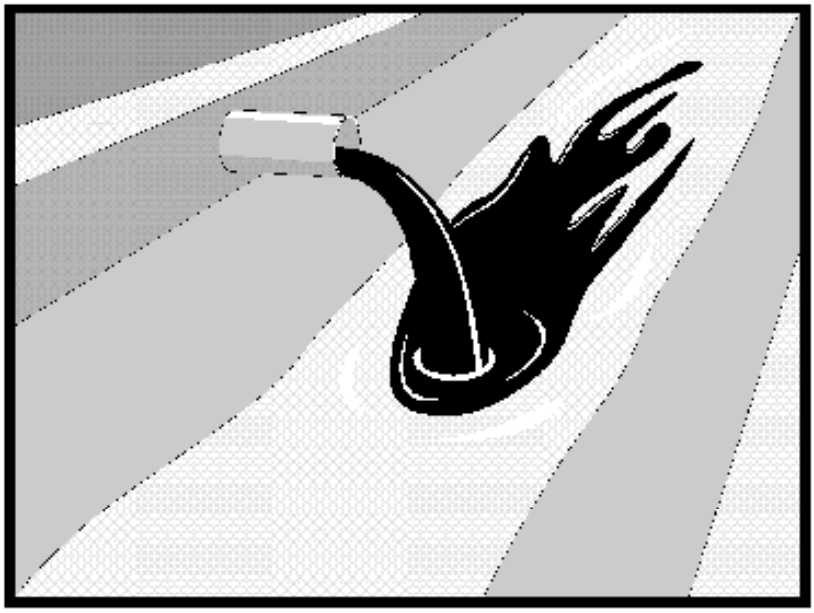
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Refer to BMP-specific inspection and maintenance requirements.

References

California Bank and Shore Rock Slope Protection Design – Practitioners Guide and Field Evaluations of Riprap Methods, Caltrans Study No. F90TL03, October, 2000.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Illicit Connection/Discharge NS-6



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.
- Inspect site regularly during project execution for evidence

of illicit connections, illegal dumping or discharges.

- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General –** unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** - Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** - signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas** - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas** - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

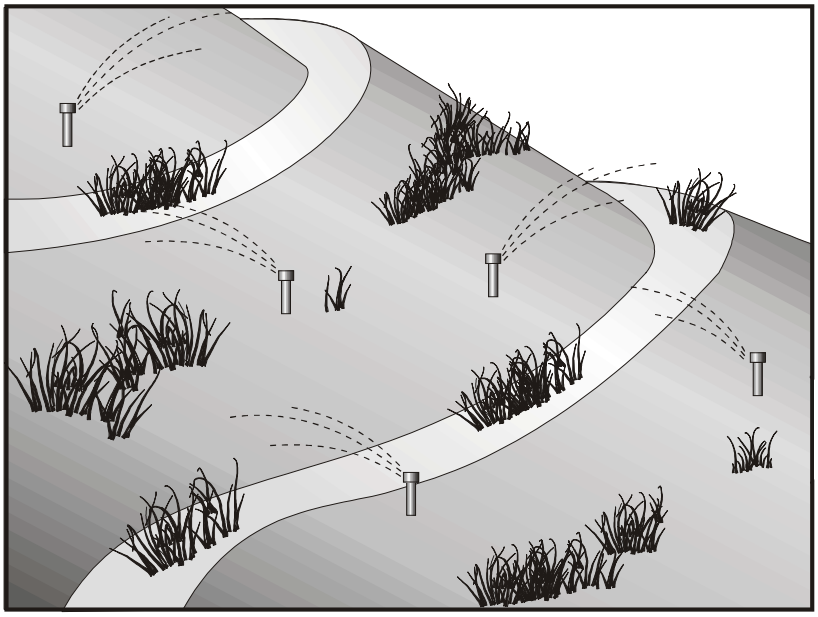
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Potable Water/Irrigation NS-7



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Potable Water/Irrigation consists of practices and procedures to manage the discharge of potential pollutants generated during discharges from irrigation water lines, landscape irrigation, lawn or garden watering, planned and unplanned discharges from potable water sources, water line flushing, and hydrant flushing.

Suitable Applications

Implement this BMP whenever potable water or irrigation water discharges occur at or enter a construction site.

Limitations

None identified.

Implementation

- Direct water from offsite sources around or through a construction site, where feasible, in a way that minimizes contact with the construction site.
- Discharges from water line flushing should be reused for landscaping purposes where feasible.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Protect downstream stormwater drainage systems and watercourses from water pumped or bailed from trenches excavated to repair water lines.
- Inspect irrigated areas within the construction limits for

excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff. Consider factors such as soil structure, grade, time of year, and type of plant material in determining the proper amounts of water for a specific area.

Costs

Cost to manage potable water and irrigation are low and generally considered to be a normal part of related activities.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Repair broken water lines as soon as possible.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

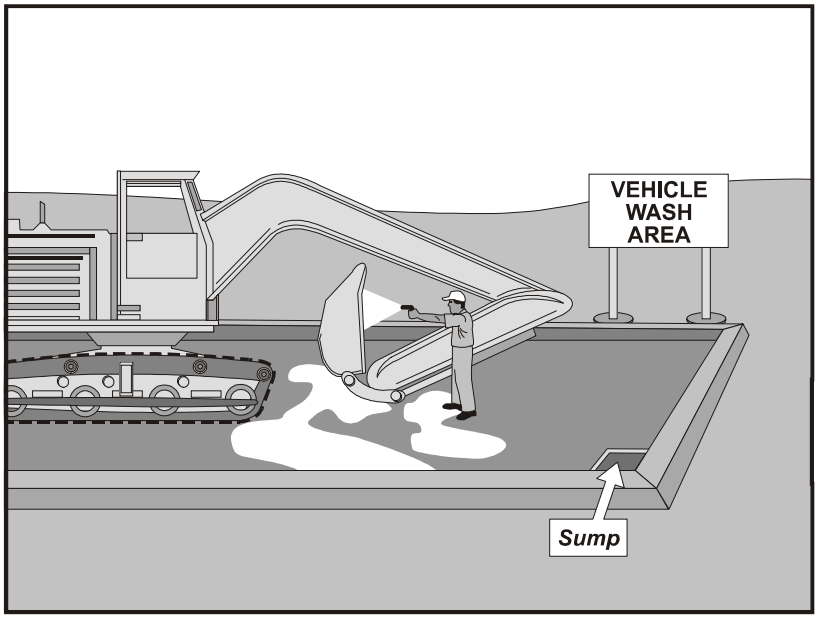
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle and Equipment Cleaning NS-8



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

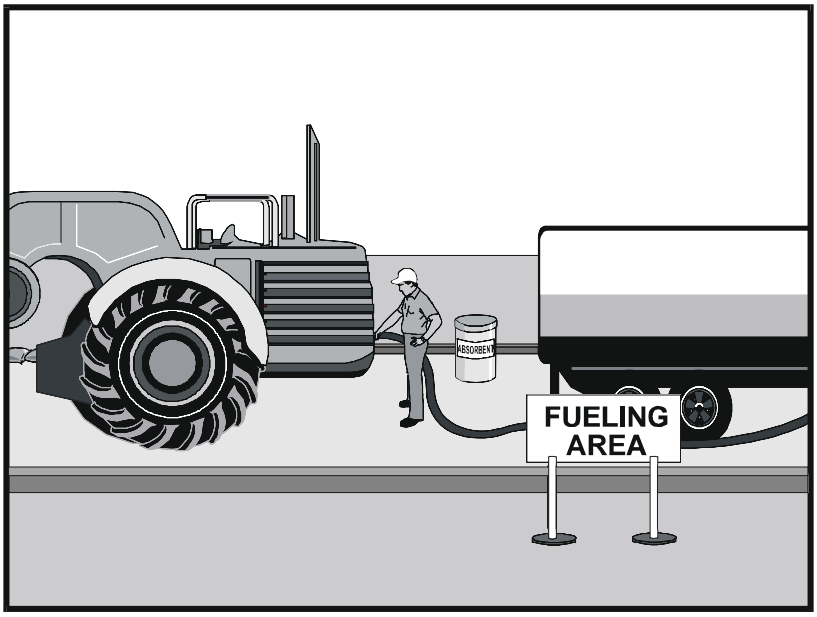
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.
- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should

be disposed of properly after use.

- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.

- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

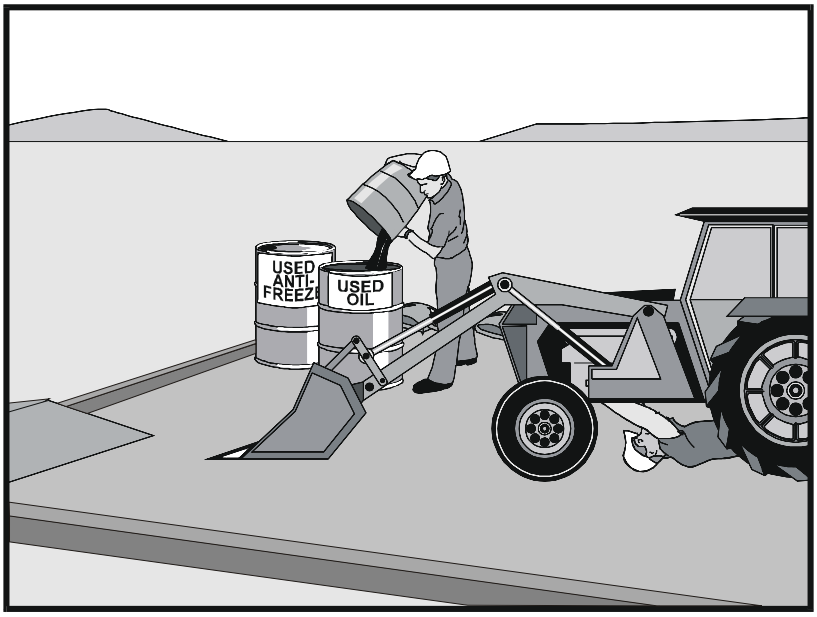
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and

Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.

- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

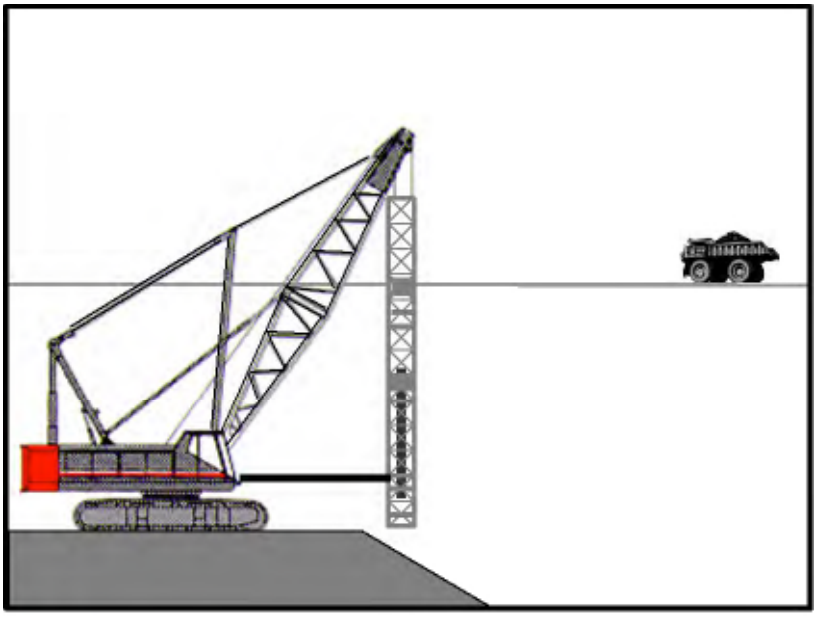
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Pile Driving Operations NS-11



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

The construction and retrofit of bridges and retaining walls often include driving piles for foundation support and shoring operations. Driven piles are typically constructed of precast concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction. Proper control and use of equipment, materials, and waste products from pile driving operations will reduce or eliminate the discharge of potential pollutants to the storm drain system, watercourses, and waters of the United States.

Suitable Applications

These procedures apply to all construction sites near or adjacent to a watercourse or groundwater where permanent and temporary pile driving (impact and vibratory) takes place, including operations using pile shells as well as construction of cast-in-steel-shell and cast-in-drilled-hole piles.

Limitations

None identified.

Implementation

- Use drip pans or absorbent pads during vehicle and equipment operation, maintenance, cleaning, fueling, and storage. Refer to NS-8, Vehicle and Equipment Cleaning, NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance.

- Have spill kits and cleanup materials available at all locations of pile driving. Refer to WM-4, Spill Prevention

and Control.

- Equipment that is stored or in use in streambeds, or on docks, barges, or other structures over water bodies should be kept leak free.
- Park equipment over plastic sheeting or equivalent where possible. Plastic is not a substitute for drip pans or absorbent pads. The storage or use of equipment in streambeds or other bodies of water must comply with all applicable permits.
- Implement other BMPs as applicable, such as NS-2, Dewatering Operations, WM-5, Solid Waste Management, WM-6, Hazardous Waste Management, and WM-10, Liquid Waste Management.
- When not in use, store pile-driving equipment away from concentrated flows of stormwater, drainage courses, and inlets. Protect hammers and other hydraulic attachments from runon and runoff by placing them on plywood and covering them with plastic or a comparable material prior to the onset of rain.
- Use less hazardous products, e.g., vegetable oil, when practicable.

Costs

All of the above measures can be low cost.

Inspection and Maintenance

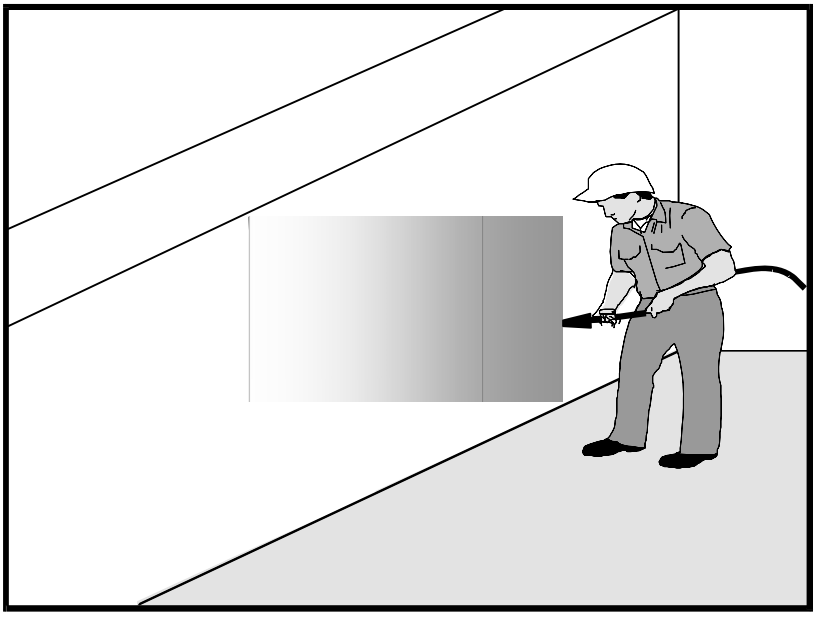
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect equipment every day at startup and repair equipment as needed (i.e., worn or damaged hoses, fittings, and gaskets). Recheck equipment at shift changes or at the end of the day and scheduled repairs as needed.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Concrete Curing NS-12



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods.

Concrete and its associated curing materials have basic chemical properties that can raise the pH of water to levels outside of the permitted range. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Proper procedures and care should be taken when managing concrete curing materials to prevent them from coming into contact with stormwater flows, which could result in a high pH discharge.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.
- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for evaporation or other means of removal in accordance with all applicable permits. See WM-8 Concrete Waste Management.
- Collect cure water at the top of slopes and transport to a concrete waste management area in a non-erosive manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Education

- Educate employees, subcontractors, and suppliers on proper concrete curing techniques to prevent contact with discharge as described herein.
- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete curing procedures.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts uncured and partially cured concrete as required by the General Permit.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

References

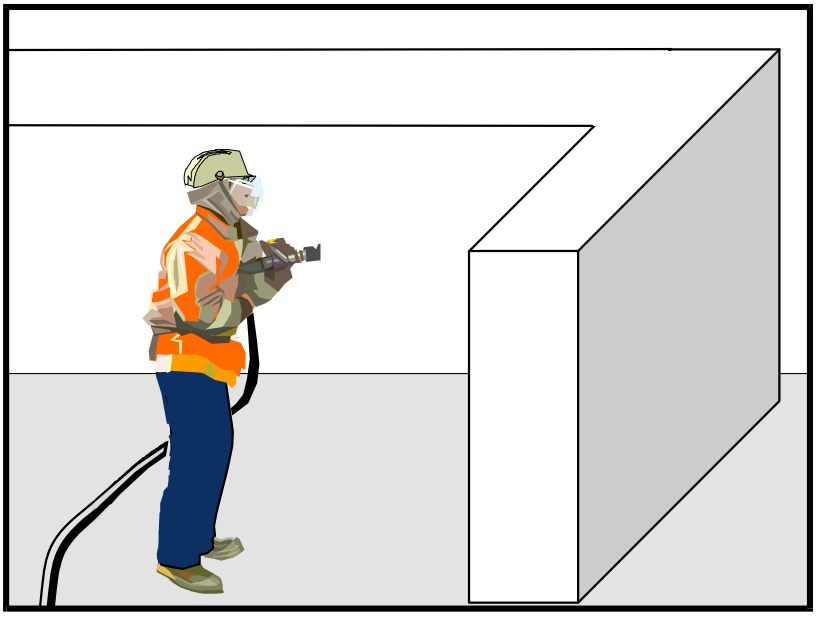
Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Concrete Finishing NS-13



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Concrete and its associated curing materials have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.
- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 Dewatering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Education

- Educate employees, subcontractors, and suppliers on proper concrete finishing techniques to prevent contact with discharge as described herein.
- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete finishing procedures.

Costs

These measures are generally of low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts concrete dust and debris as required by the General Permit.

- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.
- Inspect containment structures for damage prior to use and prior to onset of forecasted rain.

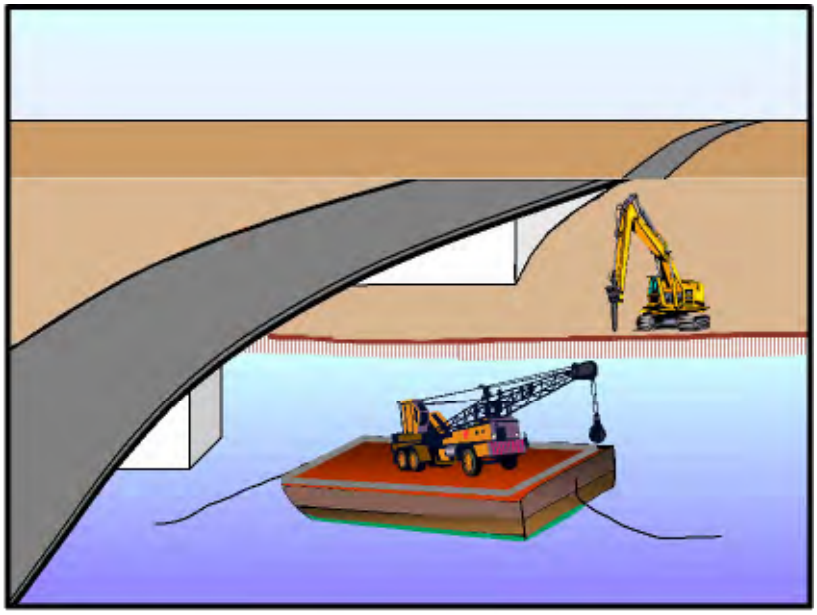
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Material Over Water NS-14



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse.

Suitable Applications

Applies where materials and equipment are used on barges, boats, docks, and other platforms over or adjacent to a watercourse including waters of the United States. These procedures should be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedances of water quality standards.

Limitations

Dredge and fill activities are regulated by the US Army Corps of Engineers and Regional Boards under Section 404/401 of the Clean Water Act.

Implementation

- Refer to WM-1, Material Delivery and Storage and WM-4, Spill Prevention and Control.
- Use drip pans and absorbent materials for equipment and vehicles and ensure that an adequate supply of spill clean up materials is available.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over

water bodies when the vehicle or equipment is expected to be idle for more than 1 hour.

- Maintain equipment in accordance with NS-10, Vehicle and Equipment Maintenance. If a leaking line cannot be repaired, remove equipment from over the water.
- Provide watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving the barge, platform, dock, etc.
- Secure all materials to prevent discharges to receiving waters via wind.
- Identify types of spill control measures to be employed, including the storage of such materials and equipment. Ensure that staff is trained regarding the use of the materials, deployment and access of control measures, and reporting measures.
- In case of spills, contact the local Regional Board as soon as possible but within 48 hours.
- Refer to WM-5, Solid Waste Management (non-hazardous) and WM-6, Hazardous Waste Management. Ensure the timely and proper removal of accumulated wastes
- Comply with all necessary permits required for construction within or near the watercourse, such as Regional Water Quality Control Board, U.S. Army Corps of Engineers, Department of Fish and Game or and other local permitting.
- Discharges to waterways should be reported to the Regional Water Quality Control Board immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures contained in SWPPP.

Costs

These measures are generally of low to moderate cost. Exceptions are areas for temporary storage of materials, engine fluids, or wastewater pump out.

Inspection and Maintenance

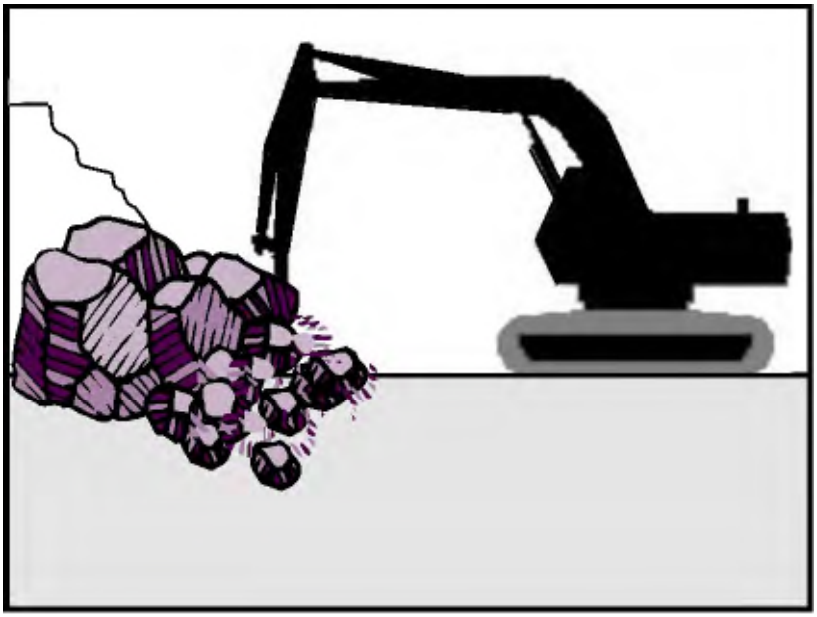
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement the appropriate measures for storage and use of materials and equipment.
- Inspect and maintain all associated BMPs and perimeter controls to ensure continuous protection of the water courses, including waters of the United States.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Demolition Adjacent to Water NS-15



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses.

Suitable Applications

Full bridge demolition and removal, partial bridge removal (barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

Limitations

None identified.

Implementation

- Refer to NS-5, Clear Water Diversion, to direct water away from work areas.
- Use attachments on construction equipment such as backhoes to catch debris from small demolition operations.
- Use covers or platforms to collect debris.
- Platforms and covers are to be approved by the owner.
- Stockpile accumulated debris and waste generated during demolition away from watercourses and in accordance with WM-3, Stockpile Management.
- Ensure safe passage of wildlife, as necessary.

- Discharges to waterways shall be reported to the Regional Water Quality Control Board immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures in the SWPPP.

- For structures containing hazardous materials, i.e., lead paint or asbestos, refer to BMP WM-6, Hazardous Waste Management. For demolition work involving soil excavation around lead-painted structures, refer to WM-7, Contaminated Soil Management.

Costs

Cost may vary according to the combination of practices implemented.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Any debris-catching devices shall be emptied regularly. Collected debris shall be removed and stored away from the watercourse and protected from runon and runoff.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Temporary Batch Plants NS-16

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

The construction of roads, bridges, retaining walls, and other large structures in remote areas, often requires temporary batch plant facilities to manufacture Portland Cement Concrete (PCC) or asphalt cement (AC). Temporary batch plant facilities typically consist of silos containing fly ash, lime, and cement; heated tanks of liquid asphalt; sand and gravel material storage areas; mixing equipment; above ground storage tanks containing concrete additives and water; and designated areas for sand and gravel truck unloading, concrete truck loading, and concrete truck washout. Proper control and use of equipment, materials, and waste products from temporary batch plant facilities will reduce the discharge of potential pollutants to the storm drain system or watercourses, reduce air emissions, and mitigate noise impacts.

The General Permit draft incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements). Many types of batch plant materials, including mortar, concrete, cement and block and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows which may cause an exceedence of the General Permit Requirements.

Suitable Applications

These procedures typically apply to construction sites where temporary batch plant facilities are used; however, some of the practices described are applicable to construction sites with general concrete use.

Limitations

The General Permit for discharges of stormwater associated with industrial activities (General Industrial Permit) may be applicable to temporary batch plants.

Specific permit requirements or mitigation measures such as Air Resources Board (ARB), Air Quality Management District (AQMD), Air Pollution Control District (APCD, Regional Water Quality Control Board (RWQCB), county ordinances and city ordinances may require alternative mitigation measures for temporary batch plants. Contact the local regulatory agencies to determine if a permit is required.

Implementation

Planning

- Temporary batch plants may be subject to the General Industrial Permit. To obtain a copy of this permit and the application forms, visit http://www.waterboards.ca.gov or contact the State Water Resources Control Board.
- Proper planning, design, and construction of temporary batch plants should be implemented to minimize potential water quality, air pollution, and noise impacts associated with temporary batch plants.
- BMPs and a Construction Site Monitoring Plan (CSMP) should be included in the project Stormwater Pollution Prevention Plan (SWPPP). BMPs should be implemented, inspected, and maintained in accordance with these plans.
- Temporary batch plants should be managed to comply with AQMD Statewide Registration Program and/or local AQMD Portable Equipment Registration requirements.
- Construct temporary batch plants downwind of existing developments whenever possible.
- Placement of access roads should be planned to mitigate water and air quality impacts.

Layout and Design

- Temporary batch plants should be properly located and designed to mitigate water quality impacts to receiving water bodies. Batch plants should be located away from watercourses, drainage courses, and drain inlets. Batch plants should be located to minimize the potential for stormwater runon onto the site.
- Temporary batch plant facilities (including associated stationary equipment and stockpiles) should be located at least 300 ft from any recreational area, school, residence, or other structure not associated with the construction project.
- Construct continuous interior AC or PCC berms around batch plant equipment (mixing equipment, silos, concrete drop points, conveyor belts, admixture tanks, etc.) to facilitate

proper containment and cleanup of releases. Rollover or flip top curbs or dikes should be placed at ingress and egress points (SE-12, Temporary Silt Dike).

- Direct runoff from the paved or unpaved portion of the batch plant into a sump and pipe to a lined washout area or dewatering tank.
- Direct stormwater and non-stormwater runoff from unpaved portions of batch plant facility to catchment ponds or tanks.
- Construct and remove concrete washout facilities in accordance with WM-8, Concrete Waste Management.
- Layout of a typical batch plant and associated BMP is located at the end of this BMP fact sheet.

Operational Procedures

- Washout of concrete trucks should be conducted in a designated area in accordance with WM-8, Concrete Waste Management.
- Do not dispose of concrete into drain inlets, the stormwater drainage system, or watercourses.
- Washing of concrete mixing and transport equipment (including concrete truck washout) should occur in a designated area in accordance with WM-8, Concrete Waste Management.
- Washing equipment, tools, or vehicles to remove PCC should be conducted in accordance with NS-7, Potable Water/Irrigation, NS-8, Vehicle and Equipment Cleaning, and WM-8, Concrete Waste Management..
- All dry material transfer points should be ducted through a fabric or cartridge type filter unless there are no visible emissions from the transfer point.
- Equip all bulk storage silos, including auxiliary bulk storage trailers, with fabric or cartridge type filter(s).
- Maintain silo vent filters in proper operating condition.
- Equip silos and auxiliary bulk storage trailers with dust-tight service hatches.
- Fabric dust collection system should be capable of controlling particulate matter in accordance with the California Air Resources Control Board and local Air Pollution Control District Regulations.
- Fabric dust collectors (except for vent filters) should be equipped with an operational pressure differential gauge to measure the pressure drop across the filters.
- All transfer points should be equipped with a wet suppression system to control fugitive particulate emissions unless there are no visible emissions.
- All conveyors should be covered, unless the material being transferred results in no visible emissions.

- There should be no visible emissions beyond the property line, while the equipment is being operated.
- Collect dust emissions from the loading of open-bodied trucks, at the drip point of dry batch plants, or dust emissions from the drum feed for central mix plants.
- Equip silos and auxiliary bulk storage trailers with a visible and/or audible warning mechanism to warn operators that the silo or trailer is full.
- All open-bodied vehicles transporting material should be loaded with a final layer of wet sand and the truck should be covered with a tarp to reduce emissions.

Tracking Control

- Plant roads (batch truck and material delivery truck roads) and areas between stockpiles and conveyor hoppers should be stabilized (TC-2, Stabilized Construction Roadway), watered, treated with dust-suppressant chemicals (WE-1, Wind Erosion Control), or paved with a cohesive hard surface that can be repeatedly swept, maintained intact, and cleaned as necessary to control dust emissions.
- Trucks should not track PCC from plants onto public roads. Use appropriate practices from TC-1, Stabilized Construction Entrance/Exit, to prevent tracking.

Materials Storage

- WM-1, Material Delivery and Storage, should be implemented at all batch plants using concrete components or compounds. An effective strategy is to cover and contain materials.
- WM-2, Material Use should be conducted in a way to minimize or eliminate the discharge of materials to storm drain system or watercourse.
- Ensure that finer materials are not dispersed into the air during operations, such as unloading of cement delivery trucks.
- Stockpiles should be covered and enclosed with perimeter sediment barriers per WM-3, Stockpile Management. Uncovered stockpiles should be sprayed with water and/or dust-suppressant chemicals as necessary to control dust emissions, unless the stockpiled material results in no visible emissions. An operable stockpile watering system should be onsite at all times.
- Store bagged and boxed materials on pallets and cover or store in a completely enclosed storage area on non-working days and prior to rain.
- Minimize stockpiles of demolished PCC by recycling them in a timely manner.
- Provide secondary containment for liquid materials (WM-1, Material Delivery and Storage, WM-10, Liquid Waste Management). Containment should provide sufficient volume to contain precipitation from a 25-year storm plus 10% of the aggregate volume of all containers or plus 100% of the largest container, whichever is greater.
- Handle solid and liquid waste in accordance with WM-5, Solid Waste Management, WM-10, Liquid Waste Management, and WM-8, Concrete Waste Management.

- Maintain adequate supplies of spill cleanup materials and train staff to respond to spills per WM-4, Spill Prevention and Control.
- Immediately contain and clean up spilled cement and fly ash and contain.

Equipment Maintenance

- Equipment should be maintained to prevent fluid leaks and spills per NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance.
- Maintain adequate supplies of spill cleanup materials and train staff to respond to spills per WM-4, Spill Prevention and Control.
- Incorporate other BMPs such as WM-5, Solid Waste Management, WM-6, Hazardous Waste Management, and WM-10, Liquid Waste Management.

Costs

Costs will vary depending on the size of the facility and combination of BMPs implemented.

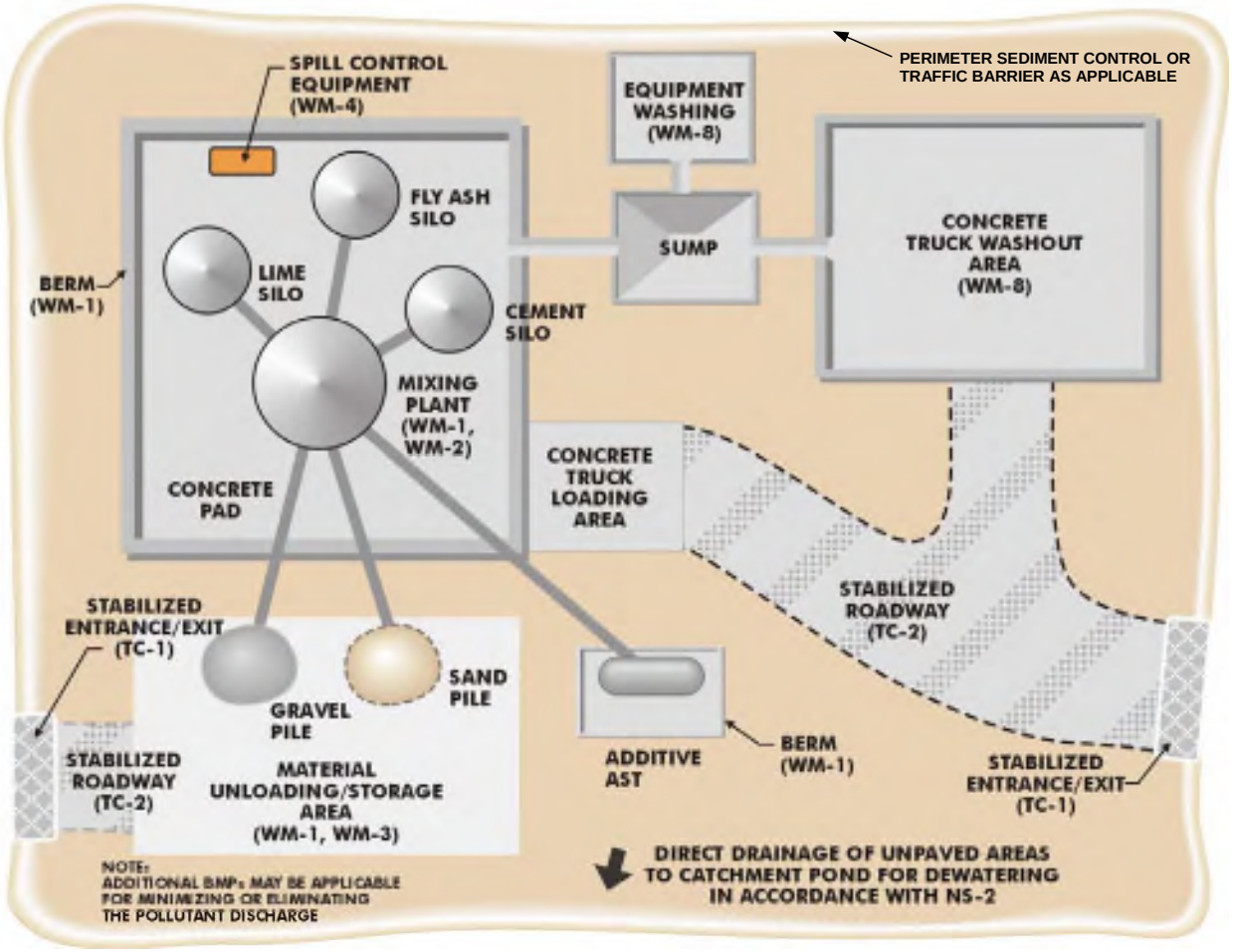
Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts cementitious materials or fly ash as required by the General Permit.
- Inspect and repair equipment (for damaged hoses, fittings, and gaskets).
- Inspect and maintain a Stabilized Construction Entrance/Exit (TC-1) as needed.
- Inspect and maintain stabilized haul roads as needed (TC-2, Stabilized Construction Roadway).
- Inspect and maintain materials and waste storage areas as needed.

References

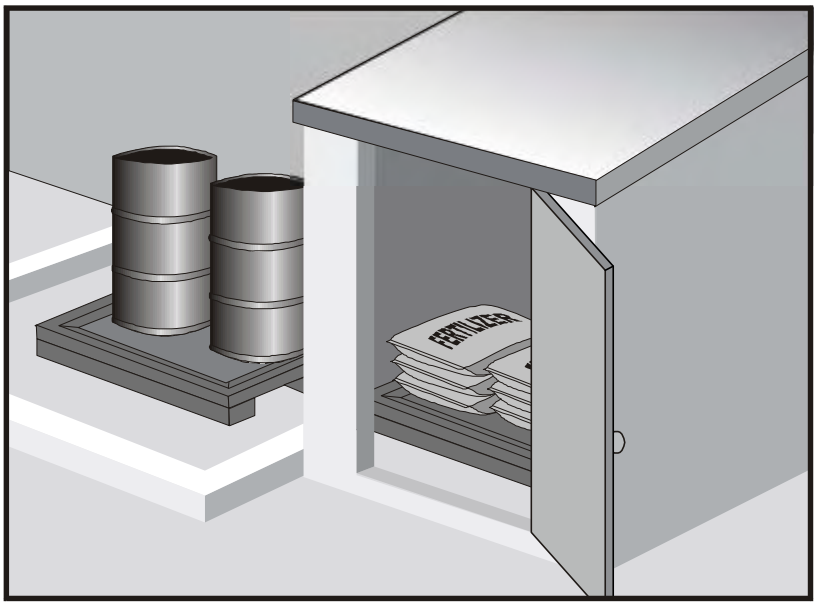
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



Typical Temporary Batch

Material Delivery and Storage WM-1



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in watertight containers and/or a completely enclosed designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease

- Asphalt and concrete components
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Chemicals must be stored in water tight containers with appropriate secondary containment or in a storage shed.
- When a material storage area is located on bare soil, the area should be lined and bermed.
- Use containment pallets or other practical and available solutions, such as storing materials within newly constructed buildings or garages, to meet material storage requirements.
- Stack erodible landscape material on pallets and cover when not in use.
- Contain all fertilizers and other landscape materials when not in use.
- Temporary storage areas should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be available on-site for all materials stored that have the potential to effect water quality.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located away from waterways, if possible.
    - Avoid transport near drainage paths or waterways.
    - Surround with earth berms or other appropriate containment BMP. See EC-9, Earth Dikes and Drainage Swales.
    - Place in an area that will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.

- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- Keep ample spill cleanup supplies appropriate for the materials being stored. Ensure that cleanup supplies are in a conspicuous, labeled area.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Materials should be covered prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or completely enclosed storage sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous wastes.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.
- If spills or leaks of materials occur that are not contained and could discharge to surface waters, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep storage areas clean and well organized, including a current list of all materials onsite.
- Inspect labels on containers for legibility and accuracy.

- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

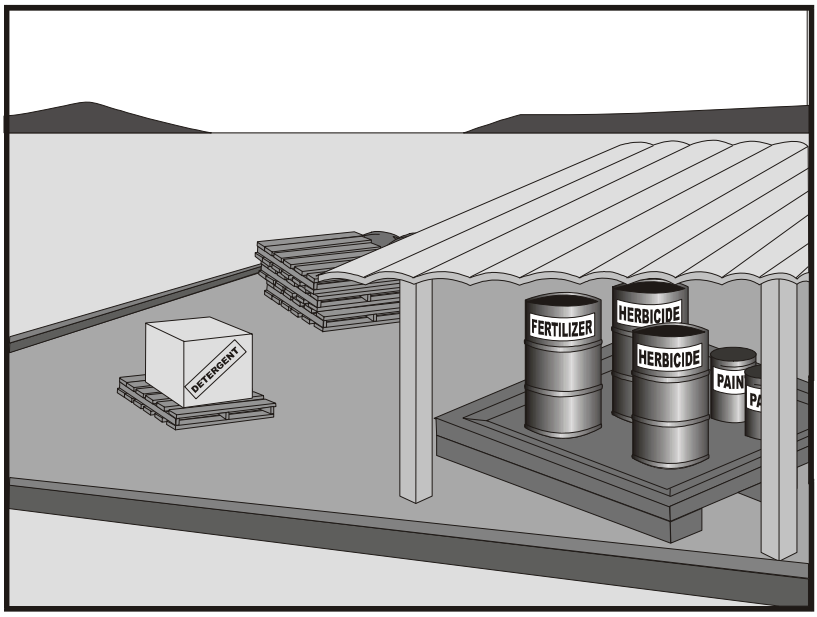
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Material Use WM-2



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Other materials that may be detrimental if released to the environment

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- The preferred method of termiticide application is soil injection near the existing or proposed structure foundation/slab; however, if not feasible, soil drench application of termiticides should follow EPA label guidelines and the following recommendations (most of which are applicable to most pesticide applications):
    - Do not treat soil that is water-saturated or frozen.
    - Application shall not commence within 24-hours of a predicted precipitation event with a 40% or greater probability. Weather tracking must be performed on a daily basis prior to termiticide application and during the period of termiticide application.
    - Do not allow treatment chemicals to runoff from the target area. Apply proper quantity to prevent excess runoff. Provide containment for and divert stormwater from application areas using berms or diversion ditches during application.
    - Dry season: Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
    - Wet season: Do not apply within 50 feet of storm drains or aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds) unless a vegetative buffer is present (if so, refer to dry season requirements).
    - Do not make on-grade applications when sustained wind speeds are above 10 mph (at application site) at nozzle end height.
    - Cover treatment site prior to a rain event in order to prevent run-off of the pesticide into non-target areas. The treated area should be limited to a size that can be backfilled and/or covered by the end of the work shift. Backfilling or covering of the treated area shall be done by the end of the same work shift in which the application is made.
    - The applicator must either cover the soil him/herself or provide written notification of the above requirement to the contractor on site and to the person commissioning the

application (if different than the contractor). If notice is provided to the contractor or the person commissioning the application, then they are responsible under the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) to ensure that: 1) if the concrete slab cannot be poured over the treated soil within 24 hours of application, the treated soil is covered with a waterproof covering (such as polyethylene sheeting), and 2) the treated soil is covered if precipitation is predicted to occur before the concrete slab is scheduled to be poured.

- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydraulic application. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals before predicted rainfall.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or contain for proper disposal off site. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.
- Document the location, time, chemicals applied, and applicator's name and qualifications.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.
- Discontinue use of erodible landscape material within 2 days prior to a forecasted rain event and materials should be covered and/or bermed.

- Provide containment for material use areas such as masons' areas or paint mixing/preparation areas to prevent materials/pollutants from entering stormwater.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Ensure employees and subcontractors throughout the job are using appropriate practices.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

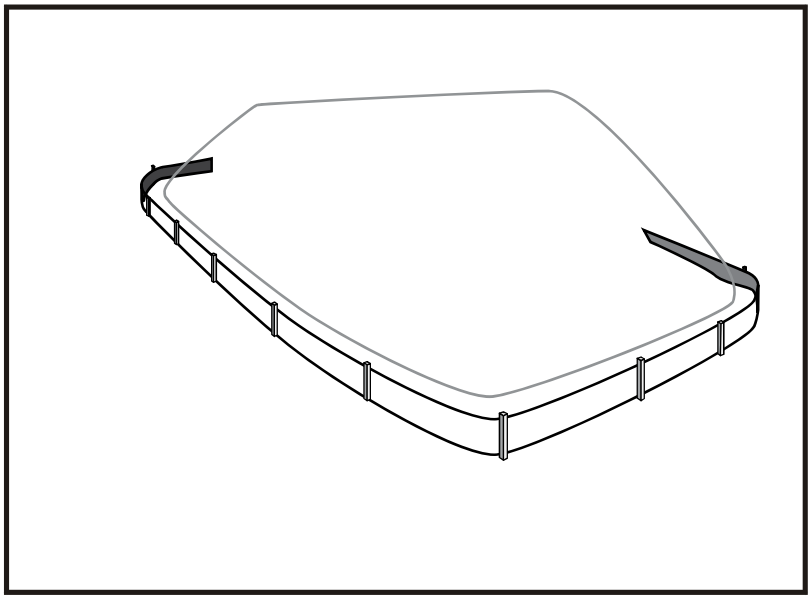
Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Comments on Risk Assessments Risk Reduction Options for Cypermethrin: Docket No. OPP–2005–0293; California Stormwater Quality Association (CASQA) letter to USEPA, 2006.Environmental Hazard and General Labeling for Pyrethroid Non-Agricultural Outdoor Products, EPA-HQ-OPP-2008-0331-0021; USEPA, 2008.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stockpile Management WM-3



Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, soil amendments, sand, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other loose materials.

Limitations

- Plastic sheeting as a stockpile protection is temporary and hard to manage in windy conditions. Where plastic is used, consider use of plastic tarps with nylon reinforcement which may be more durable than standard sheeting.
- Plastic sheeting can increase runoff volume due to lack of infiltration and potentially cause perimeter control failure.
- Plastic sheeting breaks down faster in sunlight.
- The use of plastic materials should be avoided when feasible and photodegradable plastics should not be used.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- On larger sites, a minimum of 50 ft separation from concentrated flows of stormwater, drainage courses, and inlets is recommended.
- All stockpiles are required to be protected immediately if they are not scheduled to be used within 14 days.
- Protect all stockpiles from stormwater run-on using temporary perimeter sediment barriers such as compost berms (SE-13), temporary silt dikes (SE-12), fiber rolls (SE-5), silt fences (SE-1), sandbags (SE-8), gravel bags (SE-6), or biofilter bags (SE-14). Refer to the individual fact sheet for each of these controls for installation information.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.
- Ensure that stockpile coverings are installed securely to protect from wind and rain.
- Some plastic covers withstand weather and sunlight better than others. Select cover materials or methods based on anticipated duration of use.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- Cover and project soil stockpiles with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- Consider temporary vegetation for topsoil piles that will be stockpiled for extended periods.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- Provide covers and protect these stockpiles with a temporary perimeter sediment barrier at all times.

Stockpiles of "cold mix"

- Cover cold mix stockpiles and place them on plastic sheeting (or comparable material) and surround the stockpiles with a berm all times.

Stockpiles of fly ash, stucco, hydrated lime

- Cover stockpiles of materials that may raise the pH of runoff (i.e., basic materials) with plastic and surround the stockpiles with a berm at all times.

Stockpiles/Storage of wood (Pressure treated with chromated copper arsenate or ammoniacal copper zinc arsenate)

- Cover treated wood with plastic sheeting (or comparable material) and surround with a berm at all times.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected as follows:

- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" and treated wood, and basic materials should be placed on and covered with plastic sheeting or comparable material and surrounded by a berm prior to the onset of precipitation.
- The downstream perimeter of an active stockpile should be protected with a linear sediment barrier or berm and runoff should be diverted around or away from the stockpile on the upstream perimeter.

Costs

For cost information associated with stockpile protection refer to the individual erosion or sediment control BMP fact sheet considered for implementation (For example, refer to SE-1 Silt Fence for installation of silt fence around the perimeter of a stockpile.)

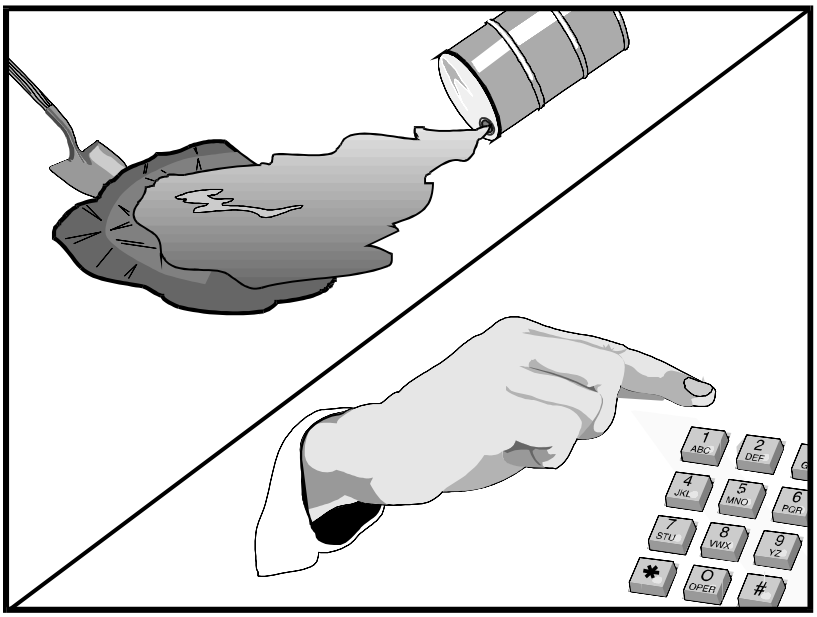
Inspection and Maintenance

- Stockpiles must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- It may be necessary to inspect stockpiles covered with plastic sheeting more frequently during certain conditions (for example, high winds or extreme heat).
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.
- Sediment shall be removed when it reaches one-third of the barrier height.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Spill Prevention and Control WM-4



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

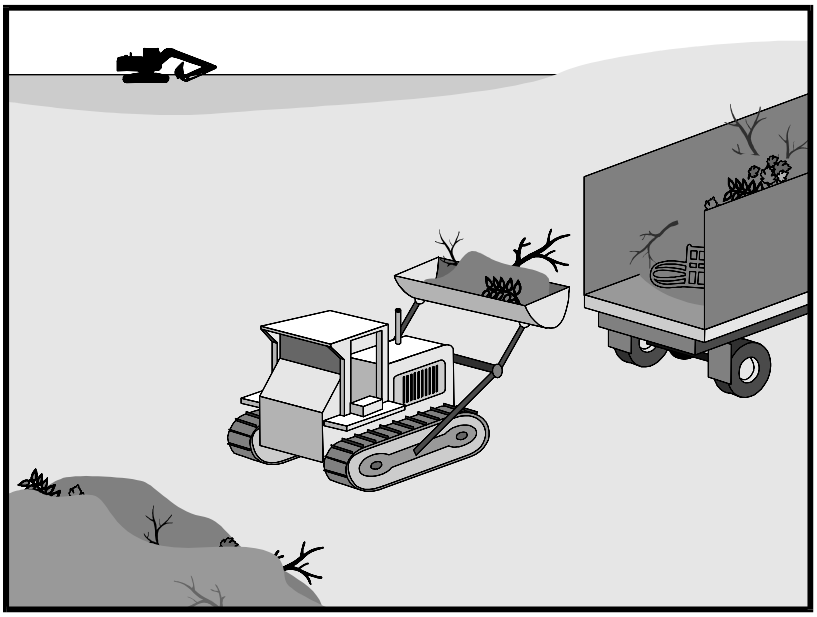
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Solid Waste Management WM-5



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials
- Highway planting wastes, including vegetative material,

plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Cover waste containers at the end of each work day and when it is raining.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

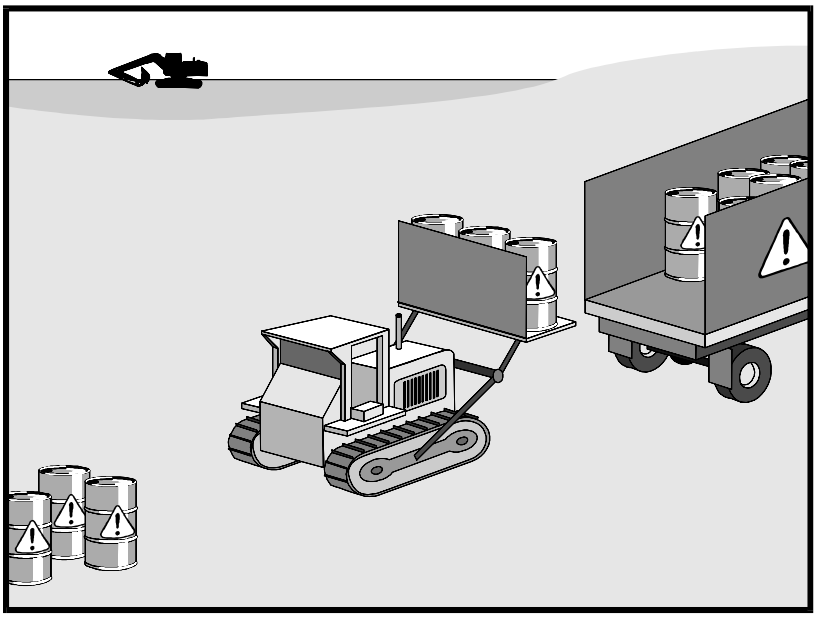
References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Hazardous Waste Management WM-6



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Concrete Curing Compounds
- Palliatives
- Septic Wastes
- Stains
- Wood Preservatives
- Asphalt Products
- Pesticides
- Acids
- Paints
- Solvents
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.
- Unless watertight, containers of dry waste should be stored on pallets.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.
- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.
- The following actions should be taken with respect to temporary contaminant:
  - Ensure that adequate hazardous waste storage volume is available.
  - Ensure that hazardous waste collection containers are conveniently located.
  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
  - Minimize production or generation of hazardous materials and hazardous waste on the job site.
  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.
  - Segregate potentially hazardous waste from non-hazardous construction site debris.
  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References

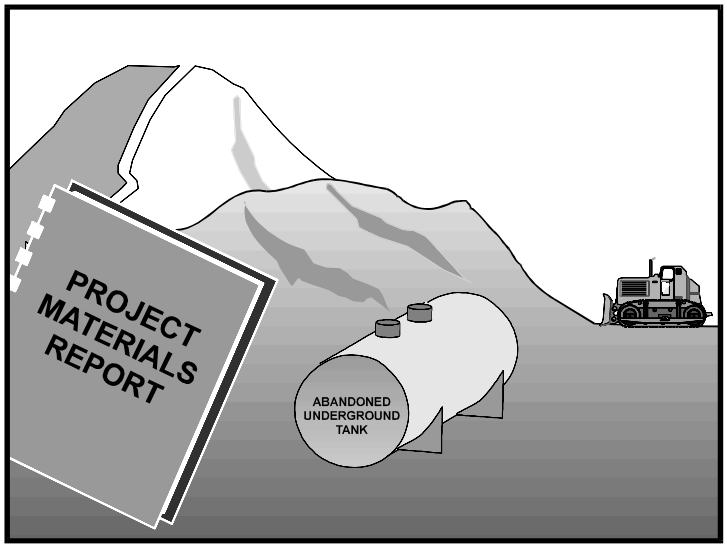
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Contaminated Soil Management WM-7



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the

plans, specifications, and SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

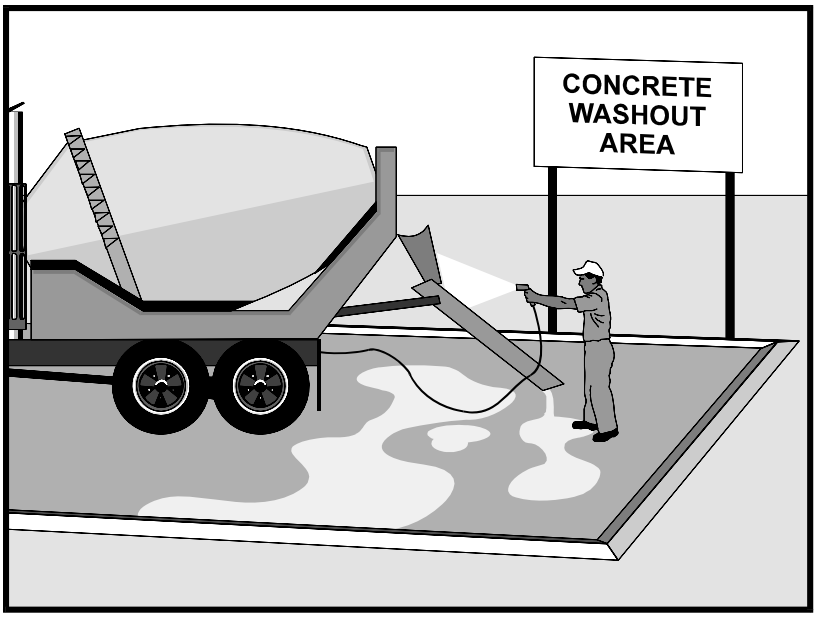
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Concrete Waste Management WM-8



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent the discharge of pollutants to stormwater from concrete waste by conducting washout onsite or offsite in a designated area, and by employee and subcontractor training.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials, including mortar, concrete, stucco, cement and block and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows and raising pH to levels outside the accepted range.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result from demolition activities.
- Slurries containing portland cement concrete (PCC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition.

- Concrete trucks and other concrete-coated equipment are washed onsite.
- Mortar-mixing stations exist.
- Stucco mixing and spraying .
- See also NS-8, Vehicle and Equipment Cleaning.

Limitations

- Offsite washout of concrete wastes may not always be possible.
- Multiple washouts may be needed to assure adequate capacity and to allow for evaporation.

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas. Refer to WM-1, Material Delivery and Storage for more information.
- Avoid mixing excess amounts of concrete.
- Perform washout of concrete trucks in designated areas only, where washout will not reach stormwater.
- Do not wash out concrete trucks into storm drains, open ditches, streets, streams or onto the ground. Trucks should always be washed out into designated facilities.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
  - On larger sites, it is recommended to locate washout areas at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Washout wastes into the temporary washout where the concrete can set, be broken up, and then disposed properly.
  - Washout should be lined so there is no discharge into the underlying soil.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.
- See typical concrete washout installation details at the end of this fact sheet.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.

- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.
- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.

Concrete Demolition Wastes

- Stockpile concrete demolition waste in accordance with BMP WM-3, Stockpile Management.
- Dispose of or recycle hardened concrete waste in accordance with applicable federal, state or local regulations.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below).
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Saw-cut concrete slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine or by sweeping. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.
- Concrete slurry residue should be disposed in a temporary washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Temporary washout facilities should be lined to prevent discharge to the underlying ground or surrounding area.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of or recycled offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of or recycle hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft; however, smaller sites or jobs may only need a smaller washout facility. With any washout, always maintain a sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Materials used to construct the washout area should conform to the provisions detailed in their respective BMPs (e.g., SE-8 Sandbag Barrier).
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
  - Alternatively, portable removable containers can be used as above grade concrete washouts. Also called a “roll-off”; this concrete washout facility should be properly sealed to prevent leakage, and should be removed from the site and replaced when the container reaches 75% capacity.
- Temporary Concrete Washout Facility (Type Below Grade)
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- The base of a washout facility should be free of rock or debris that may damage a plastic liner.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and properly disposed or recycled in accordance with federal, state or local regulations. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and properly disposed or recycled in accordance with federal, state or local regulations..

- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures. Roll-off concrete washout facilities can be more costly than other measures due to removal and replacement; however, provide a cleaner alternative to traditional washouts. The type of washout facility, size, and availability of materials will determine the cost of the washout.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and properly disposed or recycled in accordance with federal, state or local regulations.

- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

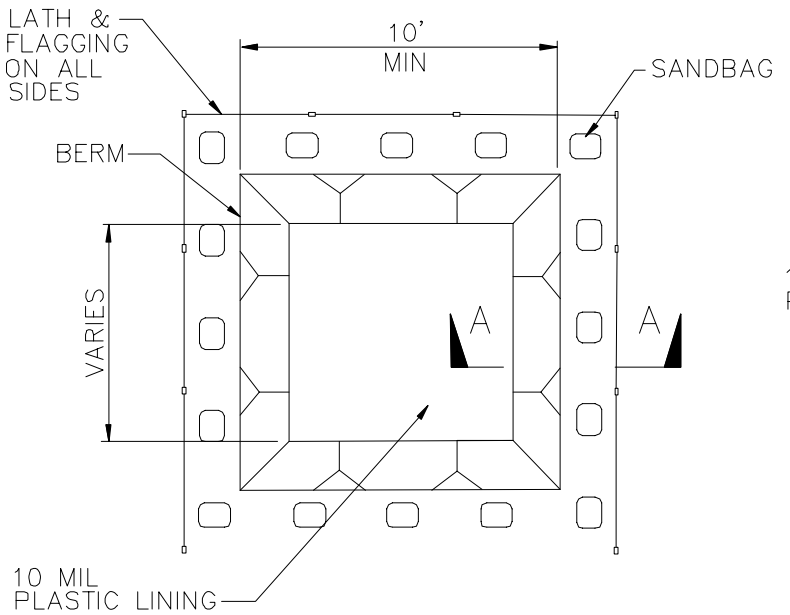
- Inspect washout facilities for damage (e.g. torn liner, evidence of leaks, signage, etc.). Repair all identified damage.

References

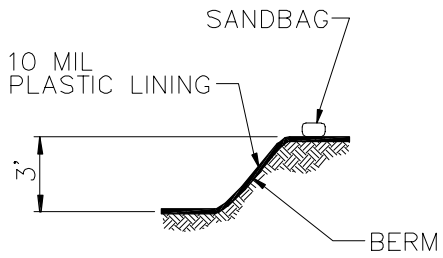
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000, Updated March 2003.

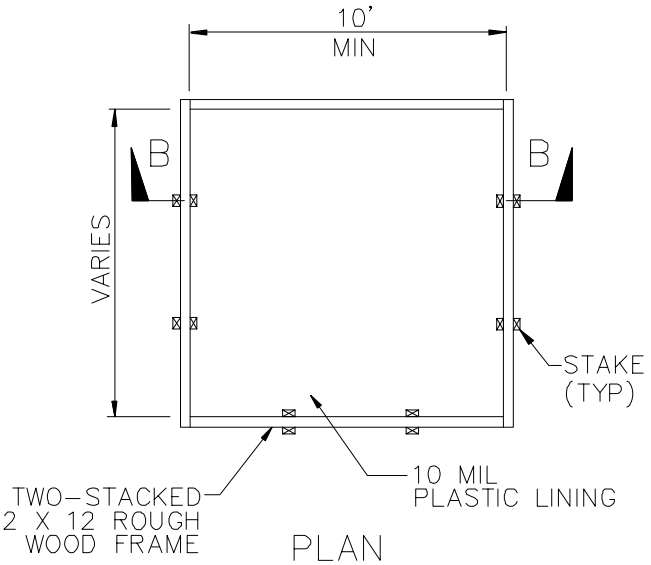
Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



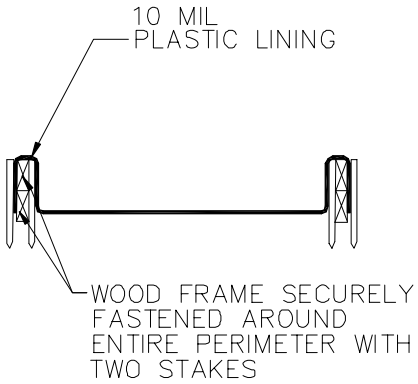
PLAN
NOT TO SCALE
TYPE "BELOW GRADE"



SECTION A–A
NOT TO SCALE



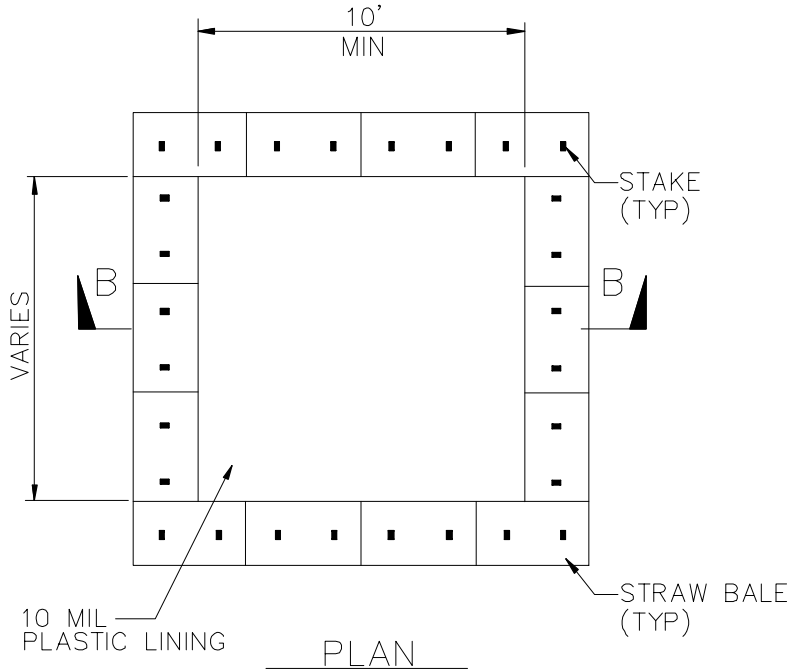
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"



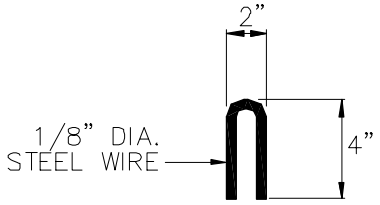
SECTION B–B
NOT TO SCALE

NOTES

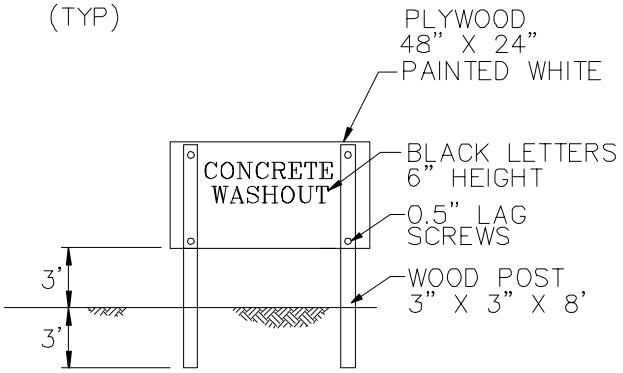
1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



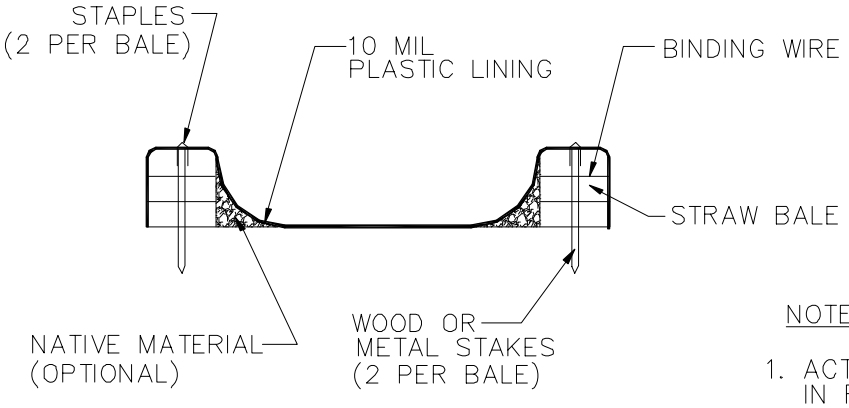
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"
WITH STRAW BALES



STAPLE DETAIL



CONCRETE WASHOUT
SIGN DETAIL
(OR EQUIVALENT)

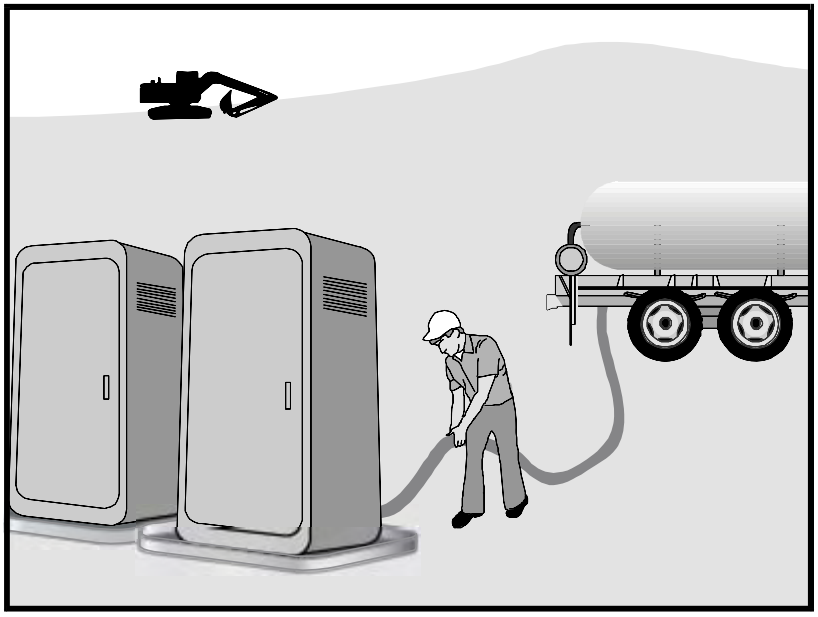


SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

Sanitary/Septic Waste Management WM-9



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.

- Temporary sanitary facilities must be equipped with containment to prevent discharge of pollutants to the stormwater drainage system of the receiving water.
- Consider safety as well as environmental implications before placing temporary sanitary facilities.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.
- If a spill does occur from a temporary sanitary facility, follow federal, state and local regulations for containment and clean-up.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce the use of sanitary facilities (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

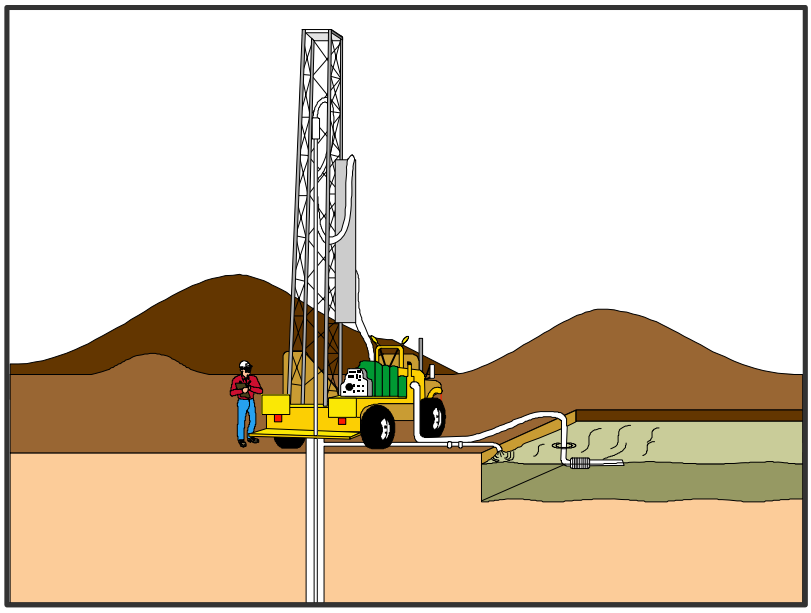
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.
- If spills or leaks from sanitary or septic facilities occur that are not contained and discharge from the site, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Liquid Waste Management WM-10



Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Liquid waste management includes procedures and practices to prevent discharge of pollutants to the storm drain system or to watercourses as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

Suitable Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous by-products, residuals, or wastes:

- Drilling slurries and drilling fluids
- Grease-free and oil-free wastewater and rinse water
- Dredgings
- Other non-stormwater liquid discharges not permitted by separate permits

Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations or to requirements of other permits secured for the construction project (e.g., NPDES permits, Army Corps permits, Coastal Commission permits, etc.).
- Liquid waste management does not apply to dewatering operations (NS-2 Dewatering Operations), solid waste management (WM-5, Solid Waste Management), hazardous wastes (WM-6, Hazardous Waste Management), or concrete slurry residue (WM-8, Concrete Waste

Management).

- Typical permitted non-stormwater discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and discharges or flows from emergency fire fighting activities.

Implementation

General Practices

- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.
- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage device, waterway, or receiving water.
- Educate employees and subcontractors on liquid waste generating activities and liquid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Verify which non-stormwater discharges are permitted by the statewide NPDES permit; different regions might have different requirements not outlined in this permit.
- Apply NS-8, Vehicle and Equipment Cleaning for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of.
- If an appropriate location is available, drilling residue and drilling fluids that are exempt under Title 23, CCR § 2511(g) may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in WM-8, Concrete Waste Management.
- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.
- Liquid wastes should be contained in a controlled area such as a holding pit, sediment basin, roll-off bin, or portable tank.
- Containment devices must be structurally sound and leak free.
- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.

- Precautions should be taken to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in WM-4, Spill Prevention and Control.

- Containment areas or devices should not be located where accidental release of the contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes that have the potential to affect the storm drainage system (such as wash water and rinse water from cleaning walls or pavement), before they run off a surface.

- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.

- Use a sediment trap (SE-3, Sediment Trap) for capturing and treating sediment laden liquid waste or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- A typical method to handle liquid waste is to dewater the contained liquid waste, using procedures such as described in NS-2, Dewatering Operations, and SE-2, Sediment Basin, and dispose of resulting solids per WM-5, Solid Waste Management.

- Methods of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, Environmental Impact Reports, 401 or 404 permits, and local agency discharge permits, etc. Review the SWPPP to see if disposal methods are identified.

- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management.

- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

Costs

Prevention costs for liquid waste management are minimal. Costs increase if cleanup or fines are involved.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task. Dispose of any solids as described in WM-5, Solid Waste Management.
- Inspect containment areas and capturing devices and repair as needed.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

APPENDIX G
BMP INSPECTION FORM

BMP INSPECTION REPORT

Date and Time of Inspection:	Date Report Written:

Inspection Type: (Circle one)	Weekly *Complete Parts I,II,III and VII*	Pre-Storm *Complete Parts I,II,III,IV and VII*	During Rain Event *Complete Parts I, II, III, V, and VII*	Post-Storm *Complete Parts I,II,III,VI and VII*

Part I. General Information

Site Information

Construction Site Name:	
Construction stage and completed activities:	Approximate area of site that is exposed:

Photos Taken: (Circle one)	Yes	No	Photo Reference IDs:

Weather

Estimate storm beginning: (date and time)	Estimate storm duration: (hours)
Estimate time since last storm: (days or hours)	Rain gauge reading and location: (in)

Is a "Qualifying Event" predicted or did one occur (i.e., 0.5" rain with 48-hrs or greater between events)? (Y/N)
If yes, summarize forecast:

Exemption Documentation (explanation required if inspection could not be conducted).

Visual inspections are not required outside of business hours or during dangerous weather conditions such as flooding or electrical storms.

Inspector Information

Inspector Name:	Inspector Title:

Signature:	Date:

Part II. BMP Observations. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level __1___ Sites	Failures or other short comings (yes, no, N/A)	Action Required (yes/no)	Action Implemented (Date)
Good Housekeeping for Construction Materials			
Inventory of products (excluding materials designed to be outdoors)			
Stockpiled construction materials not actively in use are covered and bermed			
All chemicals are stored in watertight containers with appropriate secondary containment, or in a completely enclosed storage shed			
Construction materials are minimally exposed to precipitation			
BMPs preventing the offsite tracking of materials are implemented and properly effective			
Good Housekeeping for Waste Management			
Wash/rinse water and materials are prevented from being disposed into the storm drain system			
Portable toilets are contained to prevent discharges of waste			
Sanitation facilities are clean and with no apparent for leaks and spills			
Equipment is in place to cover waste disposal containers at the end of business day and during rain events			
Discharges from waste disposal containers are prevented from discharging to the storm drain system / receiving water			
Stockpiled waste material is securely protected from wind and rain if not actively in use			
Procedures are in place for addressing hazardous and non-hazardous spills			
Appropriate spill response personnel are assigned and trained			
Equipment and materials for cleanup of spills is available onsite			
Washout areas (e.g., concrete) are contained appropriately to prevent discharge or infiltration into the underlying soil			
Good Housekeeping for Vehicle Storage and Maintenance			
Measures are in place to prevent oil, grease, or fuel from leaking into the ground, storm drains, or surface waters			
All equipment or vehicles are fueled, maintained, and stored in a designated area with appropriate BMPs			
Vehicle and equipment leaks are cleaned immediately and disposed of properly			

Part II. BMP Observations Continued. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level ___1__ Sites	Adequately designed, implemented and effective (yes, no, N/A)	Action Required (yes/no)	Action Implemente d (Date)
Good Housekeeping for Landscape Materials			
Stockpiled landscape materials such as mulches and topsoil are contained and covered when not actively in use			
Erodible landscape material has not been applied 2 days before a forecasted rain event or during an event			
Erodible landscape materials are applied at quantities and rates in accordance with manufacturer recommendations			
Bagged erodible landscape materials are stored on pallets and covered			
Good Housekeeping for Air Deposition of Site Materials			
Good housekeeping measures are implemented onsite to control the air deposition of site materials and from site operations			
Non-Storm Water Management			
Non-storm water discharges are properly controlled			
Vehicles are washed in a manner to prevent non-storm water discharges to surface waters or drainage systems			
Streets are cleaned in a manner to prevent unauthorized non-storm water discharges to surface waters or drainage systems.			
Erosion Controls			
Wind erosion controls are effectively implemented			
Effective soil cover is provided for disturbed areas inactive (i.e., not scheduled to be disturbed for 14 days) as well as finished slopes, open space, utility backfill, and completed lots			
The use of plastic materials is limited in cases when a more sustainable, environmentally friendly alternative exists.			
Sediment Controls			
Perimeter controls are established and effective at controlling erosion and sediment discharges from the site			
Entrances and exits are stabilized to control erosion and sediment discharges from the site			
Sediment basins are properly maintained			
Linear sediment control along toe of slope, face of slope an at grade breaks (Risk Level 2 & 3 Only)			
Limit construction activity to and from site to entrances and exits that employ effective controls to prevent offsite tracking (Risk Level 2 & 3 Only)			

Part II. BMP Observations Continued. Describe deficiencies in Part III.			
Minimum BMPs for Risk Level ___1__ Sites	Adequately designed, implemented and effective (yes, no, N/A)	Action Required (yes/no)	Action Implemente d (Date)
Sediment Controls			
Ensure all storm, drain inlets and perimeter controls, runoff control BMPs and pollutants controls at entrances and exits are maintained and protected from activities the reduce their effectiveness (Risk Level 2 & 3 Only)			
Inspect all immediate access roads daily (Risk Level 2 & 3 Only)			
Run-On and Run-Off Controls			
Run-on to the site is effectively managed and directed away from all disturbed areas.			
Other			
Are the project SWPPP and BMP plan up to date, available on-site and being properly implemented?			

Part III. Descriptions of BMP Deficiencies		
Deficiency	**Repairs Implemented: Note - Repairs must begin within 72 hours of identification and, complete repairs as soon as possible.**	
	Start Date	**Action**
1.		
2.		
3.		
4.		

Part IV. Additional Pre-Storm Observations. Note the presence or absence of floating and suspended materials, sheen, discoloration, turbidity, odors, and source(s) of pollutants(s).	
	Yes, No, N/A
Do storm water storage and containment areas have adequate freeboard? If no, complete Part III.	
Are drainage areas free of spills, leaks, or uncontrolled pollutant sources? If no, complete Part VII and describe below.	
Notes:	
Are storm water storage and containment areas free of leaks? If no, complete Parts III and/or VII and describe below.	
Notes:	

Part V. Additional During Storm Observations. If BMPs cannot be inspected during inclement weather, list the results of visual inspections at all relevant outfalls, discharge points, and downstream locations. Note odors or visible sheen on the surface of discharges. Complete Part VII (Corrective Actions) as needed.	
Outfall, Discharge Point, or Other Downstream Location	
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description
Location	Description

Part VI. Additional Post-Storm Observations. **Visually observe (inspect) storm water discharges at all discharge locations within two business days (48 hours) after each qualifying rain event, and observe (inspect) the discharge of stored or contained storm water that is derived from and discharged subsequent to a qualifying rain event producing precipitation of ½ inch or more at the time of discharge. Complete Part VII (Corrective Actions) as needed.**	
Discharge Location, Storage or Containment Area	**Visual Observation**

Part VII. Additional Corrective Actions Required. **Identify additional corrective actions not included with BMP Deficiencies (Part III) above. Note if SWPPP change is required.**	
Required Actions	**Implementation Date**

APPENDIX H
TRAINING REPORTING FORM

Trained Contractor Personnel Log

Storm Water Management Training Log and Documentation

Project Name: _____
WDID #: _____

Storm Water Management Topic: (check as appropriate)

☐ Erosion Control ☐ Sediment Control
☐ Wind Erosion Control ☐ Tracking Control
☐ Non-Storm Water Management ☐ Waste Management and Materials Pollution Control
☐ Storm Water Sampling

Specific Training Objective: _____

Location: _____ Date: _____

Instructor:_____ Telephone: _____

Course Length (hours): _____

Attendee Roster (Attach additional forms if necessary)

Name	Company	Phone

As needed, add proof of external training (e.g., course completion certificates, credentials for QSP, QSD).

APPENDIX I
RESPONSIBLE PARTIES

Identification of QSP

Project Name: _____

WDID #: _____

The following are QSPs associated with this project

Name of Personnel(1)	Company	Date

(1) If additional QSPs are required on the job site add additional lines and include information here

APPENDIX J
CONTRACTORS AND SUBCONTRACTORS

APPENDIX G
BIOLOGICAL ASSESSMENT

APPENDIX G

REVISED BIOLOGICAL ASSESSMENT

AREA OF INVESTIGATION 14
NON-TIME-CRITICAL REMOVAL ACTION

December 2017

Prepared for:

National Aeronautics and Space Administration,
Ames Research Center,
Moffett Field, California

Prepared by:

Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... G-vi

EXECUTIVE SUMMARY G-ES-1

1.0 INTRODUCTION G-1

1.1 BACKGROUND AND HISTORY G-3

1.2 PURPOSE, NEED, AND OBJECTIVES G-6

2.0 PROPOSED ACTION G-9

2.1 PROPOSED ACTION DESCRIPTION G-9

2.1.1 Pilot Study G-11

2.1.2 Full-Scale Investigation G-19

2.1.3 Removal G-23

2.2 DEFINITION OF THE ACTION AREA G-34

2.3 CURRENT MANAGEMENT DIRECTION/REGULATORY SETTING G-34

2.4 FEDERAL CONSULTATION ACTION HISTORY G-35

2.5 CONSERVATION MEASURES IN PLACE G-36

2.5.1 USFWS-Approved Biologist G-36

2.5.2 Biological Resources Conservation Measures G-38

2.5.3 Species-Specific Measures G-40

3.0 EXISTING CONDITIONS AND DESCRIPTION OF THE SPECIFIC AREA AFFECTED BY THE ACTION G-45

3.1 REGIONAL SETTING G-45

3.2 ACTION AREA EXISTING CONDITIONS G-46

4.0 DESCRIPTION OF LISTED SPECIES OR CRITICAL HABITAT THAT MAY BE AFFECTED BY THE ACTION G-51

4.1 BIRDS G-51

4.1.1 Western Snowy Plover (*Charadrius nivosus nivosus*) G-51

4.1.2 California Least Tern (*Sterna antillarum browni*) G-54

4.1.3 California Clapper Rail (*Rallus longirostris obsoletus*) G-55

4.2 MAMMALS G-57

4.2.1 Salt Marsh Harvest Mouse (*Reithrodontomys raviventris subsp. raviventris*) G-57

4.3 SPECIES CONSIDERED BUT ELIMINATED G-60

TABLE OF CONTENTS (CONTINUED)

5.0 ANALYSIS OF EFFECTS AND DESCRIPTION OF THE MANNER IN WHICH THE ACTION MAY AFFECT LISTED AND/OR PROPOSED SPECIES AND/OR CRITICAL HABITAT G-62

5.1 DIRECT AND INDIRECT ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES G-63

5.1.1 Birds G-63

5.1.2 Mammals G-74

6.0 CUMULATIVE EFFECTS ON THREATENED AND ENDANGERED SPECIES OR CRITICAL HABITATS G-80

7.0 CONCLUSION AND DETERMINATION OF EFFECTS FOR SPECIES AND DESIGNATED CRITICAL HABITAT G-80

7.1 WESTERN SNOWY PLOVER G-81

7.2 CALIFORNIA LEAST TERN G-81

7.3 CALIFORNIA CLAPPER RAIL G-82

7.4 SALT MARSH HARVEST MOUSE G-82

8.0 REFERENCES G-83

9.0 LIST OF PREPARERS G-90

TABLES

ES-1 SUMMARY OF EFFECTS OF AOI 14 FSFA PILOT STUDY AND FULL-SCALE INVESTIGATION SAMPLING, AND REMOVAL ACTION G-ES-3

1 AOI 14 CLEANUP GOALS G-8

2 PILOT-STUDY EQUIPMENT—ESTIMATED NOISE AND VIBRATIONS G-18

3 FULL-SCALE INVESTIGATION EQUIPMENT—ESTIMATED NOISE AND VIBRATIONS G-20

4 REMOVAL EQUIPMENT—ESTIMATED NOISE AND VIBRATIONS G-28

5 BMP IMPLEMENTATION SCHEDULE G-30

6 AOI 14 FSFA REMOVAL ACTION ESTIMATED HABITAT LOSS AND DISTURBANCE G-78

7 SUMMARY OF EFFECTS OF AOI 14 FSFA PILOT STUDY AND FULL-SCALE INVESTIGATION SAMPLING, AND REMOVAL G-81

FIGURES

1 AOI 14 SITE LOCATION G-4

2 AOI 14 SITE FEATURES G-5

3 AOI 14 ICAM SAMPLING LOCATIONS G-7

4 PROPOSED INVESTIGATION AREA GRID AND PREVIOUS SAMPLING LOCATIONS G-10

5 PROPOSED PILOT STUDY SAMPLING LOCATIONS G-12

6 STAGING AND LAYDOWN AREAS AND HAUL ROUTES G-14

7 PROPOSED FULL-SCALE INVESTIGATION SAMPLING LOCATIONS G-21

8 PICKLEWEED POTENTIALLY DISTURBED BY REMOVAL ACTION G-25

9 GRADING AND SITE RESTORATION CONCEPTUAL PLAN G-33

10 VEGETATION COMMUNITIES G-47

11 WETLANDS AND WATERS OF THE U.S. AND BURROWING OWL PRESERVES G-50

12 AREAS OF POTENTIALLY OCCURRING FEDERALLY LISTED SPECIES—WESTERN SNOWY PLOVER AND CALIFORNIA LEAST TERN G-53

13 AREAS OF POTENTIALLY OCCURRING FEDERALLY LISTED SPECIES—CALIFORNIA CLAPPER RAIL AND SALT MARSH HARVEST MOUSE G-58

APPENDICES

A USFWS SPECIES LIST

B CNDDB AND IPaC SEARCH RESULTS

ACRONYMS AND ABBREVIATIONS

AOI	Area of investigation
BA	Biological Assessment
bgs	Below ground surface
BMP	Best management practice
BO	Biological Opinion
CalTrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CNDDB	California Natural Diversity Database
dBA	A-Weighted Decibel
DCE	Design, Community and Environment
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DPT	Direct-push technology
DU	Decision unit
EE/CA	Engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ERT	Earth Resources Technology, Inc.
ESA	Endangered Species Act
FFA	Federal Facility Agreement
FHWA	Federal Highway Administration
FIAG	Fill investigation area grid
FR	Federal Register
FSFA	Former soil fill area
GPS	Global Positioning System
Hz	Hertz

ACRONYMS AND ABBREVIATIONS (continued)

IAG	Investigation area grid
ICAM	Interim corrective action measure
in/sec	Inch per second
IPaC	Information for Planning and Consultation
IR	Installation restoration
ISM	Incremental sampling methodology
kHz	Kilohertz
L_{max}	Maximum noise level
mg/kg	Milligram per kilogram
MROSD	Midpeninsula Regional Open Space District
MSL	Mean sea level
NASA	National Aeronautics and Space Administration
NASA Ames	NASA Ames Research Center
OARF	Outdoor Aerodynamic Research Facility
PCB	Polychlorinated biphenyl
PPV	Peak particle velocity
PSMHRP	Protected species mitigation and habitat restoration plan
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
Regional Water Board	California Regional Water Quality Control Board, San Francisco Bay Region
Removal Action	Non-time-critical removal action
SFBBO	San Francisco Bay Bird Observatory
SPIAG	Stormwater pond investigation area grid
SWPPP	Stormwater pollution prevention plan
SWRP	Stormwater retention pond
TAT	Turn-around time
Tetra Tech	Tetra Tech, Inc.
U.S.	United States
USACE	U.S. Corps of Engineers
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service

ACRONYMS AND ABBREVIATIONS (continued)

VOC	Volatile organic compound
WATS	West-Side Aquifers Treatment System
WRCC	Western Regional Climate Center

EXECUTIVE SUMMARY

This Biological Assessment (BA) has been prepared in accordance with Section 7 of the Endangered Species Act (ESA) (16 United States Code [U.S.C.] 1536 [c]) and ESA guidance, and follows consultation regulations (50 Code of Federal Regulations [CFR] Part 402.12[f]). The purpose of this BA is to determine the extent to which the Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA) Non-Time-Critical Removal Action (Removal Action) at National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames) may affect species requiring consultation (threatened or endangered species or their critical habitat) as designated by the U.S. Fish and Wildlife Service (USFWS). This BA also describes conservation measures that will be applied during the Removal Action to minimize adverse effects on listed species. The BA was submitted to USFWS in February 2017 to initiate formal consultation. This final BA is revised to include specific conservation measures and guidance contained in the project Biological Opinion (BO) for AOI 14 which was published by the USFWS on October 30, 2017 (USFWS 2017) and can be found in Appendix H of the *Area of Investigation 14 Removal Action Work Plan* (Tetra Tech 2017).

The BA describes activities proposed during implementation of the Removal Action at AOI 14, in fulfillment of the NASA Moffett Federal Facility Agreement (FFA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which requires NASA to conduct immediate and long-term response actions for AOI 14. The primary purpose of the Removal Action is to prevent erosion and subsequent transport of contaminated material from AOI 14 into adjacent wetlands. NASA intends this Removal Action to be the final action at AOI 14. The Removal Action consists of three phases of work: a Pilot Study, Full-Scale Investigation, and Removal. The Pilot Study and Full-Scale Investigation involve site soil sampling using incremental sampling methodology (ISM) to refine the proposed limits of excavation at the FSFA. Removal includes excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. The approximate length of time required to remove the soil and sediment will depend on the results of site sampling, but the entire Removal Action (sampling, analysis, excavation, and restoration) is estimated to take up to 14 months. Ecological monitoring and maintenance will be conducted following the excavation and restoration to ensure the effectiveness of the restoration, and are considered part of the Removal Action. After excavation and habitat restoration, the site will be suitable for unrestricted use.

The Proposed Action includes general biological and species-specific conservation measures for two species, the western snowy plover (*Charadrius nivosus* subsp. *Nivosus*, federally listed threatened and state-listed species of special concern) and salt marsh harvest mouse (*Reithrodontomys raviventris* subsp. *raviventris*, federally listed endangered and state-listed endangered and fully protected).

The Action Area as defined by 50 CFR §402.02 includes all work areas that could directly or indirectly affect federally listed species. The Action Area includes: (1) the AOI 14 FSFA and a 700-foot buffer around work areas that occur near open areas that may serve as habitat, (2) staging and laydown areas at the FSFA and N217A, (3) the contractor trailer (located either at the corner

of Allen Road and De France Avenue or south of the Eastern Diked Marsh), and (4) a portion of the haul route that extends through areas with potential habitat for listed species. The 700-foot buffer included as part of the Action Area includes a portion of the following areas: Navy Installation Restoration (IR) Site 25 stormwater retention pond (SWRP), Eastern Diked Marsh, Western Diked Marsh, and roadsides of the haul route. The Action Area includes federal property (NASA Ames) and a portion of Midpeninsula Regional Open Space District (MROSD) property.

Potential direct, indirect, and cumulative effects of the Proposed Action were evaluated for federally listed species that could occur in the Action Area, including the western snowy plover, California least tern (*Sternula antillarum browni*, federally endangered, state endangered, and state fully protected), California clapper rail (*Rallus longirostris obsoletus*, federally endangered, state endangered, and state fully protected), and salt marsh harvest mouse. Likelihoods of occurrence and effects were analyzed for the sampling phases, excavation, and site restoration. After the analysis of effects, an effect determination was made for each species, as defined under the ESA.

Effects may be one or more of the following under the ESA: beneficial, having no effect, having a potential to affect but unlikely to adversely affect, or having a potential to affect and likely to adversely affect. The effect determinations depend on the likelihood of the Proposed Action to result in a take of a species requiring consultation (individual effects) and the potential of the effect to jeopardize the continued existence of the species (population-level effects). An organism's potential to recover from injury, takes, or effects is a function of several factors such as its existing health and fitness, habitat conditions, and food availability. Baseline conditions at NASA Ames for the species evaluated in this BA are taken into account for the effects analyses, as are conservation measures.

The potential for the Proposed Action to affect species requiring consultation (in accordance with Section 7 of the ESA) in the Action Area is summarized in Table ES-1. No designated critical habitat is in the Action Area.

Stressors introduced by the Pilot Study and Full-Scale Investigation are similar in effect and would vary only by intensity. Because the Pilot Study is shorter and less intense relative to the Full-Scale Investigation, the risks of adverse effects are lower but not materially different; therefore, effects determinations for both were categorized together. Impacts listed in Table ES-1 address both sampling phases as one evaluation; effects of the removal phase are addressed separately.

As part of the BA analysis, and per 50 CFR §402.02, cumulative effects were analyzed in Section 6 and are "those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation." No state or private activities are planned in the Action Area and thus no cumulative effects are anticipated.

Non-federal regional activities that are planned or ongoing and that may contribute effects to species in the Action Area and that were evaluated for cumulative effects include South Bay Salt Ponds Restoration Project, San Francisco Estuary Invasive *Spartina* Control Project, and the

PV1 (Google) Campus Project. No adverse cumulative effects from these projects will occur for species considered in this BA.

Table ES-1: Summary of Effects of AOI 14 FSFA Pilot Study and Full-Scale Investigation Sampling, and Removal

Proposed Action Category of Effect	Western Snowy Plover	California Least Tern	California Clapper Rail	Salt Marsh Harvest Mouse
Pilot Study and Full-Scale Investigation	■	■	■	■
Removal	■	■	■	■
Effects Conclusion	■	■	■	■

Notes:

■ Likely to adversely affect.

1.0 INTRODUCTION

This Biological Assessment (BA) was prepared in accordance with Section 7 of the Endangered Species Act (ESA) (16 United States Code [U.S.C.] 1536 [c]) and ESA guidance and follows consultation regulations (50 Code of Federal Regulations [CFR] Part 402.12[f]). The purpose of this BA is to determine the extent to which the Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA) Non-Time-Critical Removal Action (Removal Action) at National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames) may affect threatened or endangered species and their critical habitat, as designated by the U.S. Fish and Wildlife Service (USFWS). This BA also describes conservation measures that will be applied during the Removal Action to minimize adverse effects on listed species. The BA was submitted to USFWS in February 2017 to initiate formal consultation. This final BA is revised to include specific conservation measures and guidance contained in the project Biological Opinion (BO) for AOI 14, which was published by the USFWS on October 30, 2017 (USFWS 2017) and can be found in Appendix H of the *Area of Investigation 14 Removal Action Work Plan* (Tetra Tech 2017).

The BA describes activities to be conducted during implementation of the Removal Action at AOI 14, in fulfillment of the NASA Moffett Federal Facility Agreement (FFA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which requires NASA to conduct immediate and long-term response actions for AOI 14. The primary purpose of the Removal Action is to prevent erosion of and subsequent transport of contaminated material from AOI 14 into adjacent wetlands. NASA intends the Removal Action to be the final action at AOI 14. The Removal Action consists of site sampling to further refine the proposed limits of excavation using incremental sampling methodology (ISM), excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. The approximate length of time required to remove the contaminated soil and sediment will depend on results of site sampling, but the Removal Action (sampling, analysis, excavation, and restoration) is estimated to take up to 14 months. Ecological monitoring and maintenance will occur following completion of the excavation and restoration to ensure the effectiveness of the habitat restoration and vegetation performance criteria are met; site restoration, ecological monitoring, and maintenance are considered part of the Removal Action. After excavation and habitat restoration, the site will be suitable for unrestricted use. Activities to occur during implementation of the Removal Action are detailed in the Removal Action Work Plan (Tetra Tech, Inc. [Tetra Tech] 2017).

The Proposed Action includes general biological conservation measures and species-specific conservation measures for two species, the western snowy plover (*Charadrius nivosus* subsp. *nivosus*, federally listed threatened and state-listed species of special concern) and salt marsh harvest mouse (*Reithrodontomys raviventris* subsp. *raviventris*, federally listed endangered and state-listed endangered and fully protected), as detailed in Section 2.5. Throughout this document, the term "project footprint" refers to the staging and laydown areas, the Removal Action area, and approximately 4 feet beyond the Removal Action area exclusion fence to include vegetation/pickleweed removal areas. The term "Action Area" refers to the area of potential effects resulting from the Proposed Action, which includes the project footprint and an adjacent buffer zone (700 feet) around work areas near open areas that may serve as habitat to account for

mobiles species, as well as potential indirect impacts (see Section 2.2). The area of the FSFA that will be sampled and excavated is shown on figures as the "Removal Action Boundary."

This document is organized as follows:

- Section 1, Introduction, details the background and history of the AOI 14 area and presents the purpose and need for the Proposed Action.

- Section 2, Proposed Action, provides a detailed description of the Proposed Action and its three phases (Pilot Study, Full-Scale Investigation, and Removal, which includes both mobilization and excavation) as well as an overview of the equipment to be used. It expands on the definition of the Action Area, which includes all work areas that could directly or indirectly affect federally listed species. Section 2 also gives an overview of the current management direction and regulatory setting of the Proposed Action and the ESA consultation history for AOI 14. Finally, Section 2 outlines in detail the conservation measures that will be applied during the Proposed Action.

- Section 3, Existing Conditions and Description of the Specific Area Affected by the Action, describes the overall regional setting of AOI 14 and its current baseline conditions including vegetation communities and habitat types.

- Section 4, Description of Listed Species or Critical Habitat that May Be Affected by the Action, provides a description of the listed species assessed in this BA. No designated critical habitat is in the Action Area. The species and life history environmental baseline for each of the species evaluated for this action takes into account the population and abundance of the species and existing environmental factors affecting the species in the Action Area. Species eliminated from further consideration in the BA are outlined in this section, along with explanations for their elimination.

- Section 5, Analysis of Effects and Description of the Manner in Which the Action May Affect Listed or Proposed Species or Critical Habitat, analyzes the potential direct and indirect effects of the proposed Removal Action for federally listed species having the potential to occur in the Action Area. This section addresses the western snowy plover, California least tern (*Sternula antillarum browni*, federally endangered), California clapper rail (*Rallus longirostris obsoletus*, federally endangered), and salt marsh harvest mouse. Baseline conditions at NASA Ames for the species evaluated in this BA are taken into account for the effects analyses, as are conservation measures.

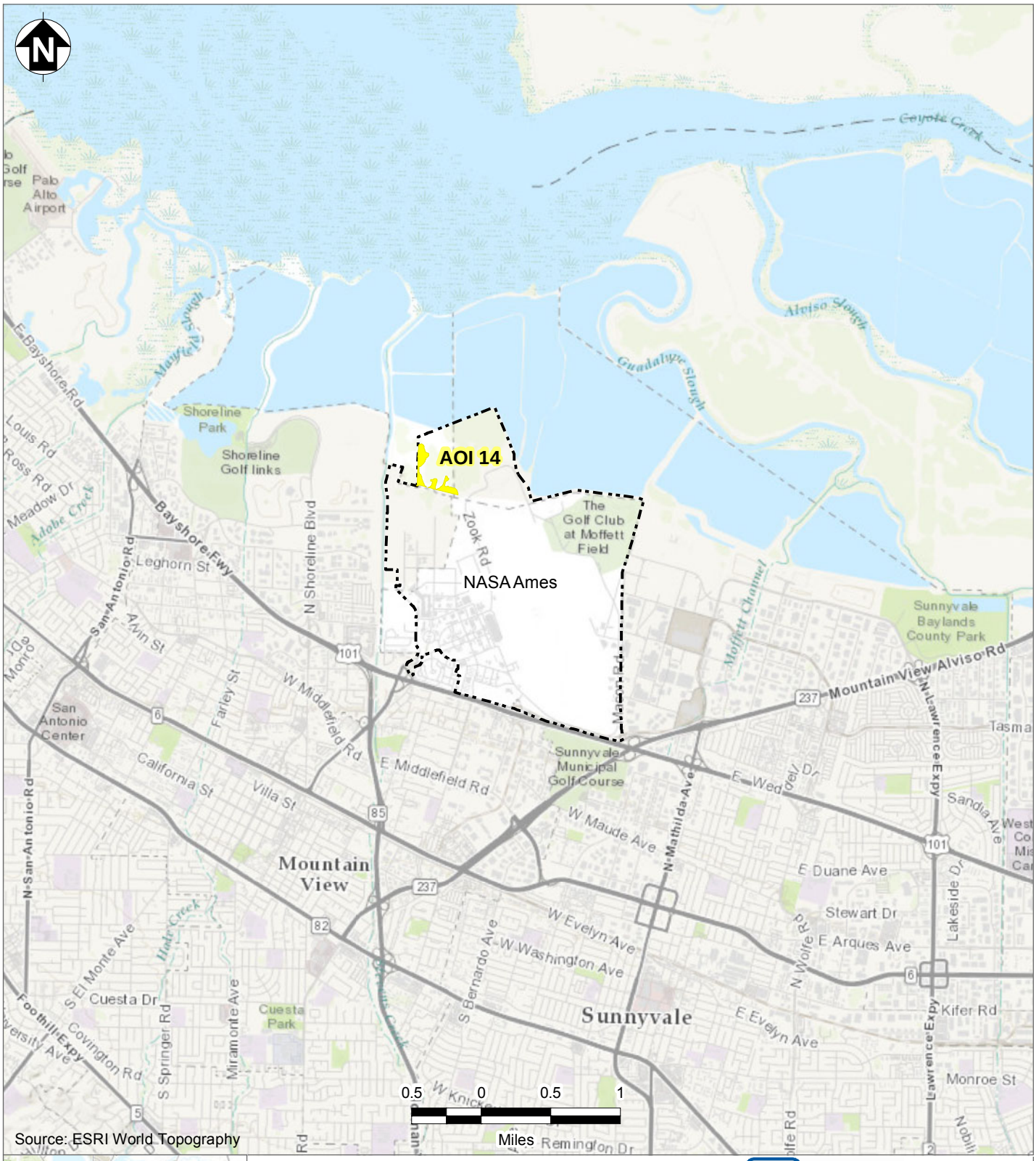
- Section 6, Cumulative Effects on Threatened and Endangered Species or Critical Habitats, analyzes the potential cumulative effects of the proposed Removal Action for federally listed species having the potential to occur in the Action Area. As part of the BA analysis, and per 50 CFR §402.02, cumulative effects are analyzed and are "those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation."

1.1 BACKGROUND AND HISTORY

NASA Ames is located in Santa Clara County, approximately 35 miles southeast of San Francisco and 10 miles northwest of San Jose (Figure 1). AOI 14 is located in the northern portion of NASA Ames and consists of three peninsulas (the FSFA, N217, and N217A) that extend into a stormwater retention pond (SWRP) that is part of Navy Installation Restoration (IR) Site 25 (Figure 2). The FSFA and N217A peninsulas were constructed by deposition of fill material on the existing surface of the SWRP. Visual observations of the surface of the peninsulas show that the fill material consists of soil and construction debris including concrete, rebar, and metal piping. Historical aerial photographs indicate that the N217 peninsula consists of native soil. Soil at the N217 and N217A peninsulas does not pose an unacceptable risk to human health or the environment and therefore the N217 and N217A peninsulas are not part of the Removal Action described in this BA (Tetra Tech 2015).

The FSFA is approximately 8 acres, and ground surface elevations vary from approximately 4 feet above mean sea level (MSL) at the southern end of the peninsula, to 11 feet above MSL at the northern end. The surface of the SWRP in the area surrounding the FSFA varies from approximately 0 foot MSL to -0.5 below MSL. Groundcover varies across the site and includes grasses and low-lying brush. The FSFA is not currently used, and access to the peninsula is restricted by the NASA Ames security fence to the south and the SWRP on all other sides. There is a public trail (Bay Trail) on the northern and eastern sides of the Navy IR Site 25 SWRP and on the northern and western sides of the Midpeninsula Regional Open Space District (MROSD) property (Figure 2).

The exact dates of construction of the FSFA and N217A fill areas are unknown, and no records of the sources of the fill material have been located. However, an approximate chronology was established through review of historical photographs. The FSFA does not appear in available historical aerial photographs prior to 1968, and deposition of fill materials appears to have ceased by 1987. Based on the direct-push borings summarized in the Engineering Evaluation/Cost Analysis (EE/CA) (Tetra Tech 2015) and nonintrusive geophysical investigation conducted by Tetra Tech (2016a), the southern end of the FSFA appears to be artificial engineered fill (with a road base on the western side), and the northern end is debris fill. Most of the soil in the debris fill areas is likely from construction projects at NASA Ames. Some of the soil may have originated from construction of the National Full-Scale Aerodynamic Complex wind tunnel test section (Building N221B), located approximately 1 mile south of AOI 14 in the center of the NASA Ames campus. An electrical substation was removed to construct the test section. Soil from this substation site may have contained polychlorinated biphenyls (PCBs) from leaks in the electrical equipment, and this soil may have been deposited at the FSFA. In addition, soil materials from other sources may have been added to the FSFA over time.



AOI 14

NASA Ames

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

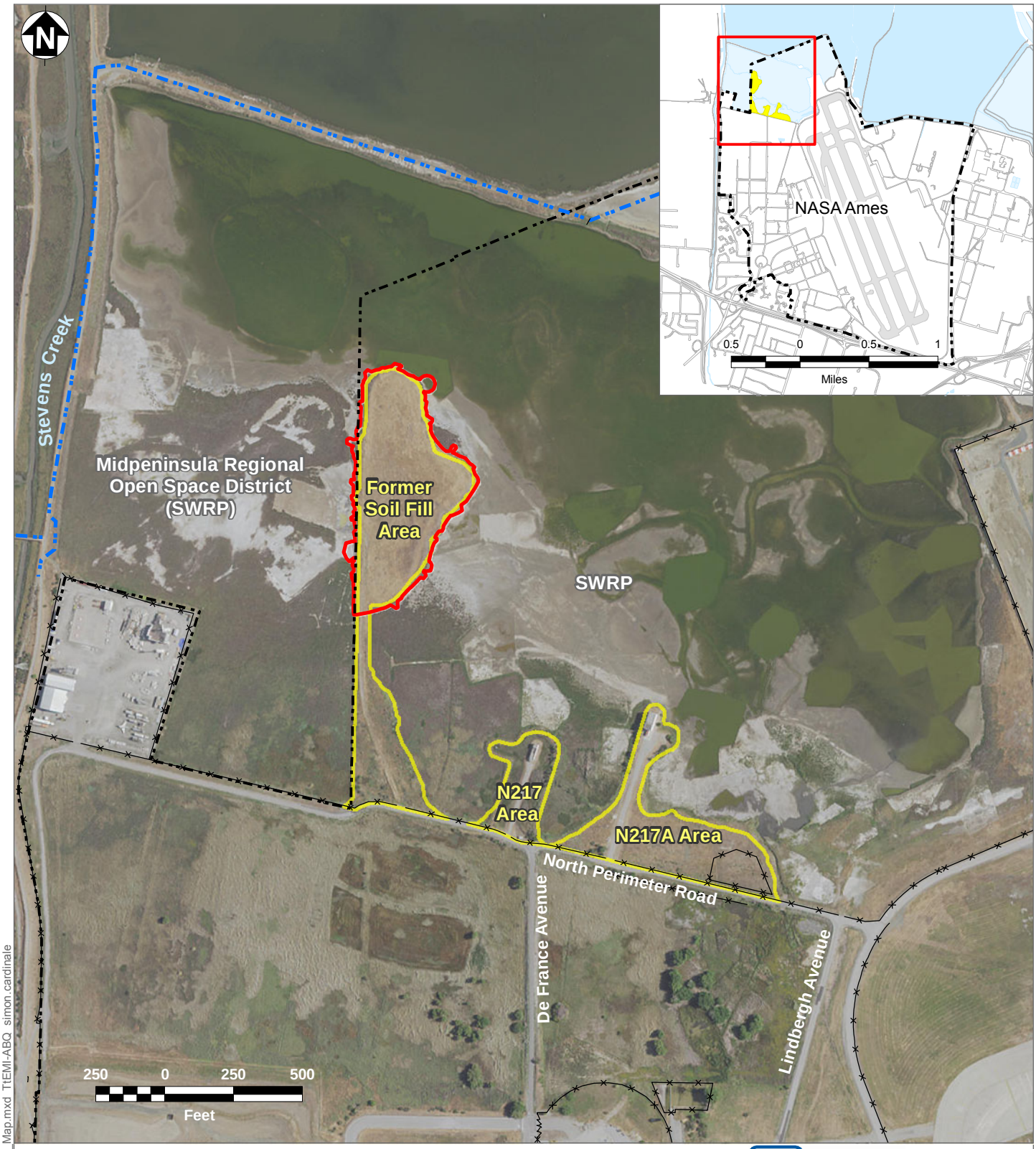
NASA Ames Research Center
Moffett Field, California

Figure 1

AOI 14 Site Location

Biological Assessment for AOI 14 Removal Action

2017-02-13 V:\NASA\Projects\007_BA\01_Site_Location.mxd TtEMI-AL simon.cardinale



AOI 14

AOI 14 Former Soil Fill Area Removal Action Boundary (Based on Toe and Bottom of Slope and Geophysical Survey Results)

NASA Ames

Bay Trail

Fence

Notes:

AOI	Area of Investigation
IR	Installation Restoration
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWRP	Stormwater retention pond

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 2

AOI 14 Site Features

Biological Assessment for AOI 14 Removal Action

2/15/2017 V:\NASA\Projects\007_BA\02_Site_Map.mxd TtEMI-ABQ simon.cardinale

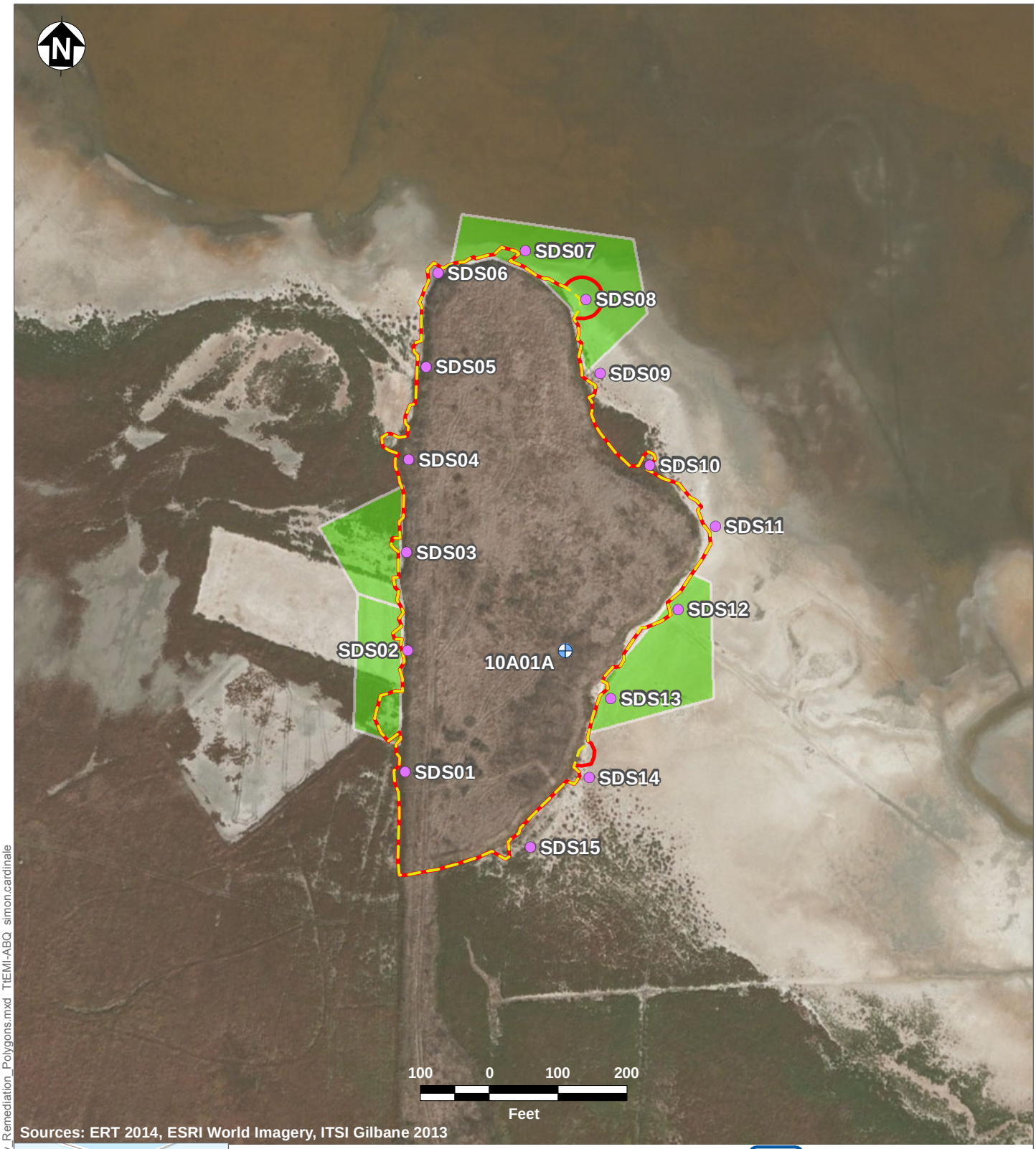
The Navy completed a remedial action at the IR Site 25 SWRP in December 2012, consisting of sediment excavation and associated habitat restoration; annual salt marsh monitoring began in 2013 and will continue for up to 5 years. Navy remediation polygons (areas of excavation) that adjoin the FSFA perimeter are shown on Figure 3. In 2013, the U.S. Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) Order (RCRA-7003-09-2013-0002) requiring NASA to conduct immediate and long-term response actions for AOI 14. The stated purpose of the RCRA Order was to stabilize and address soil contaminated with PCBs, pesticides, and metals that threatened to discharge pollutants into the surrounding Navy IR Site 25, which includes the SWRP that serves as actual and potential habitat for several ecological receptors, including special status species. In December 2013, NASA implemented an Interim Corrective Action Measure (ICAM) by installing a silt fence barrier around the perimeter of the FSFA peninsula to prevent potential soil erosion from the peninsula into the SWRP. The silt fence barrier was not placed around the N217 and N217A areas because of the depths and limited extents of contamination in these areas. NASA continues monthly inspections of the ICAM and annual sediment sampling surrounding the ICAM and submits quarterly inspection reports to EPA and the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board). ICAM sediment sampling locations are presented on Figure 3. NASA, EPA, and the State of California (through the Regional Water Board) signed an FFA for NASA Ames on March 11, 2015. EPA terminated the RCRA Order on the effective date of the FFA. Remedial activities for AOI 14 are now being implemented by NASA, as the lead agency under the NASA Moffett FFA, in accordance with CERCLA.

1.2 PURPOSE, NEED, AND OBJECTIVES

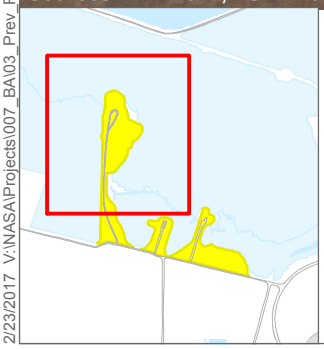
This BA has been prepared to support formal consultation between NASA and USFWS, as required by 50 CFR 402.14(c) and Section 7 of the ESA. This BA evaluates the potential effects on federally listed species and their habitats from the Proposed Action, which includes the following: (1) Pilot Study using ISM; (2) Full-Scale Investigation using ISM; and (3) Removal, including habitat restoration and monitoring. The primary objectives of the Pilot Study, Full-Scale Investigation, and Removal are:

1. Pilot Study: Determine the appropriate number of ISM sampling increments that should be collected in each decision unit (DU) for the Full-Scale Investigation at AOI 14 to achieve appropriate confidence levels such that results will be reproducible and accurate.

2. Full-Scale Investigation: Using ISM, identify areas at AOI 14 and two adjacent locations in Navy IR Site 25 where concentrations of lead, total dichlorodiphenyltrichloroethane (DDT), and total PCBs exceed cleanup goals in soil or sediment.



Sources: ERT 2014, ESRI World Imagery, ITSI Gilbane 2013



Previous Sediment Sample

Existing Monitoring Well

Navy Remediation Polygon

Apparent artificial fill boundary inferred from geophysical survey

Removal Action Boundary

Note:
ICAM Interim corrective action measure

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 3

AOI 14 ICAM Sampling Locations

Biological Assessment for AOI 14 Removal Action

2/23/2017 V:\NASA\Projects\007_BA\03_Prev_Remediation_Polygons.mxd TtEMI-ABQ simon.cardinale

3. Removal: Excavate and dispose of soil and sediment with concentrations of lead, total DDTs, or total PCBs that exceed cleanup goals. As necessary, excavate and stage for reuse soil and sediment with concentrations of lead, total DDTs, and total PCBs less than cleanup goals. The Removal will include site restoration, to be detailed in the Protected Species Mitigation and Habitat Restoration Plan (PSMHRP), which will be included as an appendix to the *Area of Investigation 14 Removal Action Work Plan* that supports overall project activities (Tetra Tech 2017). Pickleweed (*Salicornia pacifica*) will be mitigated at a 3:1 ratio, and final site grading will support pickleweed, transitional, and upland habitats. Site revegetation will include species native to the San Francisco Bay region. The PSMHRP will include a list of recommended plant species for each habitat type, monitoring and maintenance methods, and success criteria. Monitoring and maintenance will continue for 5 years or until vegetation performance criteria are met, to ensure the effectiveness of the restoration.

Cleanup goals were established in the EE/CA and specified in the Action Memorandum and are detailed in Table 1 (Tetra Tech 2015 and 2016b).

After excavation activities are completed, residual site-wide average concentrations of lead, total DDTs, and total PCBs at AOI 14 will be calculated and compared to Navy IR Site 25 site-wide (area-weighted) average remediation goals to ensure that residual concentrations are protective of wetland receptors at the IR Site 25 SWRP. The Navy IR Site 25 site-wide average remediation goals are 33 milligrams per kilogram (mg/kg) for lead, 0.016 mg/kg for total DDT, and 0.200 mg/kg for total PCBs. If residual site-wide average concentrations of lead, total PCBs, and total DDT at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14. The potential additional investigation and excavation are considered part of the Removal Action and included in the effects evaluation of this BA.

Table 1: AOI 14 Cleanup Goals

Chemical	Cleanup Goal (mg/kg)
Lead	93.8
Total DDT[a]	0.109
Total PCBs[b]	0.210

Notes:

mg/kg = Milligrams per kilogram

a Total DDT is the sum of detected concentrations of 4,4-Dichlorodiphenyltrichloroethane (DDT), 4,4- Dichlorodiphenyldichloroethane (DDD), and 4,4- Dichlorodiphenyldichloroethene (DDE).

b Total PCBs is the sum of detected concentrations of individual Aroclors. Aroclor-1254, Aroclor-1260, and Aroclor-1268 were detected at AOI 14.

2.0 PROPOSED ACTION

The following sections describe the Proposed Action at AOI 14.

2.1 PROPOSED ACTION DESCRIPTION

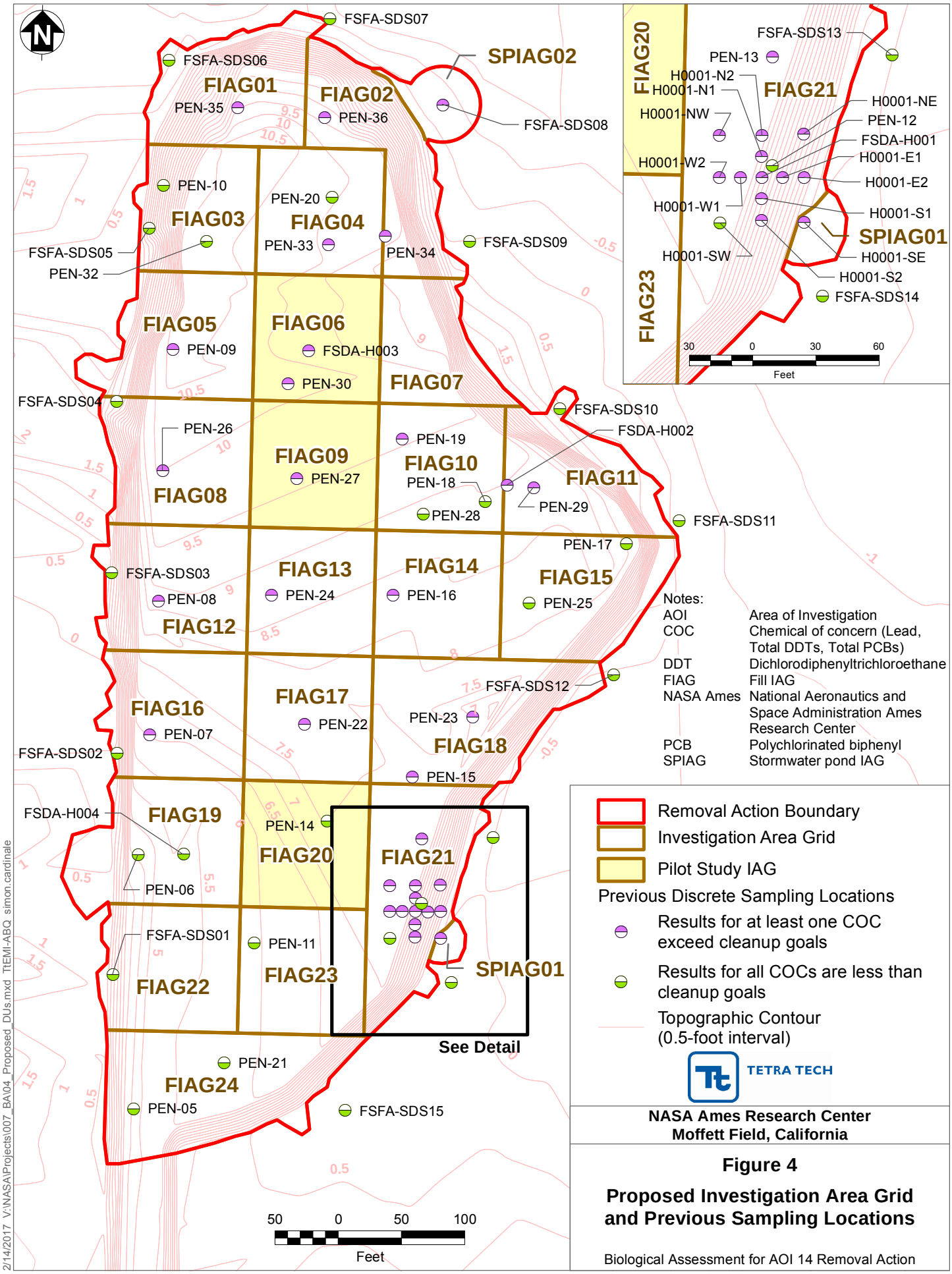
The Proposed Action consists of the following activities at the FSFA: soil and sediment sampling, excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, segregation and offsite disposal of construction and demolition debris, restoration of the excavated area to appropriate habitat, and monitoring to ensure its effectiveness. The Proposed Action addresses the northern portion of the FSFA where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in samples collected from 1992 through 2014 (Figure 4). This area is estimated to be 6 acres (270,000 square feet), and the estimated volume of fill is 65,000 cubic yards. Based on a geophysical survey conducted at the FSFA, artificial fill may extend to depths as great as 18 feet below ground surface (bgs) in the northern portion of the site and may be as shallow as 4 feet bgs in the southern portion of the site (Tetra Tech 2016a).

During soil and sediment sampling, a Tetra Tech field team and three direct-push technology (DPT) drilling teams will be on site. Sampling will occur in two phases, Pilot Study and Full-Scale Investigation. The work required for each phase of sampling is detailed in Sections 2.1.1 and 2.1.2.

After samples are analyzed, soil or sediment with concentrations of contaminants exceeding cleanup goals will be permanently removed and disposed of at an appropriate off-site facility. The work required for the Removal is detailed in Section 2.1.3.

It is assumed that the Proposed Action will require approximately 14 months to complete based on the following assumptions: (1) soil and sediment sampling (Pilot Study and Full-Scale Investigation) will require approximately 2 months; (2) mobilization, excavation, and off-site disposal will require approximately 11 months; and (3) demobilization, initial efforts for habitat restoration (including mitigation for impacted pickleweed), and site revegetation will require approximately 1 month.

The BA submitted to the USFWS in February 2017 analyzed effects to species based on the following target start dates for the three phases: the Pilot Study was targeted for May 2017 or as late as September 2017, with an expected duration of 10 days over two 5-day work weeks. The Full-Scale Investigation was targeted for late May 2017 or as late as October 2017, with an expected duration of up to 6 weeks with 5 working days each. The Removal and restoration activities were proposed to commence in October 2017 and continue through August 2018, following evaluation of Full-Scale Investigation sampling data and determination of final excavation design. The variance in target start dates was based on several factors including potential variance in timing of funding and contracting and duration of review of applicable project documents by regulatory agencies. Since the development of the BA submitted in February 2017, the project schedule has been revised to begin sampling activities in January 2018.



NASA Ames Research Center
Moffett Field, California

Figure 4

Proposed Investigation Area Grid and Previous Sampling Locations

Biological Assessment for AOI 14 Removal Action

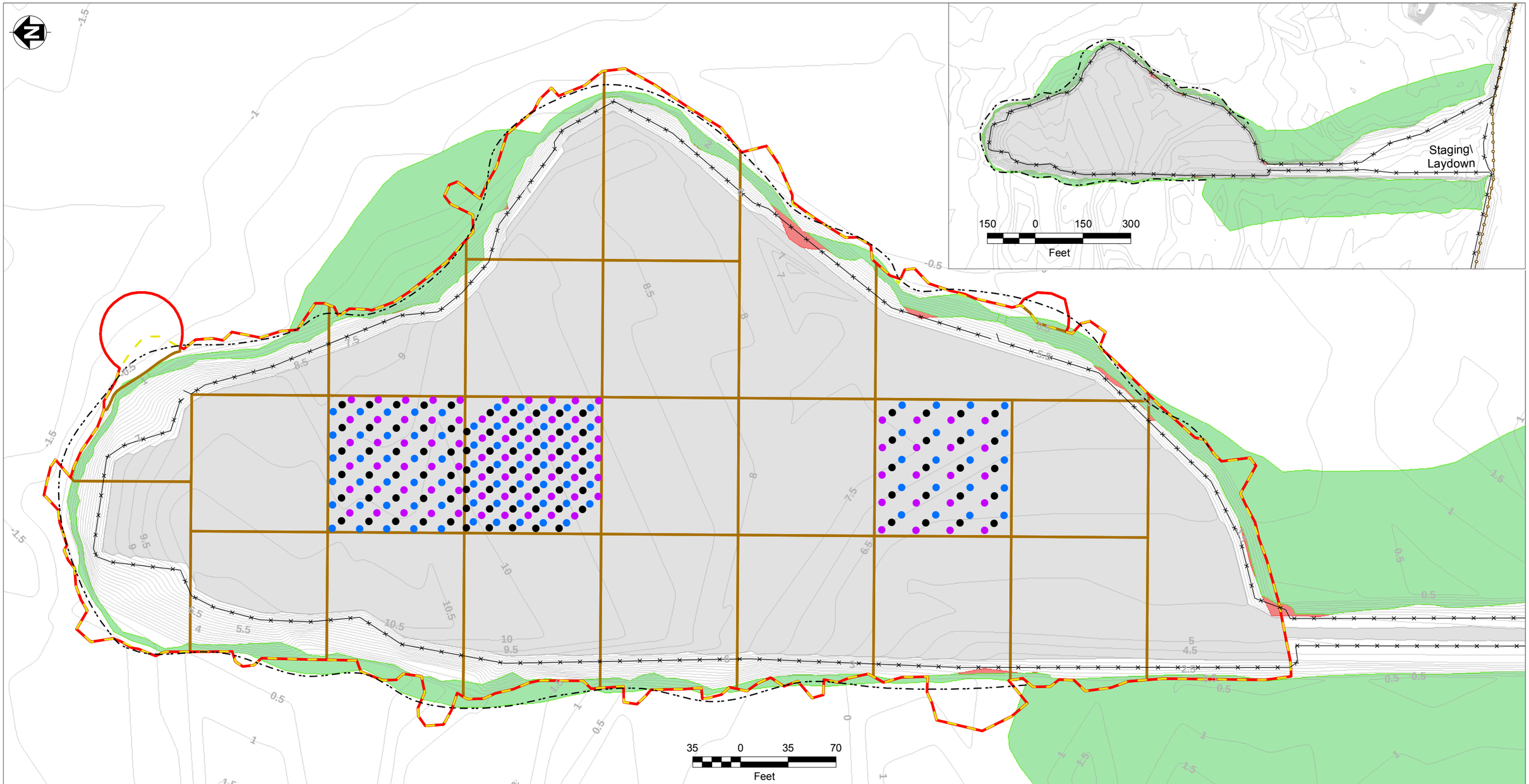
Excavation, transportation, and disposal of contaminated soil and sediment are scheduled to begin in spring 2018 and continue until fall of 2018. Final site restoration/revegetation activities are scheduled to be completed in fall 2018. The expected durations of each phase are as stated above and remain unchanged. The original impacts analyses conducted for the February 2017 BA were based on the worst case scenario of activities occurring during the species' breeding seasons, which is still the case with the revised schedule. As such, the results of the effects analysis remain unchanged from the original evaluations contained in the prior BA iteration.

Site activities will be conducted 5 days per week, Monday through Friday, during daylight hours only, between approximately 7:00 a.m. and 6:00 p.m. depending on the time of year and amount of available daylight, or as otherwise specified by a USFWS-approved biologist for the protection of listed species (still during daylight hours). The USFWS-approved biologist must be authorized by USFWS, either under the authority of a BO or permitted under Section 10A-1A of the ESA (see Section 2.5 for additional details of the USFWS-approved biologist). Weekend daytime work is not anticipated but may occur during the non-breeding season if necessary, as a result of time constraints such as those brought on by weather, unexpected contingency events, or scheduling constraints. Any work on weekends or on federal holidays will be conducted only with pre-approval from both NASA Ames and the on-site USFWS-approved biologist, and would follow the same conservation measures and practices as stipulated in this BA for work during the standard business week. Work on NASA's roadways will conform to business hours established by NASA for these roadways. The USFWS-approved biologist will be on site daily during all Removal Action activities (Pilot Study, Full-Scale Investigation, and Removal) and will remain on site for the duration deemed necessary by the biologist.

Project personnel and vehicles will proceed to work areas and staging areas over established roadways or areas previously cleared for use by the USFWS-approved biologist. During active sampling, excavation, grading, and restoration activities, local site access will be controlled by temporary barriers including warning tape and signage. During off-work hours, any work areas near existing roadways that could affect vehicle traffic will be demarcated with battery-operated reflectors. Gates between NASA Ames and the FSFA or other subcontractor laydown areas will be kept closed (and locked during off-work hours) except when project vehicles are crossing.

2.1.1 Pilot Study

The Pilot Study has an expected duration of 2 weeks (10 working weekdays). For the Pilot Study and Full-Scale Investigation, the FSFA is divided into investigation area grids (IAG). The IAGs include Fill IAGs (FIAG), which are approximately 100- by 100-foot grids on the surface of the FSFA, and stormwater pond IAGs (SPIAG), located within the SWRP, adjacent to the FSFA (Figure 4). The drilling subcontractor will advance a total of 270 direct-push borings to native bay mud, estimated to be at depths ranging from 4 to 18 feet bgs, from within three IAGs (Figures 4 and 5). The drilling subcontractor will provide three drill teams that will work concurrently.



Pilot Study Sampling Increment Location
- Replicate 1
- Replicate 2
- Replicate 3
- ICAM Silt Fence (Existing)

Anti-Perch Locations
Exclusion Fence
Topographic Contour (0.5-foot interval)
Investigation Area Grid
Apparent artificial fill boundary inferred from geophysical survey
Removal Action Boundary

Vehicle traffic, no pickleweed
Pickleweed undisturbed by Pilot Study
Pickleweed disturbed by Pilot Study (0.02 acre)

Notes:

AOI	Area of Investigation
ICAM	Interim corrective action measure
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 5
Proposed Pilot Study Sampling Locations

Biological Assessment for AOI 14 Removal Action

2/14/2017 V:\NASA\Projects\007_BA\05_Proposed_Sampling.mxd TtEMI-ABQ simon.cardinale

For the Pilot Study (and for the Full-Scale Investigation), the contractor will set up a temporary contractor trailer area with a temporary trailer for project management and health and safety activities. The contractor trailer area will also include a refrigerated trailer for temporary cold storage of soil sample cores. The contractor trailer area will be set up at one of the two locations shown on Figure 6; both locations are in developed paved areas, and setup at either location will not cause ground disturbance. The primary contractor trailer area near the intersection of Allen Road and De France Avenue is preferred; however, NASA Ames may direct the contractor to use the secondary area if other facility activities preclude use of the primary location. The contractor trailer area will include a diesel-fueled generator or a tie-in to the local NASA Ames power supply to provide electricity to the trailer. Temporary sanitation facilities will be installed near the trailer and at additional locations at the laydown areas and FSFA as necessary. The contractor trailer area will remain for the duration of the Removal Action.

A contractor staging/laydown area will be established at the southern end of the FSFA (primary staging area) (Figure 6). The primary staging area will include a solid waste dumpster, vehicle tracking controls (such as rumble strips) to prevent dirt from exiting the site, and an entrance/outlet tire wash area equipped with a liner and wastewater collection and storage. Tire washing is a contingency plan that should be necessary only in the event of rain to decontaminate equipment tires and prevent off-site transport of FSFA soils. Rain events are not expected, as sampling is targeted to occur prior to the rainy season.

Within the upland portion of the Removal Action boundary, a mobile field trailer will be set up near the sampling area to process soil samples, which will require a generator (with secondary containment) for power. A portable toilet with secondary containment will be stationed adjacent to the field trailer. The field trailer will be used for the Pilot Study and Full-Scale Investigation, and removed before the Removal (Section 2.1.3).

The Pilot Study will include the following activities:

- Biological surveys and FSFA peninsula top vegetation removal:
    - No more than 3 days prior to IAG surveying and marking (described below) and Pilot Study sampling, a USFWS-approved biologist will conduct a walking survey of the FSFA and a visual survey of the Action Area to determine the presence or absence of special status species in the area. At this time, the biologist will survey the extent and condition of pickleweed that occurs along the FSFA slopes and SWRP, to a distance of approximately 50 feet from the Removal Action boundary.

Former Soil Fill Area

Primary Contractor Staging/Laydown Area

Secondary Contractor Staging/Laydown Area

N217A Area

Western Diked Marsh

Eastern Diked Marsh

Gate 16C Site Entry /Exit

Secondary Contractor Trailer Area

Primary Contractor Trailer Area

Gate H - Truck Waiting Area and Potential Loaded Truck Inspection Station (Guard to be Provided by Contractor)

Gate

Gate

Moffett Federal Airfield

South Main Gate (Ellis St Gate) Truck Ingress/Egress to Moffett Field

Main Gate (NASA)

Entrance to Highway 101

Entrance to Highway 101

Northern Channel

Moffett Field Golf Course

Lockheed Martin Corporation

North PerimeterRd

North Patrol Rd

Zook Rd

Lindbergh Ave

Defrance Ave

Allen Rd

RT Jones Rd

Wescoat Rd

Macon Rd

East Patrol Rd

101

500 0 500 1,000

Feet

Bay Trail

One Way Direction of Truck Traffic

Two-Way Direction of Truck Traffic

Exclusion Fence

Anti-Perch Locations

Area of Investigation (AOI) 14

Contractor Staging/ Laydown or Trailer Area

Removal Action Boundary

Action Area

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 6

Staging and Laydown Areas and Haul Routes

Biological Assessment for AOI 14 Removal Action

12/15/2017 V:\NASA\Projects\007_BA\06_Haul_Route.mxd TtEMI-ABQ simon.cardinale

- Pickleweed coverage will be surveyed using a handheld Global Positioning System (GPS) instrument. Pickleweed condition (height and a visual estimate of cover [as a percentage]) will be recorded and photographically documented. Plant species observed within the Removal Action boundary will be recorded, and conditions atop the peninsula will be photo-documented. To document pre-impact conditions, at least three transects will be surveyed within the pickleweed habitat along the slopes of the peninsula. The upland vegetation has been mowed; no transects are required in the upland. A biologist skilled in California native and invasive plant identification will conduct a walking reconnaissance of the upland and transitional areas and document plant species as feasible.

- Once deemed clear of mice by a USFWS-approved biologist, vegetation within 50 feet of the edge of pickleweed will be removed by hand or cut to ground level (using non-motorized hand tools) in the presence of a USFWS-approved biologist and per the requirements in Section 2.5.

- Once deemed clear of special status species by the USFWS-approved biologist, the upland portion of the FSFA peninsula (starting from the edge of the hand-cleared areas addressed above and from a distance of 50 feet from the uppermost pickleweed edge) will be mowed to stubble no higher than 1 inch. The USFWS-approved biologist will walk a safe distance in front of the mower to ensure that no salt marsh harvest mice are present. With the approval of the USFWS-approved biologist and once deemed clear of mice, mowing will be conducted as necessary for the duration of the Removal Action to maintain upland vegetation at a height of 1 inch or less.

- A USFWS-approved biologist will be on site daily during surveying and sampling activities and will remain on site for the duration deemed necessary by the biologist. Decision criteria will include the current nature of project activities, degree of noise or disturbance they are producing, intensity of activities, presence of species, or other factors.

- Additional conservation measures are described in Section 2.5.

- Surveying and marking of IAGs: No more than 5 days prior to sampling, a surveyor will conduct a detailed topographic survey of the area within the Removal Action boundary; the surveyor will also survey and stake the corners of the sampling IAGs for the entire FSFA. Drilling locations for the Pilot Study IAGs will be marked in the field with wooden stakes, and the locations will be indicated on a map. To discourage use by raptors for perching, wooden stakes will be no higher than 3 feet. In addition, flagging will be tied to the top of the wooden stakes as an additional deterrent to raptor perching. Stakes for drilling locations will be removed immediately after sampling is complete.

- Installation of an exclusion fence and removal of vegetation from FSFA slopes:

    - After the IAGs are surveyed and marked, the FSFA peninsula slopes will be surveyed by a USFWS-approved biologist for the presence or absence of special status species.

    - The layout of the exclusion fence will be marked in the field with stakes no higher than 3 feet to guide vegetation removal. Stakes will be removed after vegetation is removed, as described below.

    - Vegetation within 4 feet of the exclusion fence stakes (measured from the outside edge) will be removed to discourage salt marsh harvest mice from entering the work area. Pickleweed will be removed by hand and under the supervision of a USFWS-approved biologist. Pickleweed removal areas will be surveyed using a handheld GPS instrument to record the area of impact. The layout of the exclusion fence and estimated areas of pickleweed removal for the Pilot Study are depicted on Figure 5. The areas of pickleweed shown on Figure 5 are based on a July 2016 survey of pickleweed within 100 feet of the FSFA (NASA 2016).

    - A temporary exclusion fence will be installed as close to the anticipated work areas as practicable. The fence will extend around the entire FSFA, including the access road and contractor staging/laydown area on the southern end of the FSFA peninsula (Figure 5). The exclusion fence will be no higher than 3 feet to prevent raptor perching and will include low-density polyethylene sheeting such as Visqueen to prevent salt marsh harvest mice from entering the work area. The sheeting will be buried at least 4 inches below the ground surface to prevent burrowing animals from entering the project footprint. Support posts will be on the inside of the fence (work area side). A portion of the fence along North Perimeter Road will be open during periods of activity to allow traffic and personnel to access the FSFA. This portion will be closed at night and during periods of extended inactivity and secured with sandbags or equivalent.

- Installation of anti-perch devices: Anti-perch devices such as spike strips will be installed on the NASA perimeter fence along North Perimeter Road (Figure 6). The anti-perch devices will remain in place during and after the Removal Action to prevent predators from perching near salt marsh harvest mouse habitat.

- Direct-push boring: The Pilot Study will consist of collecting samples via ISM from three IAGs with 20, 30, and 40 increments, respectively, each in triplicate, from multiple depth intervals. Each increment will be a boring (or segment of a boring) advanced using DPT to the bottom of fill (estimated at depths of 4 to 18 feet bgs). Borings will be approximately evenly spaced within the IAG, forming an approximate gridded pattern. Triplicate samples (three field replicates) will be collected in an overlapping array by stepping out two times from the original boring locations (Figure 5). A geologist (licensed or under supervision of a licensed Professional Geologist) will log each boring to indicate percent recovery for each push, as well as depth of the bottom of debris fill, bottom of artificial fill, top of native

soil, and visual discolorations or sheens. ISM increment compositing will be conducted at a field location on the FSFA.

- In the first IAG (FIAG20), 20 triplicate DPT borings (for a total of 60 borings) will be advanced and logged to the interface between fill and underlying native soil. The second and third rounds of triplicate borings will be located within 1 to 2 feet of the first round of borings.

- In the second IAG (FIAG06), 30 triplicate DPT borings (for a total of 90 borings) will be advanced and logged to the interface between fill and underlying native bay mud.

- In the third IAG (FIAG09), 40 triplicate DPT borings (for a total of 120 borings) will be advanced and logged to the interface between fill and underlying native bay mud.

- Following ISM protocol, triplicate ISM samples representing 13 separate (in some cases overlapping) depth horizons will be collected from the following depth intervals at each IAG, resulting in a total of 39 ISM samples per IAG, and a Pilot Study total of 117 samples.

- Sample analyses: All ISM soil samples will be analyzed for lead, dichlorodiphenyldichloroethene (DDE), dichlorodiphenyldichloroethane (DDD), DDT, and PCBs as Aroclors on a 5-day turn-around time (TAT).

Table 2 lists the type of equipment to be used, duration of use, and estimated noise and vibration anticipated during the Pilot Study. Noise and vibration are known stressors to wildlife and are included here for use in the effects evaluation in Section 5.0.

Table 2: Pilot-Study Equipment—Estimated Noise and Vibrations

Equipment	Quantity	Duration of Use (days)	Use Each Day (hours)	Noise Level (dBA at 50 feet)	Vibration Output(1) PPV at 50 feet (in/sec)	Vibration Output(1) Frequency at 50 feet (Hz)
Direct-Push Drill Rig(2)	3	10	10	89 each (93.8 total for concurrent use of all three)	0.01	15
Diesel Generator	1(3)	30	10	81	0.01	15

Notes:

dBA = A-Weighted Decibel

in/sec = Inches per second

Hz = Hertz

PPV = Peak particle velocity

(1) Typical vibration from transportation and non-blasting construction sources falls in the low frequency range of 5 to 30 Hz, and usually centers around 15 Hz. Professional judgement was used to identify values in Table 2 based on this range and measured or reported values for similar equipment (Jones and Stokes 2004; New Hampshire Department of Transportation 2012). Vibrations are anticipated from the hydraulic hammer on the direct-push rig drill bit whenever dense material is encountered. Typically, the drill rig will move to a new boring if soil is too dense or debris is encountered. Some hammering is anticipated for every boring; however, hammering is anticipated to only occur about 5 percent of the time. The materials in the FSFA are mostly a mixture of debris and non-structural soil material. These materials are intermixed and inconsistent, and as such do not easily transmit vibrations. Forces from impacts are not anticipated to propagate very far beyond the localized point of impact (New Hampshire Department of Transportation 2012).

(2) Based on noise from a jackhammer, which is similar to that of the hydraulic hammer on a direct-push rig and applicable to the noise level of the direct-push drill rig. Value is from Actual Measured L_{max} (maximum noise level) based on average of hundreds of exposure measurements performed at work sites. This noise level is expected only about 5 percent of the time, when refusal is encountered (U.S. Department of Transportation 2006).

(3) One generator would be stationed adjacent to the mobile field trailer atop the FSFA peninsula to power the field trailer lights. One generator would be stationed at the primary staging area at the south end of the AOI 14 FSFA to power a spray washer during wet decontamination, and would cycle on and off as needed. Wet decontamination would be necessary only during times of rain. As such, noise values are based on one generator operating for the duration of the work day.

(4) Total estimated noise output from Pilot Study activities: 94 dBA. Maximum combined noise levels were calculated using the online calculator: https://noisemeters.com/apps/db-calculator.asp (U.S. Department of Transportation 2006).

2.1.2 Full-Scale Investigation

The Full-Scale Investigation has an expected duration of 6 weeks, 5 working days each, and will follow the Pilot Study. The results from the Pilot Study will determine the number of soil borings required in each IAG for the Full-Scale Investigation. The following borings will be advanced during the Full-Scale Investigation:

- Between 420 and 930 DPT borings to native bay mud (estimated between 4 and 18 feet bgs, depending on the location) within 21 to 23 approximately 100-foot by 100-foot FIAGs located within the FSFA. Approximately 10 percent of these DPT borings will be advanced using angle-hole methods to the depth of native bay mud to obtain material representative of soil and fill within the side slopes.

- Up to 30 borings (total) will be advanced using a hand auger on the side slope (to a maximum depth of 4 feet bgs) in FIAGs located on the FSFA perimeter.

- Up to 30 borings (total) will be advanced using a hand auger or slam bar (i.e., non-powered hand tool) into SWRP sediment (to a maximum depth of 1 foot below the sediment surface) in FIAGs where the IAG boundary extends into the SWRP.

- Between 40 and 80 borings will be advanced using a hand auger or slam bar into SWRP sediment (to a maximum depth of 1 foot below the sediment surface) in two areas adjacent to the toe of the FSFA slope; these areas are referred to as SPIAGs.

Table 3 lists the types of equipment to be used, durations of use, and estimated noise and vibration levels anticipated for the Full-Scale Investigation. Figure 7 shows the proposed sampling locations.

Table 3: Full-Scale Investigation Equipment—Estimated Noise and Vibrations

Equipment	Quantity	Duration of Use (days)	Use Each Day (hours)	Noise Level (dBA at 50 feet)	Vibration Output(1) PPV at 50 feet (in/sec)	Vibration Output(1) Frequency at 50 feet (Hz)
Direct Push Drill Rig(2)	3	30	10	89 (93.8 total for all three)	0.01	15
Power Hand Auger or Non-powered Slam Bar(3)	1	30	10	84	0.01	15
Diesel Generator	1(4)	30	10	81	0.01	15

Notes:

dBA =A-Weighted Decibel

in/sec = Inches per second

Hz = Hertz

PPV = Peak particle velocity

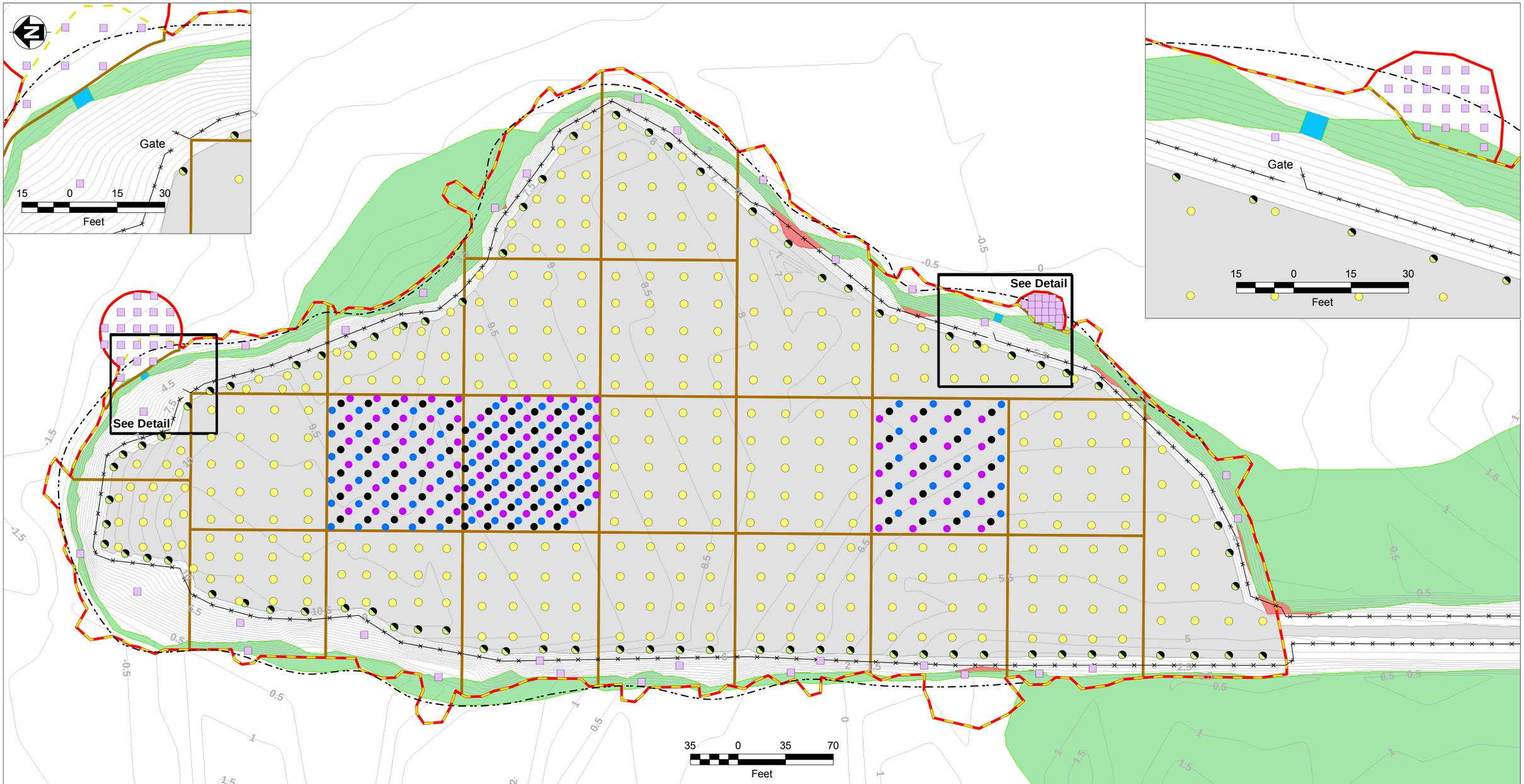
(1) Typical vibration from transportation and non-blasting construction sources falls in the low frequency range of 5 to 30 Hz and usually centers around 15 Hz. Professional judgement was used to identify values in Table 3 based on this range and measured or reported values for similar equipment (Jones and Stokes 2004; New Hampshire Department of Transportation 2012). Vibrations are anticipated from the hydraulic hammer on the direct-push rig drill bit whenever dense material is encountered. Typically, the drill rig will move to a new boring if soil is too dense or debris is encountered. Some hammering is anticipated for every boring; however, hammering is anticipated to occur only about 5 percent of the time. The materials in the FSFA are mostly a mixture of debris and non-structural soil material. These materials are intermixed and inconsistent and as such do not easily transmit vibrations. Forces from impacts are not anticipated to propagate very far beyond the localized point of impact (New Hampshire Department of Transportation 2012).

(2) Based on noise from a jackhammer, which is similar to that of the hydraulic hammer on a direct push rig and applicable to the noise level of the direct push drill rig. Value is from Actual Measured L_{max} based on the average of hundreds of exposure measurements performed at work sites. Total noise output for three drill rigs and one hand auger is estimated to be 94.2 dBA at 50 feet (U.S. Department of Transportation 2006).

(3) Hand samples may use a power hand auger or non-powered slam bar. The slam bar is a hand tool that is expected to generate less noise than a jackhammer, and noise and vibration similar to those of a power hand auger or pneumatic tool, but would be non-continuous (percussive) (U.S. Department of Transportation 2006).

(4) One generator would be stationed adjacent to the mobile field trailer atop the FSFA peninsula to power the field trailer lights. One generator would be stationed at the primary staging area at the south end of the AOI 14 FSFA to power a spray washer during wet decontamination, and would cycle on and off as needed. Wet decontamination would be necessary only during times of rain. As such, noise values are based on one generator operating for the duration of the work day.

(5) Total estimated noise output from Full-Scale Investigation activities: 94.4 dBA. Maximum combined noise levels were calculated using the online calculator: https://noisemeters.com/apps/db-calculator.asp (U.S. Department of Transportation 2006).



DPT vertical borings
DPT angle-hole borings
Hand auger boring

Pilot Study Sampling Increment Location
- Replicate 1
- Replicate 2
- Replicate 3
- ICAM Silt Fence (Existing)

Exclusion Fence
Topographic Contour (0.5-foot interval)
Investigation Area Grid
Apparent artificial fill boundary inferred from geophysical survey
Removal Action Boundary

Vehicle traffic, no pickleweed
Pickleweed undisturbed by Pilot Study
Pickleweed disturbed by Pilot Study (0.02 acre)
Pickleweed disturbed by full investigation (64 square feet/ 0.001 acre)

Notes:

AOI	Area of Investigation
DPT	Direct-push technology
ICAM	Interim corrective action measure
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 7

Proposed Full-Scale Investigation Sampling Locations

Biological Assessment for AOI 14 Removal Action

2/14/2017 V:\NASA\Projects\007_BA\07_Proposed_Sampling_Full_Scale.mxd TtEMI-ABQ simon.cardinale

The Full-Scale Investigation will include the following activities:

- Biological surveys and FSFA peninsula top vegetation removal:
    - No more than 3 days prior to IAG surveying and marking (described below) and Full-Scale Investigation sampling, a USFWS-approved biologist will conduct a walking survey of the FSFA and a visual survey of the surrounding environs to determine the presence or absence of special status species in the area.
    - The USFWS-approved biologist will be on site daily during surveying and sampling activities and will remain on site for the duration deemed necessary by the biologist, using decision criteria stated above (under Pilot Study). Hand auger borings on FSFA peninsula slopes and in the SWRP in areas of pickleweed will be conducted in the presence of a USFWS-approved biologist. Additional conservation measures are described in Section 2.5.
- Mark locations: All drilling and hand auger locations will be marked in each IAG, including locations on the side slopes and within the SPIAGs, applying the same methods as the Pilot Study.
- Additional vegetation removal along footpaths:
    - The exclusion fence layout and vegetation clearing (4-foot buffer from fence line) conducted for the Pilot Study may exclude some single-sample hand-auger areas along the slopes. Sampling along the slopes will occur in the presence of a USFWS-approved biologist. To minimize disturbance, no pickleweed will be removed from these areas.
    - For safe access to hand-sampling areas within the SWRP (SPIAG02 and SPIAG01), the exclusion fence will be modified to create an opening, and pickleweed will be cleared from a small swath (less than 10 feet wide) to create a footpath to the sample area. Access areas and pickleweed removal are shown on Figure 7. Pickleweed removal areas will be surveyed with a handheld GPS instrument.
- Collect ISM samples: The Full-Scale Investigation will follow the same ISM protocol as outlined for the Pilot Study. ISM samples representing the initial, secondary, and final DUs will be collected. ISM increment compositing will be conducted at a field location on the FSFA. Samples will be collected from direct-push and hand-augered borings.
    - Direct-push borings: ISM samples will be collected from between 21 and 23 FIAGs (one to two of the Pilot Study IAGs may be resampled if 30 or 40 increments are necessary) with 20, 30, or 40 increments, from multiple depth intervals. The number of increments will be determined by results of the Pilot Study.

- Hand-augered borings: Hand augers will be used to collect soil at FIAGs that are located on the perimeter of the FSFA, and in SPIAGs located in the SWRP (Figures 4 and 7). At FIAGs, a hand auger will be used to collect soil to represent the side slopes and the SWRP sediment located within the FIAG boundary. Soil from these borings will be incorporated into the ISM soil sample from the direct-push borings. In addition, SPIAG ISM samples will be collected from the two SPIAGs with the same number of increments as the FIAG samples (20, 30, or 40, as determined by the Pilot Study), collected in a gridded pattern. The SPIAG samples will be collected to total depths of 1 foot bgs. Two vertical DUs have been established at each SPIAG; the top interval ranges from 0 to 0.5 foot bgs, and the bottom interval ranges from 0.5 to 1 foot bgs.

- Analyze ISM samples: All ISM soil samples will be analyzed at an off-site laboratory for lead, DDE, DDE, DDT, and PCBs as Aroclors on a 5-day TAT.

2.1.3 Removal

The Removal has an expected duration of 12 months and will follow evaluation of the Pilot Study and Full-Scale Investigation data and final determination of excavation design. Removal will consist of the stages described below, some of which may occur concurrently.

2.1.3.1 Mobilization

Mobilization is expected to occur over a period of approximately one month. Prior to excavation, a utility clearance and pre-construction photographic survey of the site, including all potential contractor staging areas and the haul route will be conducted. The utility clearance is routinely conducted for construction sites to avoid inadvertently striking utility lines, and the photographic survey is conducted for photographic documentation of conditions before and after the Removal Action.

Prior to excavation, the following activities (biological surveys, vegetation removal, and exclusion fence realignment) will occur to support protection of federally listed species:

- No more than 25 days prior and again 3 days prior to commencing site excavation, the USFWS-approved biologist will survey the FSFA via a site walk and will visually survey the Action Area for the presence of special status species.

- The exclusion fence constructed before the Pilot Study may be relocated based on the anticipated excavation area, after results of the ISM sampling are evaluated. The ICAM silt fence will remain in place unless it hinders Removal activities; if it does hinder activity, the existing silt fence will be relocated farther outside the work area. In this case, the ICAM silt fence will be modified with Visqueen sheeting to act as the exclusion fence, depending on the location of Removal activities in relation to the existing silt fence.

- Prior to excavation, pickleweed will be hand-removed from areas requiring excavation and within 4 feet of the exclusion fence, under the supervision of the USFWS-approved biologist, per guidelines on vegetation removal set in a previous formal consultation for the salt marsh harvest mouse (USFWS 2016a). Pickleweed removal areas will be surveyed with a handheld GPS instrument. Pickleweed will not be removed from areas of the FSFA that do not require disturbance. Conservation measures are detailed in Section 2.5. The areas of pickleweed potentially disturbed by sampling and excavation activities are shown on Figure 8.

- Other areas of the project footprint will be cleared and grubbed as necessary, including laydown or staging areas and upland areas of the FSFA. All clearing and grubbing activities will be conducted under the supervision of a USFWS-approved biologist. Clearing and grubbing may include removal of large bushes and surface debris such as concrete blocks, rebar, and asphalt. Areas not to be excavated will not be disturbed, except to remove debris that may pose a health and safety risk (such as exposed rebar).

- A USFWS-approved biologist will monitor mobilization, excavation, and loading activities and will provide guidelines to minimize impacts of Removal activities on the surrounding habitat.

- Additional conservation measures are detailed in Section 2.5.

Stormwater may accumulate in the SWRP surrounding the FSFA, particularly in the wet season from October through April. Water diversion efforts or temporary dams may be necessary to prevent stormwater from entering the project footprint. Water diversion will include a combination of temporary dams and localized dewatering in areas targeted for excavation. Temporary dams may consist of plastic-partition-type (Porta Dam or equal) or bladder-type inflatable dams (Aqua Dam or equal). Temporary dam installation and layout will be coordinated with NASA Ames personnel and the USFWS-approved biologist and will occur within barren areas of the SWRP or as close to the excavation area as feasible to minimize disturbance of pickleweed. Existing stormwater within the project footprint during and immediately after the temporary dams are installed will be pumped over the dam and into the SWRP using a portable diesel generator with secondary containment. Stormwater that falls on the project footprint during Removal activities may also accumulate behind the dams and exclusion fence. Water that accumulates within the project footprint will be collected in small sumps, filtered to remove sediment, and pumped via a centrifugal or diaphragm pump into the SWRP, or will be containerized and disposed of along with wastewater from the decontamination station. The temporary dams will be removed as soon as possible when they are no longer required or after excavation and regrading activities are complete.

The West-Side Aquifers Treatment System (WATS), a contaminated-groundwater treatment system, discharges treated groundwater at a rate of approximately 50 gallons per minute into the Eastern Diked Marsh stormwater retention (settling) basin, which eventually discharges to the SWRP. WATS effluent may be diverted away from the SWRP before construction activities begin, to reduce the standing water within the project footprint or for use during construction.

ICAM Silt Fence (Existing)
Anti-Perch Locations
Exclusion Fence*
Topographic Contour (0.5-foot interval)

Investigation Area Grid
Apparent artificial fill boundary inferred from geophysical survey
Removal Action Boundary

Pickleweed† undisturbed by Removal Action
Pickleweed† disturbed by both the Pilot Study and Full-Scale Investigation (0.02 acre)
Pickleweed† potentially disturbed by Removal (0.6 acre)

Notes:

*	The final layout of exclusion fence for the Removal is to be determined. Layout depicted here is applicable to the Pilot and Full-Scale Investigation.
†	Pickleweed depicted is based on mapped extent in July 2016, 100 feet out from FSFA boundary (NASA 2016).
AOI	Area of Investigation
FSFA	Former Soil Fill Area
ICAM	Interim corrective action measure
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 8

Pickleweed Potentially Disturbed by Removal Action

Biological Assessment for AOI 14 Removal Action

2/14/2017 V:\NASA\Projects\007_BA\08_pickleweed_disturbed.mxd TtEMI-ABQ simon.cardinale

The WATS effluent water is routinely sampled for analysis of volatile organic compounds (VOC) and other constituents and is typically devoid of contamination (Earth Resources Technology, Inc. [ERT] 2017).

If necessary, the WATS water will be diverted by application of the same methods used for the Navy IR Site 25 remedial action (ITSI Gilbane 2012). The diversion of WATS water will entail installing a lift pump, powered by a diesel generator or existing electrical supply, into an existing manhole at the connection to the stormwater retention basin south of the Eastern Diked Marsh. The pump (and generator, if used) would cycle on and off based on the level of water in the manhole. The pump discharge will be connected to temporary pipes or fire hoses and directed to an existing catch basin east of Zook Road and west of the Moffett Federal Airfield flight line. The catch basin will convey the water by gravity eastward under the flight line to join the NASA storm drainage system, eventually discharging to the Northern Channel (Figure 6). From the Northern Channel, water is pumped into the Sunnyvale West Flood Control Channel.

Alternatively, if WATS water is used for construction purposes (dust control or equipment decontamination), the water will be diverted from the Eastern Diked Marsh to the FSFA or contractor staging areas. The Removal contractor will prepare a water diversion plan for approval by NASA Ames before diverting the WATS water to the construction area.

The contractor will use the primary staging area set up for the Pilot Study and Full-Scale Investigation. If an additional staging area is needed, the contractor may establish a secondary staging area at N217A (Figure 6). Additional exclusion fence will be constructed around the secondary contractor staging/laydown area at the N217A area, if the contractor plans to use this area during Removal activities. The following items will be stationed at either the primary or secondary staging area:

- Sanitary facilities (including personnel decontamination facility, portable toilets, non-potable water, and drinking water).
- Equipment decontamination facility (rumble strips, dry decontamination area, and wet decontamination area with liner and wastewater collection and storage).
- Facilities for refueling construction equipment, including fuel tanks with secondary containment, fueling nozzles, and containment facilities to prevent spills during refueling.
- Staging areas for equipment and material when not in use, including materials necessary to repair or maintain roads damaged during construction, materials used to construct stormwater or biological mitigation measures, and fencing.
- Generator for on-site power.

Anticipated equipment is detailed in Table 4 and includes tractor trailers to move equipment and office/sampling facilities, front-end loaders with slings to move materials, diesel generators for power, and hand tools. Table 4 lists the types of equipment used, durations of use, and estimated associated noise and vibration levels anticipated for the Removal and categorized by phase (A—Mobilization and site preparation; B—Excavation, loading, and disposal; C—Final grading, site restoration, and demobilization). Numbers of items and duration of use for each type of equipment are estimated based on data presented in the EE/CA (Tetra Tech 2015). Actual numbers and durations will be determined by the contractor based on results of the Full-Scale Investigation.

Stormwater pollution control Best Management Practices (BMPs) will be employed to prevent migration of surface water runoff into the adjacent SWRP. Erosion control BMPs are detailed in the project *Stormwater Pollution Prevention Plan* (SWPPP) (Appendix G of the *Area of Investigation 14 Removal Action Work Plan*) (Tetra Tech 2017). These BMPs include use of berms around material storage and refueling areas, vehicle tracking controls (such as rumble strips) to prevent dirt from exiting the site, tire washes, and street sweepers to collect soil at the site exit and on the haul route. Table 5 lists SWPPP BMPs and their schedules for implementation.

Dry decontamination methods will be applied to the maximum extent possible to clean excavators, backhoes, trucks, and other associated tools and equipment. If decontamination fluids are used, equipment decontamination areas will be established in an upland area of the FSFA and at any staging areas to avoid tracking of contaminated soil off site. Decontamination water will be contained, collected in a storage tank, and reused on site or disposed of at a licensed disposal facility, based on characterization results. Solids collected in the decontamination area will be stored and characterized for subsequent reuse or disposal.

2.1.3.2 Excavation

The AOI 14 FSFA excavation areas, depths, and volumes will be determined based on the results of the Pilot Study and Full-Scale Investigation and may include soil and construction debris at the FSFA and soil and sediment within the adjacent SWRP. The expected duration of the excavation is approximately 10 months.

The contractor will excavate and segregate construction debris, soil, and sediment from each IAG at the FSFA according to ISM sampling results. Construction debris encountered during excavation or on the surface of the FSFA in work areas will be removed, segregated from the soil and sediment, and transported to an appropriate landfill for disposal or recycling. Soil and sediment with contaminant concentrations greater than the cleanup goals will be loaded into trucks for off-site transportation and disposal.

Table 4: Removal Equipment—Estimated Noise and Vibrations

Equipment	Quantity	Duration of Use	Use Each Day (hours)	Noise Level(1) (dBA at 50 feet)	Maximum Combined Noise (dBA at 50 feet)	Vibration Output(2) PPV at 50 feet (in/sec)	Vibration Output(2) Frequency at 50 feet (Hz)	Equipment Phase
Tractor Trailer	2	2 weeks	10	90[3]	93	0.010	40	A, C
Diesel Generator	1[4]	12 months	10	81	81	0.010	15	A, B, C
Drill Rig	1	1 day	3	84	84	0.03	35	A
Hydraulic Excavator	2	10 months	10	81	84	0.019	40	B
Bulldozer	4	12 months	10	82	88	0.03	40	A (1), B (4), C (1)
Front-End Loader	2	10 months	8	79	82	0.019	40	B
Backhoe/Loader	1	3 months	10	78	78	0.015	40	B
Small Dragline Excavator	1	1 month	10	81	81	0.019	40	B
Dump Truck	32/[95](5) loads/day	10 months/ [20 days](5)	8	76	79	0.009	35	B
Grapple Truck	1	1 month	10	87	87	0.03	45	B
Scraper	1	6 months	10	84	84	0.015	46.8	B, C
Grader	2	2 months	10	85	88	0.015	40	B, C
Roller/Compactor	2	2 months	10	80-83	83-86	0.210	30	B, C

Notes:

dBA = A-Weighted Decibel

ft = Foot

in/sec = Inches per second

Hz = Hertz

PPV = Peak particle velocity

Equipment Phase: A—Mobilization and site preparation; B—Excavation, loading, and disposal; C—Final grading, site restoration, and demobilization.

(1) Values are from Actual Measured L_{max} based on the average of hundreds of exposure measurements performed at work sites. The total maximum combined noise output (at 50 feet from the source) is estimated to be 94.1 dBA for Phase A, 94.7 dBA for Phase B, and 95.4 dBA for Phase C. Noise outputs may be less, depending on what equipment is running concurrently. Maximum combined noise levels were calculated using the online calculator: https://noisemeters.com/apps/db-calculator.asp (U.S. Department of Transportation 2006).

Table 4 Notes (Continued): Removal Equipment—Estimated Noise and Vibrations

(2) Typical vibration from transportation and non-blasting construction sources falls in the low frequency range of 5 to 30 Hz and usually centers around 15 Hz. Professional judgement was used to identify values in Table 4 based on this range and measured or reported values for similar equipment (Jones and Stokes 2004; New Hampshire Department of Transportation 2012). Impacts of vibrations from construction equipment are low because the vibrations are not expected to propagate far from the source. Impacts of vibrations can increase when construction equipment contacts large debris. The impacts will be short-term moderate vibrations in a localized area. The materials in the FSFA are mostly a mixture of debris and non-structural soil material. These materials are intermixed and inconsistent and as such do not easily transmit vibrations. Forces from impacts are not anticipated to propagate very far beyond the localized point of impact (New Hampshire Department of Transportation 2012).

(3) Value from semi-truck noise level (Signal Communications Corporation 2016).

(4) Up to four generators may be used at various locations and at different times during the Removal. One generator may be stationed at the primary staging area at the south end of the AOI 14 FSFA to operate a power spray washer for wet decontamination and equipment fueling; one generator may be stationed at the secondary staging area in the event that refueling is stationed here instead of the primary staging; a third may be placed in the contractor trailer area but may be unnecessary if connection is available to a nearby NASA Ames electrical source. A fourth generator may be necessary to pump water from excavation areas within the SWRP. At the FSFA, only one generator is accounted for in the noise calculations, as it is unlikely that all would run concurrently or continuously.

(5) During dry periods, high-volume transportation and loading may occur; truck trips may increase for up to 20 days and no more than 5 consecutive days, for an estimated maximum of 95 loads removed per day. Combined noise assumes up to two trucks at a time on the peninsula. Additional trucks would wait on paved and gravel surfaces along the haul route as shown on Figure 6, and would not idle longer than 5 minutes. In the event that high-volume transportation and loading occur, the overall duration of excavation would decrease by an estimated two months.

Table 5: BMP Implementation Schedule

	BMP	Implementation	Duration
Erosion Control	EC-1 Scheduling	Prior to construction	Entirety of project
	EC-2 Preservation of Existing Vegetation	Start of construction	Entirety of project
	EC-4 Hydroseed	When area will no longer be disturbed	Two weeks after excavation is complete
	EC-15 Slope Roughening	When excavation is complete	End of project
Sediment Control	SE-1 Silt Fence	Start of construction	Entirety of project
	SE-5 Fiber Rolls	Upon final grading of slopes	Through final stabilization
	SE-7 Street Sweeping	As needed	Entirety of project
Tracking Control	TC-1 Stabilized Construction Entrance and Exit TC-3 Entrance Outlet Tire Wash	Prior to construction	Entirety of project
Wind Erosion	WE-1 Wind Erosion Control	Upon soil movement	Entirety of project
Non-Stormwater BMPs	NS-1 Water Conservation Practices NS-2 Dewatering Operation NS-5 Clear Water Diversion NS-6 Illicit Connection/Discharge NS-9 and 10 Vehicle and Equipment Fueling and Maintenance	Beginning of construction	Entirety of project
Temporary Materials Management	WM-01 Material Delivery and Storage WM-02 Material Use WM-03 Stockpile Management WM-04 Spill Prevention and Control WM-05 Solid Waste Management WM-06 Hazardous Waste Management WM-07 Contaminated Soil Management WM-09 Sanitary Septic Waste Management WM-10 Liquid Waste Management	Beginning of construction	Entirety of project

Note:

BMP = Best management practice

Based on the results of the geophysical investigation and discrete soil sampling at the FSFA prior to 2016, an estimated amount up to 65,000 (bank) cubic yards of material may be excavated. However, the actual volume of material necessary to be excavated will be based on results of the Full-Scale Investigation. It is assumed that up to 48,000 (bank) cubic yards will be excavated, sampled, and disposed of at a nonhazardous waste landfill, and up to 3,000 (bank) cubic yards will require disposal at a hazardous waste landfill. Assuming a bulking factor of 40 percent and use of trucks with capacities of 20 cubic yards, up to approximately 3,400 loads will be hauled through NASA Ames, Moffett Field, and the surrounding community. The excavation will not extend significantly below the grade of the surrounding SWRP and is not expected to encounter groundwater because the fill material was placed on top of native soil to create a peninsula.

Soil and sediment with contaminant concentrations less than cleanup goals will be left in place or, if necessary, staged and stockpiled for use in developing the final grade of the site. All activities will be conducted under the supervision of a USFWS-approved biologist.

The contractor will abandon existing monitoring well 10A01A (Figure 3). Monitoring well 10A01A extends to 20 feet bgs, which is below the anticipated extent of fill material at that location. The monitoring well will be drilled out or pressure grouted in accordance with Santa Clara Valley Water District Well Ordinance 90-1.

During the Removal, the contractor will coordinate with NASA Ames to establish truck routes and holding areas. Anticipated truck routes are shown on Figure 6. All trucks transporting excavated material from the FSFA will strictly follow the designated haul route. During high-volume transportation and disposal operations, traffic controls will include signage and flagmen. Traffic controls will be consistent with guidance from the *California Manual on Uniform Traffic Control Devices for Streets and Highways* (CalTrans 2014). The area near Gate H will serve as the truck waiting area, where trucks will remain until they are ready to be loaded (Figure 6). The trucks will then proceed to the FSFA to receive their loads. Waiting trucks will not idle for longer than 5 minutes, in accordance with California Environmental Protection Agency regulations (California Code of Regulations, Title 13, Division 3, Article 1, Chapter 10, §2485).

A USFWS-approved biologist will monitor the excavation and loading and will provide guidelines to minimize the impact on the surrounding habitat. Conservation measures are detailed in Section 2.5.

2.1.3.3 Grading

Disturbed areas will be graded during and after excavation for stormwater drainage. Bulldozers and road graders will move the temporarily stockpiled clean soil into excavated areas. Final grades generally will be sloped to minimize erosion and maximize the area for optimal pickleweed growth (which currently occurs in the SWRP at elevations ranging from 0.5 to 3.5 feet above MSL). Clean soil, rock, and other structures not posing a worker or site visitor safety risk may be left in place. Any rebar or other dangerous materials will be removed.

The final site grading will be determined by the extent of the excavation and disturbed areas. It is anticipated that the final grading plan will be consistent with the surrounding SWRP, with similar bottom elevations, gentle slopes, and uplands. Erosion control devices, such as fiber rolls and sheeting to cover temporary stockpiles, will be installed during construction. Fiber rolls on the final slopes and ICAM silt fence will remain in place until vegetation is established.

2.1.3.4 Habitat Restoration

After regrading is finished, a hydroseeder—typically a water truck with seed, straw, and hoses—will spray pickleweed seed and other seeds native to the region over the surface of the regraded soils to create a vegetative cover. Restoration may include installation of nursery-grown container stock plants. The final site restoration design will be determined by the extent of the excavation and disturbed areas. It is anticipated that the final grading plan will support a mixture of wetland (vegetated salt marsh and salt panne), transitional habitat, and upland vegetation. Figure 9 is a conceptual drawing of final grading and planned vegetation communities. The final grading will include elevations conducive to pickleweed growth. Pickleweed disturbed during the Removal Action will be mitigated at a 3:1 ratio on site. It is anticipated that up to 0.62 acre of pickleweed may be disturbed, based on the extent of pickleweed mapped on site in 2016 and removal 4 feet beyond the exclusion fence boundary. Figure 8 depicts the area of potential pickleweed impacts based on the maximum potential area of FSFA requiring excavation.

Based on a 3:1 ratio, restoration would include at least 1.86 acres of pickleweed on site. Final acreages of impacts will be delineated after excavation activities are completed. Final grading will increase salt marsh habitat, with the goal of creating a sustainable site that supports native species. Restoration methods and performance criteria are detailed in the PSMHRP, which is an appendix in the *Area of Investigation 14 Removal Action Work Plan* (Tetra Tech 2017).

2.1.3.5 Demobilization

Demobilization is expected to occur over approximately 1 month. During demobilization, all equipment, offices, and materials that were moved onto the FSFA, staging/laydown areas, or other work areas will be removed. After field activities are complete, the contractor will conduct final cleanup of the site and all disturbed areas and will replace or repair any existing utilities (including any roads damaged by trucks or other equipment) or landscaping that was damaged during construction activities.

Conceptual final grade elevation

Current Topographic Contour (0.5-foot interval)

Apparent artificial fill boundary inferred from geophysical survey

Removal Action Boundary

Pickleweed Restoration Area (0.5 to 3.0 ft ft above MSL)

Transitional Vegetation Restoration Area (3.0 to 5.0 ft above MSL)

Upland Vegetation Restoration Area (Greater than 5.0 ft above MSL)

Notes:

AOI	Area of Investigation
ft	Feet
MSL	Mean sea level
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 9

Grading and Site Restoration Conceptual Plan

Biological Assessment for AOI 14 Removal Action

2/14/2017 V:\NASA\Projects\007_BA\09_grading_plan.mxd TtEMI-ABQ simon.cardinale

2.1.3.6 Restoration Monitoring and Maintenance

Areas where sensitive habitat is disturbed during the Removal Action will be restored. Monitoring and maintenance will occur following completion of the Removal Action excavation, for 5 years or until vegetation restoration performance criteria are met, to ensure the effectiveness of the restoration, which includes mitigation of disturbance to pickleweed. Maintenance work will be conducted by hand to the maximum extent possible. Materials and supplies will be transported to the site by truck, offloaded, and moved by hand into the restoration areas. Irrigation of upland and transitional plants will include the use of a water hog or water truck and hoses. No irrigation system is planned. Maintenance will include regular invasive species control by application of manual and chemical methods. Herbicide treatment will occur by a licensed qualified applicator, according to product labels, when no rain is anticipated, and, if applying by sprayer, on days with wind velocities less than 5 miles per hour. Herbicide used in or near the SWRP will be approved by EPA for use in wetlands.

Annual monitoring will occur in upland, transitional, and wetland habitats to determine the success of revegetation. Monitoring will include comparison of restoration site data with performance criteria and with data acquired concurrently at selected reference sites. Restoration and monitoring methods and performance criteria are detailed in the PSMHRP, which is an appendix in the *Area of Investigation 14 Removal Action Work Plan* (Tetra Tech 2017).

2.2 Definition of the Action Area

The Action Area, as defined by 50 CFR §402.02, includes all areas that could directly or indirectly affect federally listed species. The Action Area comprises the AOI 14 FSFA and a 700-foot buffer around all work areas that occur near open areas that may serve as habitat, as shown on Figure 6. The Action Area includes the AOI 14 FSFA, project staging and laydown areas at the FSFA and N217A, and a portion of the haul route that extends through areas with potential habitat for listed species, as shown on Figure 6. The contractor trailer area that will house health and safety and project management activities will be located either within the developed portion of NASA Ames or on an existing concrete pad within the Outdoor Aerodynamic Research Facility (OARF), south of the Eastern Diked Marsh. The contractor trailer area is not anticipated to have adverse effects on listed species.

The 700-foot buffer includes a portion of the following areas: Navy IR Site 25 SWRP, Eastern Diked Marsh, Western Diked Marsh, and roadsides of a portion of the haul route (Figure 6).

2.3 Current Management Direction/Regulatory Setting

Current management direction is based on guidance contained in either acts or codes that provide guidance for protecting threatened and endangered wildlife and plant biological resources. (Neither invertebrate or fisheries guidance is included because these species are not addressed in this BA). A description and list of the relevant documents, acts, and plans is provided below.

Federal jurisdiction and guidance for protecting threatened and endangered wildlife, plant, or fishery resources are addressed in the following laws:

- ESA (16 U.S.C. §§ 1531-1534);
- Fish and Wildlife Coordination Act (16 U.S.C. §§ 661-666c);
- Migratory Bird Species Act (16 U.S.C. §§ 703–712); and
- National Environmental Policy Act (42 U.S.C. §§ 4321-4370d).

Federal jurisdiction oversight for ESA-listed terrestrial species is provided by USFWS.

2.4 FEDERAL CONSULTATION ACTION HISTORY

The following is a summary of federal consultation actions that have been conducted to date (as of February 2017) for the AOI 14 FSFA:

In 2013, EPA issued a RCRA Order (RCRA-7003-09-2013-0002) requiring NASA to conduct immediate and long-term response actions for AOI 14. In December 2013, NASA implemented an ICAM by installing a silt fence barrier around the perimeter of the FSFA peninsula to prevent potential soil erosion from the peninsula into the Navy IR Site 25 SWRP. On September 25, 2013, NASA submitted a letter to USFWS requesting emergency consultation on the silt fence (NASA 2013).

On January 14, 2016, NASA Ames (Kimberly Finch, Donald Chuck, and Hugo Hoffman) and Leidos (Chris Alderete) communicated via email with USFWS (Kim Squires) to discuss biological resource and consultation-related questions regarding the NASA Ames AOI 14 Project. On January 29, 2016, USFWS responded with input via email regarding and confirming nesting plover buffer areas of 700 feet during periods of work, as well as confirmation that no hazing or exclusion had been allowed on any previous projects. USFWS replied that it was not aware of disturbance of nesting western snowy plovers having been included in previous BOs, included dates for nesting seasons for the plover, and emphasized the importance of having an experienced USFWS-approved biologist on site.

On June 28, 2016, NASA Ames (Kim Finch) and Leidos (Chris Alderete and Jessica Degner) participated in a teleconference with USFWS (Kim Squires) to discuss pre-removal sampling investigation activities (Pilot Study) at AOI 14 FSFA (Leidos 2016).

On November 9, 2016, NASA Ames (Kim Finch), Leidos (Chris Alderete and Jessica Degner), and Tetra Tech (Kevin Bricknell, Katie Henry, Ann Zoidis, Angela Lortie, Carolyn Hunter, Jean Michaels, Jason Brodersen, Dayna Aragon, and Diane MacMillan) personnel met with a USFWS representative (Anne Mankowski) to discuss AOI 14 Removal Action activities.

Other federal actions that have occurred in the Action Area and that required Section 7 consultations for the four species covered in this BA (western snowy plover, California least tern, California clapper rail, and salt marsh harvest mouse) include remediation of contaminated sediments at Navy IR Site 25 Eastern Diked Marsh in 2003 (Foster Wheeler Environmental Corporation 2003), Navy IR Site 25 SWRP in 2012 (ITSI Gilbane 2012), Navy IR Site 27 in 2006; and the AOI 15 fuel line demolition project in 2011 (NASA 2011). Navy IR Site 25 includes the Eastern Diked Marsh and SWRP, and Navy IR Site 27 includes the Northern Channel, North Patrol Ditch, and Marriage Road Ditch. The AOI 15 fuel line demolition project occurred at the northeast portion of NASA Ames at the NASA Fuel Pier and included portions of Northern Channel.

2.5 CONSERVATION MEASURES IN PLACE

The conservation measures detailed below are incorporated into the project description and are considered part of the Proposed Action. The source of the language below and specific guidance for these conservation measures were developed in conjunction with the USFWS and formalized in the AOI 14 BO (USFWS 2017).

2.5.1 USFWS-Approved Biologist/Biological Monitoring Measures

The following measures detail the roles and responsibilities of NASA and the USFWS-approved biologist.

BIO-1 At least 15 days prior to the onset of any construction-related activities or species/activities, NASA proposed and shall submit to the USFWS, for approval, the name(s) and credentials of biological monitors it requests to conduct activities specified for this project. Information included in a request for authorization must include, at a minimum: (1) relevant education; (2) relevant training on species identification, survey techniques, handling individuals of different age classes, and handling of different life stages by a permitted biologist or recognized species expert authorized for such activities by the USFWS; (3) a summary of field experience conducting requested activities (to include project/research information and actual experience with the species); (4) a summary of biological opinions and/or informal consultations under which they were authorized to work with the listed species and at what level (such as construction monitoring versus handling), and will include the names and qualifications of persons under which the work was supervised as well as the amount of work experience on the actual project including detail on whether the species was encountered or not; and (5) a list of 10(a)1(A) permits, if any, held or under which individuals are authorized to work with the species (to include permit number, authorized activities, and name of permit holder). No project activities shall begin until the NASA has received written USFWS approval for biologists to conduct specified activities.

BIO-2 A USFWS-approved biologist will be on site daily for the duration of the proposed project, with varying daily frequency as determined by that biologist using decision criteria including the current nature of project activities, degree of noise or disturbance they are producing, intensity of activities, presence of species, or other factors. The biologist(s) will be responsible for monitoring compliance with and implementation of conservation measures and reasonable and prudent measures. The biologist(s) will have stop-work authority in the event of non-compliance with the measures and for protection of salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern, as stipulated in the measures.

BIO-3 A USFWS-approved biologist will monitor the site's fencing to ensure it is functioning properly and will monitor the fencing and staking to ensure they do not serve as raptor perches. In addition to the requirement specific to the perimeter fence that is articulated in Conservation Measure #20, if any fencing in the project site is found to act as perches, a USFWS-approved biologist will modify the fence and staking with non-lethal anti-perch devices (spike strips or other non-lethal devices) to prevent raptor predation.

BIO-4 One or more USFWS-approved biologists will conduct a training session for all project personnel and visitors prior to the beginning of any ground-disturbing and vegetation-clearing activities within the project footprint. All personnel or visitors entering the areas with any ground-disturbing and vegetation-clearing activities must attend. The training will be developed and implemented by the USFWS-approved biologist and a copy of the training module will be given to each person working on the project with other available copies to be kept in the project management trailer. The training module will include general provisions of the Act and penalties associated with violating those provisions, conservation measures and reasonable and prudent measures listed in the biological opinion, color photographs, a brief natural history description, and description of habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. The module will also include descriptions of pickleweed, the protection of which is important to the salt marsh harvest mouse, and the invasive pepperweed (*Lepidium latifolium*) with practices to avoid its spread.

For work in non-sensitive habitats, environmental briefings will occur weekly or as needed. A USFWS-approved biologist will keep the NASA informed about significant biological resources observed on site, such as nests that require buffers. The NASA and contractors will comply with all input from a USFWS-approved biologist throughout the duration of the project. For work in non-sensitive habitats, environmental briefings will occur weekly or as needed. A USFWS-approved biologist will keep NASA informed about significant biological resources observed on site, such as nests that require buffers. NASA and contractors will comply with all input from the USFWS-approved biologist throughout the duration of the project.

BIO-5 A USFWS-approved biologist will monitor the site's fencing to ensure it is functioning properly and will monitor the fencing and staking to ensure they do not serve as raptor perches. In addition to the requirement specific to the perimeter fence that is articulated in Conservation Measure #20, if any fencing in the project site is found to act as perches, a USFWS-approved biologist will modify the fence and staking with non-lethal anti-perch devices (spike strips or other non-lethal devices) to prevent raptor predation.

2.5.2 General Conservation Measures

General biological resource conservation measures (which would apply to any listed species) and species-specific measures for the salt marsh harvest mouse and western snowy plover are detailed below. These species would also benefit from additional BMPs detailed in the project SWPPP (Appendix G of the *Area of Investigation 14 Removal Action Work Plan*), which is designed to minimize pollution, contain contamination, and control erosion (Tetra Tech 2017).

BIO-6 All construction activity will occur within the project footprint, which includes the removal action area, approximately 4 feet beyond the removal action area exclusion fence to include vegetation/pickleweed removal areas, and staging and laydown areas. All parties entering the project footprint will be provided maps showing the project boundaries and access and staging areas and will be informed that construction activity must be confined to those corridors. Maps will include the locations of listed species and habitats and U.S. Army Corps of Engineers (Corps) jurisdictional waters.

BIO-7 Before construction begins, work areas will be clearly marked with flagging tape to avoid unintended impacts to sensitive areas and to minimize impacts to vegetation and salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern habitat. If stakes are used for flagging, they will not exceed 3 feet in height, to avoid use as perches by predatory raptors. Flagging will be removed promptly when the proposed project is complete.

BIO-8 Work will occur only during daylight hours.

BIO-9 Trash will be disposed of properly, and work sites will be kept trash free to reduce animal attraction. Trash cans must have secure lids that close tightly.

BIO-10 Staging will occur only in designated staging areas.

BIO-11 The existing ICAM silt fence will be maintained during all excavation activities to prevent migration of sediments into adjacent downgradient habitat (SWRP) and according to the salt marsh harvest mouse-specific conservation measures (BIO-23, BIO-24, BIO-25, and BIO-26).

BIO-12 Construction equipment, including workers' boots, will be cleaned of soil, seed, and plant material before entering the work site to prevent introduction of pepperweed. Workers will avoid walking through patches of pepperweed to the extent feasible.

BIO-13 Noise-reducing devices will be used during sampling and excavation activities to the extent practicable. These devices will include baffles and mufflers for construction equipment and temporary noise barrier walls around stationary noise sources such as generators. Noise-reducing practices will also be implemented where feasible, such as limiting the number of pieces of equipment running concurrently, prohibiting machinery and vehicle idling, limiting the practice of disaggregating rubble and concrete, and avoiding dropping loads into empty beds from a greater height than necessary.

BIO-14 Vehicular traffic will be confined to established access and haul routes. Dump trucks waiting to access the site will not be allowed to idle their engines for more than 5 minutes, in accordance with California Environmental Protection Agency regulations (California Code of Regulations, Title 13, Division 3, Article 1, Chapter 10, Section 2485). Dump trucks waiting for access will stay on areas of gravel or paved roadways. Trucks will not be allowed to drive or park on vegetated areas along the haul routes.

BIO-15 Any period of intense haul traffic (up to 95 loads per day) will only be allowed to occur a maximum of 20 days throughout the entire proposed project duration and for no more than 5 consecutive days at a time.

BIO-16 Equipment fueling will be confined to within upland bermed areas with spill prevention kits.

BIO-17 NASA will finalize a SWPPP (Appendix F of the *AOI 14 Removal Action Work Plan*) that will include additional details for stormwater pollution prevention. No part of the final SWPPP will replace any part of the BO without reinitiating formal consultation with USFWS. USFWS will review the final draft of the SWPPP and provide NASA with comments regarding any lack of consistency with elements articulated in the BO.

BIO-18 Non-native vegetation removed during the Removal Action (during mowing and excavation) shall be disposed of at a municipal landfill.

BIO-19 Potential perches and wildlife cover (stacks of wood, pallets, and piles of debris) will be removed from the project footprint as quickly as possible and as much as is feasible. If they cannot be removed in the short term, they will be covered with tarps and/or enclosed with exclusion fencing. Minimization of these habitat elements will reduce listed species' attraction to these areas, and a lack of perch opportunities will reduce potential predation on these species.

BIO-20 The NASA perimeter fence in the vicinity of salt marsh harvest mouse habitat in the storm water retention pond along North Perimeter Road will be modified with non-lethal anti-perch devices (spike strips or other non-lethal devices) to prevent raptor predation on salt marsh harvest mice, western snowy plovers, California clapper rails, and California least terns. Additional perch deterrents will be installed at structures adjacent to the SWRP, as feasible.

BIO-21 Any construction personnel who inadvertently injure or kill a salt marsh harvest mouse, western snowy plover, California clapper rail, or California least tern will immediately report the incident to the USFWS-approved biologist(s). The USFWS-approved biologist(s) will immediately notify the NASA, who will immediately notify the USFWS by telephone and email. The NASA will follow up with written notification to the USFWS within 5 working days of the incident by providing a hardcopy of the incident report.

BIO-22 NASA will compensate at a 3:1 ratio for impacts to pickleweed habitat by restoring/creating three times as much pickleweed habitat on site as is damaged or destroyed by the Removal Action. It is estimated that up to 0.62 acre of pickleweed may be disturbed and will be compensated for by restoring up to 1.86 acres on site. Final acreages of impacts will be delineated after completion of excavation activities.

2.5.3 Species-Specific Measures

Conservation measures specific to federally listed species are detailed below.

Salt Marsh Harvest Mouse-Specific Measures

BIO-23 **Surveys:** Prior to the beginning of ground disturbance, one or more USFWS-approved biologists will survey the project footprint and for a distance of 10 feet beyond the project footprint for salt marsh harvest mice.

a. Surveys will be conducted no more than 3 days prior to sampling activities and no more than 25 days prior (and repeated 3 days prior) to excavation activities.

b. Surveys will be repeated daily prior to the beginning of project activities at the proposed project site; one or more USFWS-approved biologists will survey the proposed project site to ensure it is clear of salt marsh harvest mice.

c. In the event that a salt marsh harvest mouse is encountered, work will be halted and a no-work zone of at least 10 feet will be maintained around the animal until the animal has moved out of the area of its own volition. If deemed necessary by the USFWS-approved biologist, work will be relocated to other areas, as directed by the biologist, to minimize disturbance from noise, human presence, or vibration. Work will not occur in this area until it is deemed clear of mice by the USFWS-approved biologist. Survey reports shall be submitted to the USFWS quarterly and at the end of the project and should include GPS locations (latitude and longitude) and dates for observed individuals.

d. The USFWS shall be notified within 1 day when any nest is found. Nest information reported to the USFWS shall include a GPS location of the nest (latitude and longitude), condition of the nest, and status of nesting activity (nest construction, feeding young, etc.). Active nests shall be monitored twice weekly. Nest fate information shall be reported to the USFWS upon nest failure or successful weaning, and information reported should include a GPS location of the nest (latitude and longitude), dates of monitoring, number of young in the nest, and fate of young upon final nest report.

BIO-24 **Vegetation clearing**:

a. Once deemed clear of mice by a USFWS-approved biologist, the upland portion of the proposed project footprint to within 50 feet of the edge of pickleweed will be mowed to stubble no higher than 1 inch. The biologist will walk a safe distance in front of the mower to ensure no salt marsh harvest mice are present.

b. Once deemed clear of mice by a USFWS-approved biologist, vegetation within 50 feet from the edge of pickleweed will be removed by hand or cut to ground level (using hand tools) in the presence of a USFWS-approved biologist. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving down the slope toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

c. On slopes within the proposed project footprint, in areas deemed clear of mice and nests, pickleweed will be removed by hand or cut to ground level (using hand tools) in the presence of a USFWS-approved biologist. The biologist will walk a safe distance in front of vegetation removal to ensure no salt mice harvest mice are present. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation. Where feasible, pickleweed will be salvaged for off-site nursery propagation for use in habitat restoration on site.

d. Vegetation will be cleared by hand or cut to ground level (using hand tools) in the presence of a USFWS-approved biologist to create a 4-foot buffer from the outside edge of the layout for the exclusion fence, and in a small swath (no more than 10 feet wide), to create footpaths to sampling locations in the SWRP. The biologist will walk a safe distance in front of vegetation removal to ensure no salt mice harvest mice are present. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

e. Vegetation will not be cleared in the vicinity of a salt marsh harvest mouse nest. The no-work zone established in conservation measure BIO-23 (c) will be adhered to, and a vegetated path from the nest and the no-work zone to another larger patch of pickleweed within the SWRP will be left in place to allow movement of mice after weaning. After weaning, the area where the nest occurred could be cleared if necessary and with approval from a USFWS-approved biologist.

BIO-25 **Exclusion fencing:** Under supervision of a USFWS-approved biologist, a temporary exclusion fence will be installed as close to the anticipated work areas as practicable.

a. Before the fence is installed, conservation measures BIO-23 and BIO-24 will be implemented. A USFWS-approved biologist will inspect the fence area for salt marsh harvest mice. If a mouse is observed, it will be allowed to leave the

area of its own volition. Work will not continue in this area until it is deemed clear of mice by the USFWS-approved biologist.

b. The exclusion fence will be no higher than 3 feet to prevent raptor perching and will include low-density polyethylene sheeting, such as Visqueen, to prevent mice from climbing the fence to enter the area. The sheeting will be buried at least 4 inches below the ground surface to prevent mice from burrowing under the fence. Support posts will be on the inside of the fence (work area side).

c. The fence will extend around and enclose the entire Removal Action boundary, the access road and contractor staging/laydown area on the southern end, and the secondary staging area (N217A), if used. The site entrance will be closed and secured with sand bags or other material at the conclusion of each workday.

d. Prior to excavation activities, the exclusion fence will be realigned to enclose areas requiring excavation along the perimeter of the proposed project site. In some areas (to be determined based on the extent of the excavation), it may be practicable to modify the existing silt fence with low-density polyethylene sheeting such as Visqueen to function as the exclusion fence.

e. In the event of a significant lag time between work phases, the exclusion fence will be modified to have 5-foot openings every 100 feet (or whatever distance allows movement of mice across the upland/wetland interface to large pickleweed patches within the SWRP). The fence gaps will be closed after project activity recommences and upon approval by a USFWS-approved biologist.

BIO-26 A USFWS-approved biologist will monitor the exclusion fencing to ensure that it remains an effective barrier to prevent entry of salt marsh harvest mice into work areas. Monitoring is required daily during fieldwork, prior to excavation and sampling activities. During periods of project inactivity at the site, the fencing will be monitored: (1) once weekly during clear weather and (2) within 48 hours after every storm that produces greater than 1 inch of precipitation within a 24-hour period or winds greater than 20 miles per hour (as reported by the National Weather Service Moffett Field Station). If the USFWS-approved biologist determines that monitoring is necessary within 48 hours after a storm that produces less than 1 inch of precipitation within a 24-hour period, the biologist will notify NASA, who will notify the USFWS, with a recommended revision to this specific monitoring requirement. Maintenance of the fence will be conducted as needed throughout the work period. Any necessary repairs must be completed within 24 hours after the damage is observed. Excavation must not continue within 100 feet of the damaged fencing until the fences are repaired and the site is surveyed by a USFWS-approved biologist to ensure that mice have not entered the work area.

Western Snowy Plover, California Clapper Rail, and California Least Tern-Specific Measures

BIO-27 **Breeding Season Surveys**: A USFWS-approved biologist shall conduct breeding season daily monitoring for the western snowy plover, California clapper rail, and California least tern. Breeding season monitoring reports shall be submitted to the USFWS at the end of the breeding season monitoring period and at the end of the project and will include locations and dates for observed individuals.

a. Breeding season monitoring for the western snowy plover will be conducted within the project footprint and for a distance of 600 feet from the project footprint from March 1 to September 14.

b. Breeding season monitoring for the California clapper rail will be conducted within the project footprint and for a distance of 700 feet from the project footprint from February 1 to August 31.

c. Breeding season monitoring for the California least tern will be conducted within the project footprint and for a distance of 300 feet from the project footprint from April 15 to August 15.

d. The USFWS shall be notified within 1 day when any nest is found. Nest information reported to the USFWS shall include a GPS location of the nest (latitude and longitude), condition of the nest, and status of nesting activity (nest construction, incubating eggs, feeding young, etc.). Active nests shall be monitored twice weekly until young have fledged. Nest fate information shall be reported to the USFWS upon nest failure or successful fledging, and information reported will include GPS location (latitude and longitude) of the nest, dates of monitoring, number of young in the nest, and fate of young upon final nest report.

BIO-28 **Non-Breeding Season Surveys:** A USFWS-approved biologist shall conduct non-breeding season daily monitoring for the presence of individual western snowy plover, California clapper rail, and California least tern in the project footprint and for a distance of 10 feet from the project. Non-breeding season monitoring reports shall be submitted to the USFWS at the end of the non-breeding season monitoring period and at the end of the project and will include GPS locations (latitude and longitude) and dates for observed individuals.

a. Non-breeding season monitoring for the western snowy plover will be conducted from September 15 to February 28.

b. Non-breeding season monitoring for the California clapper rail will be conducted from September 1 to January 31.

c. Non-breeding season monitoring for the California least tern will be conducted from August 16 to April 14.

BIO-29 In the event that a western snowy plover, California clapper rail, or California least tern is encountered, work will be halted by a USFWS-approved biologist and a no-work zone of at least 10 feet will be maintained around the animal until the animal has moved out of the area of its own volition. NASA has determined that it cannot halt work in the vicinity of western snowy plover, California clapper rail or California least tern nests for the length of time necessary to allow young to fledge, so stop-work in relation to nests will be until adults and any motile young have moved out of the no-work zone area of their own volition. If deemed necessary by a USFWS-approved biologist, work will be relocated to other areas, as directed by the biologist, to minimize disturbance from noise, human presence, or vibration.

3.0 EXISTING CONDITIONS AND DESCRIPTION OF THE SPECIFIC AREA AFFECTED BY THE ACTION

The following sections describe the regional setting and existing conditions of the Action Area.

3.1 REGIONAL SETTING

AOI 14 is located at the southern end of San Francisco Bay in an area that was historically coastal salt marsh and part of the larger San Francisco Bay Estuary. San Francisco Bay is the largest estuary on the west coast of the U.S. and supports a high diversity of wildlife despite the loss of an estimated 90 percent of historical tidal wetlands to diking, draining, and filling.

AOI 14 is composed of three upland peninsulas located within the Central Basin of the SWRP, also referred to as Crittenden Marsh (East and West). The SWRP is approximately 203 acres and is hydrologically disconnected from tidal influence; levees border the site to the north, west, and east. The area west of AOI 14 FSFA is owned and managed by MROSD. Pedestrians regularly recreate on the Bay Trail, which runs along the top of the levees at the northern, western, and eastern perimeters of the SWRP and the levee north of North Channel, north of North Patrol Road (Figure 6). Stevens Creek, a tidal creek that is hydrologically connected to the bay, runs north-south and is west of the SWRP and west of the Western Diked Marsh, outside NASA Ames property (Figure 2).

To the north of the SWRP and north of North Patrol Road are the Alviso ponds, diked ponds (formerly the Cargill Evaporation Ponds) owned by USFWS as part of the Don Edwards San Francisco Bay Wildlife Refuge complex (Figure 10). USFWS manages these ponds as waterfowl production areas that are open to tidal influence and regularly flooded. Waterfowl hunting is allowed in these areas. NASA's Moffett field runway is southeast of the AOI 14 FSFA. Lockheed Martin Corporation is east of NASA Ames, east of East Patrol Road (Figure 6).

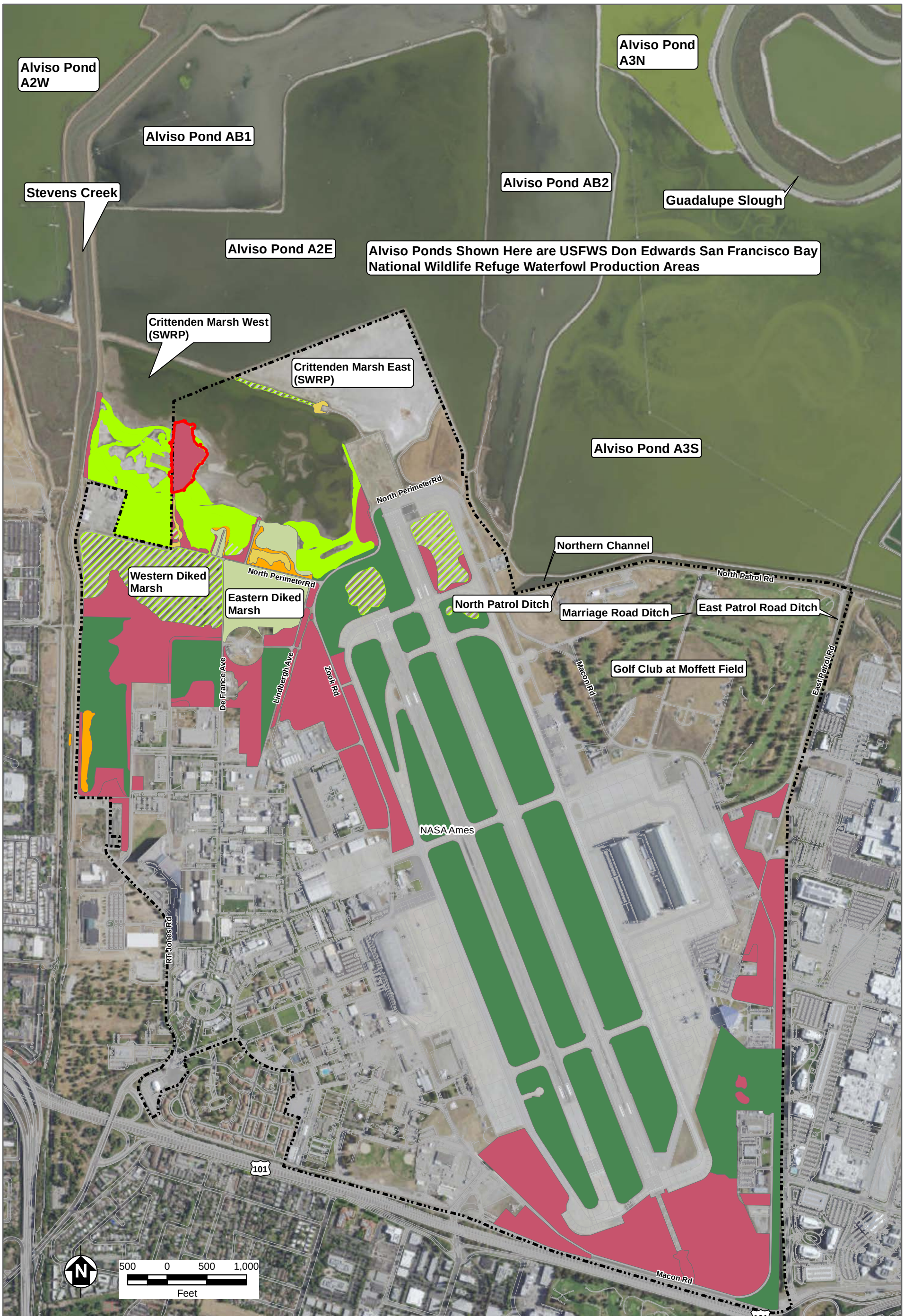
The San Francisco Bay area has a Mediterranean climate characterized by mild wet winters and dry warm summers. Precipitation occurs largely in the fall and winter months (usually October through April), with the greatest average rainfall occurring in January. Average annual precipitation for the region is 15.21 inches, based on data collected from September 1, 1953, to June 4, 2016, from Palo Alto. Precipitation over the last 5 years has generally been below average, with the exception of 2012, which had 16.33 inches of rain (WRCC 2016). Annual rainfall can be variable, depending on the climate cycles of El Niño and La Niña.

3.2 ACTION AREA EXISTING CONDITIONS

Existing conditions in the Action Area are described below and address the AOI 14 FSFA peninsula, N217A staging area, SWRP, and buffers along the haul route shown on Figure 6. Vegetation communities are described according to the nomenclature presented in *Terrestrial Vegetation Communities of California* (Barbour et al. 2007) and used in previous vegetation surveys conducted at NASA Ames (SAIC 1999). The vegetation communities of NASA Ames are shown on Figure 10. Industrial and commercial developed areas within the Action Area boundary are also shown on Figure 6.

The top of the AOI 14 FSFA peninsula ranges in elevation from 4 feet above MSL at the south to 11 feet above MSL at the north (Figure 8). Vegetation is dominated by non-native species including wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), fennel (*Foeniculum vulgare*), bristly ox-tongue (*Picris echioides*), teasel (*Dispacus* spp.), Italian thistle (*Carduus pycnocephalus*), and pepperweed. The slopes and the toe of the slope along the perimeter of the peninsula have a dominance of pickleweed and sparse occurrence of alkali heath (*Frankenia salina*), salt grass (*Distichlis spicata*), and seaside heliotrope (*Heliotropium curassavicum*), species typical of coastal salt marsh habitat.

The SWRP is surrounded by levees that isolate it from tidal influence and the saltwater evaporation ponds to the northeast. The SWRP is approximately 203 acres and supports open water, mudflats, salt panne, and vegetated salt marsh at its fringes that is largely dominated by pickleweed. Other salt marsh species observed within the vegetated portions of the SWRP include alkali heath and salt grass. The Navy completed sediment removal at IR Site 25 in 2012 to address ecologic risk from PCBs, pesticides, and metals. The SWRP excavated areas were hydroseeded in winter 2012 and again in 2013. Areas not hydroseeded were planted with pickleweed seedlings (Gilbane Federal 2016). Three years of restoration monitoring of the seeded and planted areas were concluded in 2016.



Removal Action Boundary

NASA Ames

Vegetation Communities

Seasonal salt marsh and transition

Coastal salt marsh

Fresh and brackish water marsh

Coyote brush scrub

Isolated seasonal marsh

Weed dominated area

Non-native grassland

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
IR = Installation Restoration
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
USFWS = U.S. Fish and Wildlife Service

Source: Adapted from NASA GIS databases using vegetation communities, Leidos mapped pickelweed (2016), and IR Site 25 vegetation mapping (2012) layers.

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 10
Vegetation Communities

Biological Assessment for AOI 14 Removal Action

2/13/2017 H:\Tetra tech\NASA\NASA_GIS\Interim Draft BA Figs\10_BIO_VegCommunities_11X17REV.mxd TtEMI-BLDR angela.lortie

The AOI 14 secondary staging area (N217A peninsula) has infrastructure, a dirt road leading from North Perimeter Road, and upland vegetation consisting of non-native grassland, with similar non-native species as the FSFA.

The SWRP receives stormwater runoff from the western half of the NASA Ames property, a drainage area estimated to be 1,000 acres, and also receives regular freshwater discharge from the WATS treatment plant. Storm runoff flows to a stormwater retention basin located at the southern perimeter of the Eastern Diked Marsh to settle out sediment and potential contaminants. The stormwater retention basin discharges into the Eastern Diked Marsh and is ultimately conveyed through a series of culverts under North Perimeter Road into the SWRP. Historically, stormwater flow dries up in the summer months. WATS discharges approximately 50 gallons per minutes of treated groundwater into the storm drain system. The constant flow of fresh water into the SWRP results in a regularly ponded area (approximately 8 acres) near the inlet at the southeastern corner of the SWRP, which supports a large patch of freshwater marsh with a monotypic stand of cattails (*Typha* spp.). Conditions within the remainder of the SWRP vary seasonally from fresh to hyper-saline as a result of winter precipitation and runoff and summer evapotranspiration. As a result of changing conditions, the areal extent of pickleweed varies year to year and lacks the vegetative and structural diversity of a natural salt marsh.

The haul route occurs along paved roads, as shown on Figure 6. Vegetation communities in the areas of the haul routes include those associated with the Eastern Diked Marsh, Western Diked Marsh, and a portion of the airfield, as described below (Figure 10).

The Eastern Diked Marsh is between De France Avenue and Lindbergh Avenue and consists of fresh and brackish water marsh and non-native annual grassland (Figure 10). Large areas are dominated by invasive perennial pepperweed, which has spread into the SWRP stormwater channel and is aggressively spreading throughout the Eastern and Western Diked Marshes. Pepperweed, when left unchecked, creates a monoculture that has little to no habitat value for wildlife. Also present are pampas grass (*Cortaderia* sp.), bristly ox-tongue, fennel, Himalayan blackberry (*Rubus armeniacus*), and dock (*Rumex* sp.). Native species include patches of cattails, creeping wild rye (*Leymus triticoides*), California bulrush (*Schoenoplectus californicus*), willow herb (*Epilobium ciliatum*), nutsedge (*Cyperus eragrostis*), Baltic rush (*Juncus balticus*), and willow (*Salix* sp.). Plant species observed in the upland ruderal areas of the Eastern Diked Marsh and Western Diked Marsh include fennel, bristly ox-tongue, ripgut grass, wild oat, teasel, and pampas grass. The Eastern Diked Marsh is part of Navy IR Site 25 and was remediated by the Navy in 2003 and 2012. The vegetation in the areas of soil excavation consisted of reed grasses including tules, which are not considered habitat for endangered species; as such, no active restoration of the Eastern Diked Marsh areas was required. Reed grasses currently on site were passively restored (Gilbane Federal 2016).

The Western Diked Marsh is west of De France Avenue and consists of a mix of seasonal salt marsh and transition, non-native, annual grassland and weed-dominated areas (Figure 10). The seasonal salt marsh and transition habitat is at the northwestern corner of the Western Diked Marsh and contains pickleweed, Baltic rush, spearscale (*Atriplex prostrata*), and non-native grasses (SAIC 1999). In recent years, perennial pepperweed has spread throughout the Western Diked

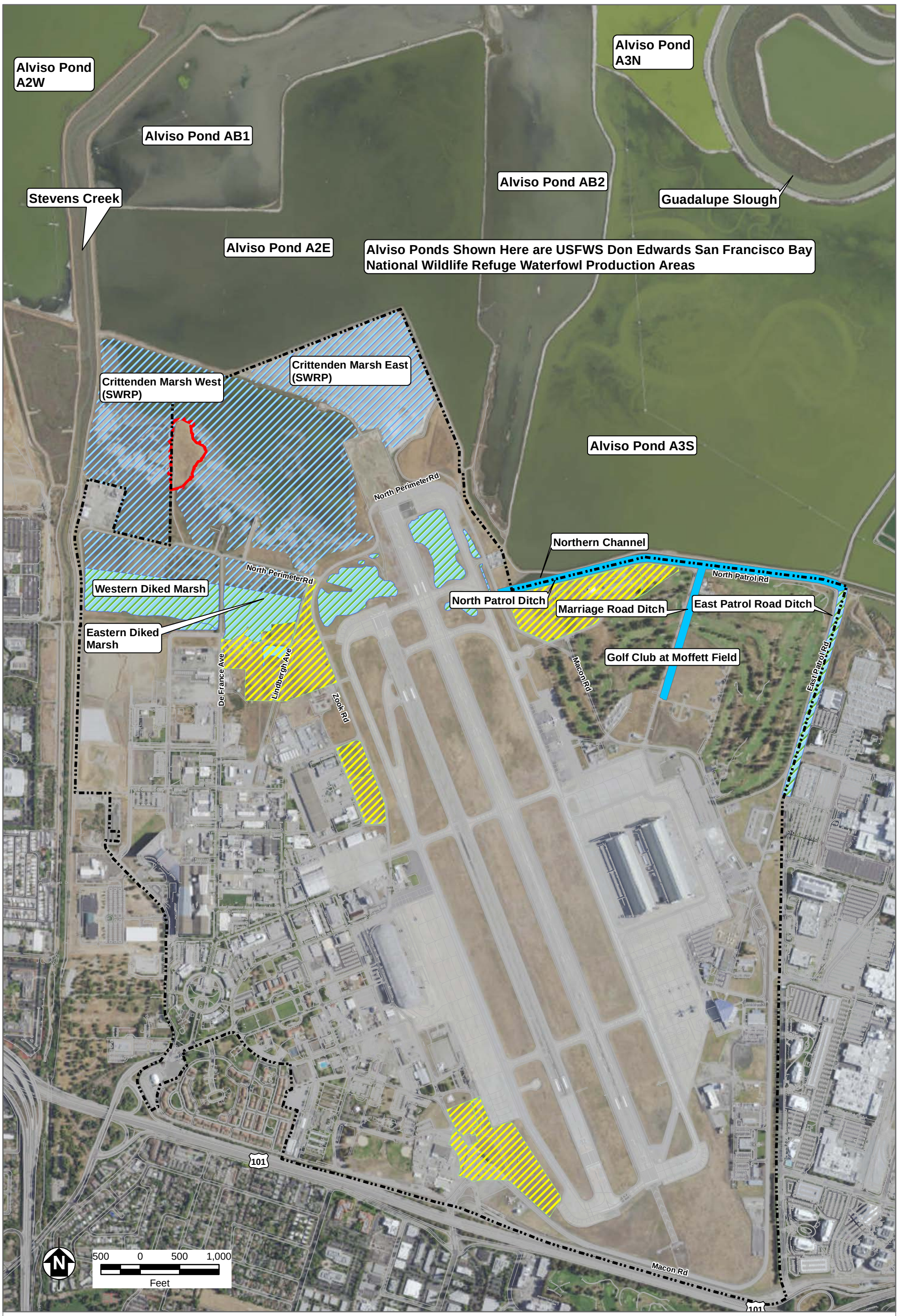
Marsh. Non-native grassland and weed-dominated areas have similar species composition as the Eastern Diked Marsh.

Weed-dominated areas that occur in the Action Area are regularly mowed or disked and include roadsides and the open areas around the airfield (Figure 10). These areas are characterized by a dominance of non-native annual herbs and grasses including bristly ox-tongue, geranium (*Geranium dissectum*), wild oat, rabbitsfoot grass (*Polypogon monspeliensis*), English plantain *(Plantago lanceolata*), bird's foot trefoil (*Lotus corniculatus*), bromes, and barley (*Hordeum* sp.) (SAIC 1999).

NASA Ames manages several grassland areas as western burrowing owl nesting habitat preserves (Figure 11). These areas are non-native annual grassland and contain species such as wild oats, bromes, rattail fescue (*Vulpia myuros*), red fescue (*Festuca rubra*), and Mediterranean rye (*Lolium multiflorum*). Preserves are managed in the following manner: supplemental artificial burrows are placed within the preserves; preserves are regularly mowed to maintain short grass; some preserves are fenced to limit access; raptor perches are removed or mitigated with bird spikes; and ground squirrels are transplanted to the preserves to repopulate these areas, many of which are devoid of ground squirrels (Tetra Tech 2016c).

Wetlands at NASA Ames, last delineated by USACE in 2009, include 51.1 acres of jurisdictional wetlands and Waters of the U.S. Wetlands and Waters of the U.S. include the following ditches shown on Figure 11: Northern Channel, North Patrol Ditch, and Marriage Road Ditch. East Patrol Ditch is a jurisdictional wetland. These ditches support brackish marsh habitat. Northern Channel is a storm channel managed for stormwater flow and flows east into Moffett Channel and ultimately Guadalupe Slough; water control structures (gates and pumps) prevent backflow from the bay into Northern Channel. However, the ditch salinity is influenced by seepage from the Alviso ponds which are north of the Northern Channel and separated by a levee (ERT 2015; Tetra Tech 2016d).

Jurisdictional wetlands also include the southern halves of the Eastern Diked Marsh and Western Diked Marsh and seasonal wetlands between Zook Road and the Moffett Airfield (USACE 2009). The seasonal wetlands around the airfield are slightly brackish or alkaline and support Baltic rush, creeping wild rye, cattails, spearscale, salt grass, clustered field sedge (*Carex praegracilis*), and pepperweed. The 2009 survey area, however, did not include the northern half of the Western and Eastern Diked Marshes or any of the SWRP. These areas were previously mapped as Wetlands and Waters of the U.S. in a wetland delineation verified by the USACE in 1989 (Figure 3.9-3 of Design, Community and Environment [DCE] 2002).



NASA Ames

Removal Action Boundary

Burrowing Owl Preserve

Waters of the U.S. (2009)

Wetlands (2009)

Wetlands and Waters of the U.S. (1989)

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
USFWS = U.S. Fish and Wildlife Service
(Year) denotes verification of delineation by U.S. Army Corps of Engineers (USACE)

Sources: NASA Ames GIS database, NASA Ames Development Plan Environmental Impact Statement (Design, Community and Environment 2002), and NASA Ames Environmental Resources Document (Earth Resources Technology, Inc. 2015).

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 11
Wetlands and Waters of the U.S. and Burrowing Owl Preserves

Biological Assessment for AOI 14 Removal Action

2/13/2017 H:\Tetra tech\NASA\NASA_GIS\Interim Draft BA Figs\11_BIO_Wetlands11X17REV.mxd TtEMI-BLDR angela.lortie

4.0 DESCRIPTION OF LISTED SPECIES OR CRITICAL HABITAT THAT MAY BE AFFECTED BY THE ACTION

On November 1, 2016, NASA requested and received an official list of federal ESA-listed threatened and endangered species that could occur in the Action Area from USFWS' Information for Planning and Consultation (IPaC) (USFWS 2016b). The species list provided by USFWS is included in Appendix A. Appendix B provides the results of two additional searches using the California Natural Diversity Database (CNDDB) and USFWS IPaC on-line planning tools. No critical habitat is in the Action Area. The following sections detail federally listed species that could occur in the Action Area. Species considered but eliminated from effects evaluation based on no potential to occur are detailed in Section 4.3.

4.1 BIRDS

Three federally listed birds (western snowy plover, California least tern, and California clapper rail) have potential to occur in the Action Area and are described in the following sections.

4.1.1 Western Snowy Plover (*Charadrius nivosus nivosus*)

4.1.1.1 Species and Life History

The USFWS designated the coastal population of snowy plovers as threatened in 1993 (58 Federal Register [FR] 12864). There is no critical habitat for the western snowy plover in the Action Area. The nearest critical habitat is approximately 5.5 miles northwest at the Ravenswood Unit (USFWS 2012b). The decline in western snowy plover populations has been attributed to lower reproduction caused by human disturbance, predation, and habitat loss through invasion by non-native plants.

The western snowy plover is a subspecies of snowy plover that breeds and winters on coastal beaches along the Pacific coastline from southern Washington State to Magdalena Bay, Baja California Sur, Mexico. Populations consist of migrants and year-round residents, depending on locality. Snowy plovers breeding in Oregon have been recorded wintering in California as far south as Monterey, and snowy plovers breeding in central California have been recorded south as far as Guerrero Negro, Baja California Sur, Mexico (Warriner et al. 1986).

Snowy plovers forage primarily in areas of wet sand at the beach-surf interface, where they feed on small crustaceans, marine worms, insects, and amphipods. Adults and young forage on these invertebrates along intertidal areas, on beaches in wet sand and surf cast kelp, in foredune areas of dry sand above the high tide, on salt pannes, and along the edges of salt marshes and salt ponds.

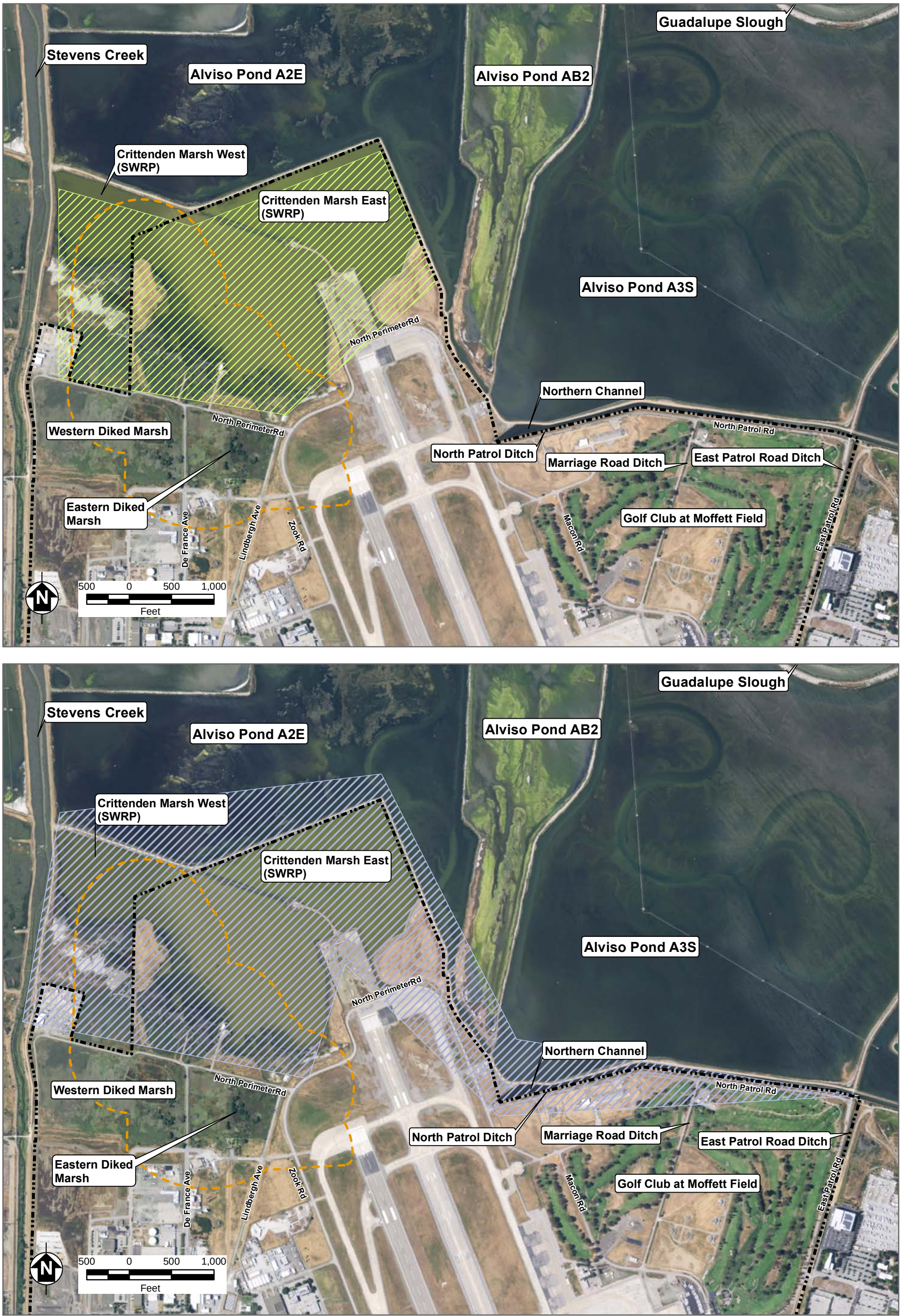
Western snowy plovers nest in depressions or scrapes made in flat open areas with sandy or saline substrates, such as sandy beaches, gravel bars, and salt pannes at lagoons and estuaries along the California coast (USFWS 2007). At San Francisco Bay, western snowy plovers nest almost exclusively in dry salt panne habitat provided by salt evaporation ponds (Tokatlian et al. 2014).

Nesting (initiation and egg laying) generally occurs from early March through July, with an average of three eggs per nest (USFWS 2007). Western snowy plovers in the South Bay area typically have multiple nesting pulses throughout the breeding season; the 2014 breeding season documented peaks in numbers of nests initiated in April, May, and June (Tokatlian et al. 2014). Both sexes incubate the eggs, with females commonly incubating during the day and males at night. Incubation lasts for approximately 28 days. Adults attempt to distract potential predators and humans from hatching eggs using alarm calls or distraction displays. Chicks leave the nest within 24 hours after they hatch and immediately follow the male to foraging areas along the sandy shoreline, salt pannes, and at times, mudflats. Males attend the young until they fledge, typically about a month after hatching.

4.1.1.2 Environmental Baseline

San Francisco Bay Bird Observatory (SFBBO) monitors western snowy plovers for USFWS Recovery Unit 3, which includes Crittenden Marsh. Beginning in August 2013, SFBBO began surveying Crittenden Marsh weekly after reports of western snowy plover chick sightings in the area (Robinson-Nilsen et al. 2013). Since 2014, SFBBO has monitored plovers weekly through the breeding season at Crittenden Marsh (East and West) and Alviso Pond A2E, collectively referred to as "Mountain View" (Figure 12). Alviso Pond A2E is approximately 725 feet north of the Action Area, across the levee, and Crittenden Marsh East and West comprise the SWRP. The AOI 14 FSFA peninsula is within the Crittenden Marsh West, bounded by levees that separate it from Alviso Pond A2E at the north and Crittenden Marsh East at the east. Alviso Pond A3S is just north of North Patrol Road, but SFBBO had no data for 2009 through 2015 for A3S (Pearl et al. 2015). A representative from the Don Edwards San Francisco Bay Wildlife Refuge indicated that the A3S area is a waterfowl production area, regularly flooded and used for waterfowl hunting, and is not managed for plovers (Tetra Tech 2016e).

In 2014, SFBBO documented a combined average of 12 adult plovers per week at Alviso Pond A2E and Crittenden Marsh (East and West) (Tokatlian et al. 2014). An average of 0.3 plover sightings per week were documented at A2E and Crittenden Marsh (East and West) in 2015. No nests were documented at A2E in 2014 and 2015. Alviso Pond A2E water levels are kept high to provide foraging habitat to California least terns and larger shorebirds, precluding available habitat for plover nesting. Crittenden Marsh East had 12 nests (10 hatched, two predated) in 2014 and zero in 2015; Crittenden Marsh West had two hatched nests in 2014 and one predated nest in 2015. SFBBO attributed the low nesting at Crittenden Marsh West in 2015 to high water levels and associated lack of exposed salt panne habitat throughout the nesting season, compared with available habitat (at Crittenden East) in 2014 (Pearl et al. 2015).



NASA Ames

Action Area

Federally Listed Species Area of Potential Occurrence

Western Snowy Plover

California Least Tern

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 12
Areas of Potentially Occurring Federally Listed Species – Western Snowy Plover and California Least Tern
Biological Assessment for AOI 14 Removal Action

12/18/2017 H:\Tetra tech\NASA\NASA_GIS\Interim Draft BA Figs\12_BIO_Species11X17.mxd TtEMI-BLDR angela.lortie

Survey records from Naval Air Station Moffett Field in 1994 and 1995 indicate that western snowy plovers were observed in and near Crittenden Marsh (East and West were not distinguished), with most sightings of plovers occurring during the winter months from November 1994 to February 1995, on the levees immediately north of Moffett Field; one individual was sighted in Crittenden Marsh in July 1994 (Layne and Harding-Smith 1995). More recently, a survey conducted by NASA in December 2013 recorded two western snowy plovers in the salt flats of the SWRP (Alderete 2013a). A review of facility resource documents and historical survey data indicates that western snowy plovers have not been recorded along the haul route. Notably, pedestrian traffic along the Bay Trail and aircraft overflights (incoming and outgoing) from Moffett Airfield may discourage nesting in the SWRP. Studies indicate that declines in breeding occur in areas with pedestrian traffic and low aircraft overflights (Federal Highway Administration [FHWA] 2004).

SFBBO notes that the most abundant potential avian predators at Crittenden Marsh are California gulls; red-tailed hawks, peregrine falcons, and common ravens have also been documented flying over A2E and Crittenden Marsh (Tokatlian et al. 2014; Pearl et al. 2015).

4.1.2 California Least Tern (*Sterna antillarum browni*)

4.1.2.1 Species and Life History

The California least tern was listed as endangered by USFWS in June 1970 (35 FR 16047) and is recommended for downlisting to threatened. The number of California least tern nesting sites has nearly doubled since its listing, and the population has increased from 600 in 1973 to roughly 7,100 pairs in 2005. No critical habitat has been designated for this species. The current scientific name accepted by the American Ornithologists' Union since 2006 and used throughout this document is *Sternula antillarum browni*; an exception is the title of this subsection which matches the nomenclature used on the USFWS official species list (Appendix A).

California least terns are a migratory species and colonial nesters. Winter distribution is largely unknown, although least terns banded as chicks in California have been found as far south as southern Colima, Mexico, and Guatemala. During the breeding season (spring and summer), California least terns are found nesting along the Pacific Coast as far north as Pittsburg, Contra Costa County, California, and as far south as Bahia Magdalena, Mexico. In the State of California, least terns nest annually at about 35 sites from San Diego County to Contra Costa County. The breeding locations shift somewhat as a result of annual conditions (USFWS 2006).

Least terns arrive at colonial nesting locations in late April and nest from mid-May through August. Nesting colonies average 25 pairs. California least terns breed mostly in coastal foredunes and in other sparsely vegetated sites with sandy or gravelly soils. Loss of natural habitat has caused these birds to become opportunistic, using areas such as newly filled or graded lands and airports for nesting. California least terns nest in areas relatively free of human or predatory disturbance because this species tends to abandon nesting areas readily if disturbed (Zeiner et al. 1990). Nesting areas must be located near open water, usually along coastal beaches and estuaries, and they must host adequate numbers of small elongate fishes to sustain adults and growing young.

One brood of one to three chicks is raised yearly. Females typically lay one to two eggs in scrapes, and the parents feed fish to the young. Young California least terns fledge at 3 weeks (USFWS 2006).

Young, well-fledged, least terns eventually leave breeding sites and disperse to localized post-breeding foraging areas where fish are plentiful and waters are calm. These post-breeding foraging areas, which offer young birds opportunities to develop foraging skills and provide all terns the food to build reserves for migration, are considered by some to be as important to the survival of juvenile terns as the nesting areas. California least terns most often finish breeding activities by late August and are usually absent from California breeding and post-breeding areas by late September. It takes 2 to 3 years for least terns to mature (USFWS 2006).

The decline in California least tern populations has been attributed to lower reproduction caused by human disturbance, predation, and habitat loss. Another key threat includes predation by other wildlife species (such as American kestrels or crows) or domestic or feral animals (such as cats and dogs) (USFWS 2006).

4.1.2.2 Environmental Baseline

Regionally, nesting colonies of California least terns occur in San Francisco Bay at Alameda. California least terns also nest at Albany and at Pittsburg on Suisun Bay, and have been known to nest at the Oakland airport and Bair Island. No nesting has been documented at NASA Ames.

Several post-breeding sites in the Bay Area are located at South Bay intake salt ponds. Shallow tidal areas are also used, such as at the E.B. Roemer Bird Sanctuary in Alameda and at Roberts Landing in San Leandro. California least terns use the regularly flooded USFWS waterfowl production areas (Alviso ponds complex) that are north of the SWRP and north of the NASA Ames Moffett airfield as a post-breeding staging area. California least terns use these areas from late June through late August for foraging and roosting prior to fall migration. Adults and juveniles roost on salt pond levees and boardwalks and forage in the salt ponds and open waters of the bay (Layne and Harding-Smith 1995; H.T. Harvey and Associates 2005). Surveys from 1994 recorded California least terns in the flooded ponds north of the SWRP (A2E and A3S [Figure 12]) (Layne and Harding-Smith 1995). A review of facility resource documents and historical survey data indicates that California least terns have not been recorded along the haul route.

4.1.3 California Clapper Rail (*Rallus longirostris obsoletus*)

4.1.3.1 Species and Life History

The California clapper rail is a federally listed endangered species indigenous to estuarine marshlands in San Francisco Bay (35 FR 16047-16048 [13 October 1970]). The American Ornithologist Union taxonomically reclassified and renamed this subspecies of rail the California Ridgway's rail (*Rallus obsoletus obsoletus)* (Chesser et al. 2014); formal USFWS recognition of this nomenclatural change is pending. Until USFWS publishes formal recognition of this name

change, California clapper rail (*Rallus longirostris obsoletus*), as it still appears in all of the legal rules, is used here.

The historical distribution of the California clapper rail included tidal marshes of coastal California from Humboldt Bay in the north to Morro Bay in the south; the California clapper rail is extirpated from all sites outside of San Francisco Bay. Remaining marshes are geographically disjunct and characterized by lack of significant transition zones to terrestrial habitat, relatively small size, large edge-to-area ratio, and close proximity to urban and industrial development. Several factors have been identified as negatively affecting California clapper rail populations, including predation by native and non-native species, marsh conversion, habitat fragmentation and degradation, and mercury toxicity (USFWS 2015).

The California clapper rail is a secretive, rarely observed, hen-like waterbird found primarily in emergent and brackish tidal marshes. California clapper rails forage along the interface of the mudflat and the marsh, along mud banks, and in shallow tidal creeks. At times, rails will forage in the high marsh. Their diet consists of crabs and salt marsh gastropods. Their preferred habitat is subject to direct tidal circulation and is characterized by predominant coverage of pickleweed, with extensive stands of Pacific cordgrass (*Spartina foliosa*). California clapper rails also occur in brackish wetlands consisting of bulrush (*Bolboschoenus* spp.). In these areas, rails use bulrush plant material for nest building and cover, but nests are still associated with tidal channels, as in pickleweed dominated marshes. This type of habitat occurs along the larger creeks in the South Bay (USFWS 2015).

Clapper rails usually begin breeding when pairs form around mid-February. Nesting occurs from mid-March and extends into August. The end of the breeding season is typically defined as the end of August, which corresponds with the time when eggs laid during re-nesting attempts have hatched and young are mobile. Clutch sizes range from 5 to 14 eggs. Both parents share in incubation and rearing (USFWS 2015).

4.1.3.2 Environmental Baseline

Regionally, in Santa Clara County, California, clapper rails occur outboard of salt evaporation pond levees and along major tidal sloughs such as Alviso and Charleston sloughs; the USFWS recovery plan for rails notes that they occur in "outboard marshes of Moffett Field and Guadalupe Slough" (USFWS 2013). During 2015 surveys of California clapper rails in San Francisco Bay conducted by the San Francisco Estuary Invasive *Spartina* Project, rails were detected in Alviso Slough (2.65 miles east of AOI 14 FSFA) at a medium density (0.2 to 0.5 rail per hectare), Guadalupe Slough (1.54 miles east of AOI 14 FSFA) at a low density (less than 0.2 rail per hectare), and Charleston Slough (1.8 miles west) at a high density (0.5 to 1.0 rail per hectare). No rails were detected in Stevens Creek (to Long Point), 0.25 mile west of AOI 14 FSFA and adjacent to the SWRP. Data for surveys conducted from 2010 through 2015 for the Stevens Creek to Long Point area resulted in one rail observed in 2013. Stevens Creek discharges to San Francisco Bay and is open to tidal inundation; the report cites habitat quality at Stevens Creek to Long Point as "fair" (McBroom 2015).

Several historical observations of California clapper rails have been documented at NASA Ames. Figure 13 shows areas on NASA Ames where California clapper rails could occur. In 1992, Orton-Palmer and Takekawa (1992) observed a pair of rails and one individual in a dense pickleweed stand of Crittenden Marsh. The following year, in 1993, a single clapper rail was heard in approximately the same location during a directed California black rail survey (Burns and Harding-Smith 1993). In more recent years, California clapper rails have not been detected; surveys conducted by the Navy in 2005, 2011, and 2012 had no detections of California clapper rails. The 2011 and 2012 survey reports indicate that habitat in and near the SWRP is of poor quality and nesting California clapper rails are unlikely (Alderete 2005b; Bumgardner Biological Consulting 2011 and 2012). A review of facility resource documents and historical survey data indicates that California clapper rails have not been recorded along the haul route.

4.2 MAMMALS

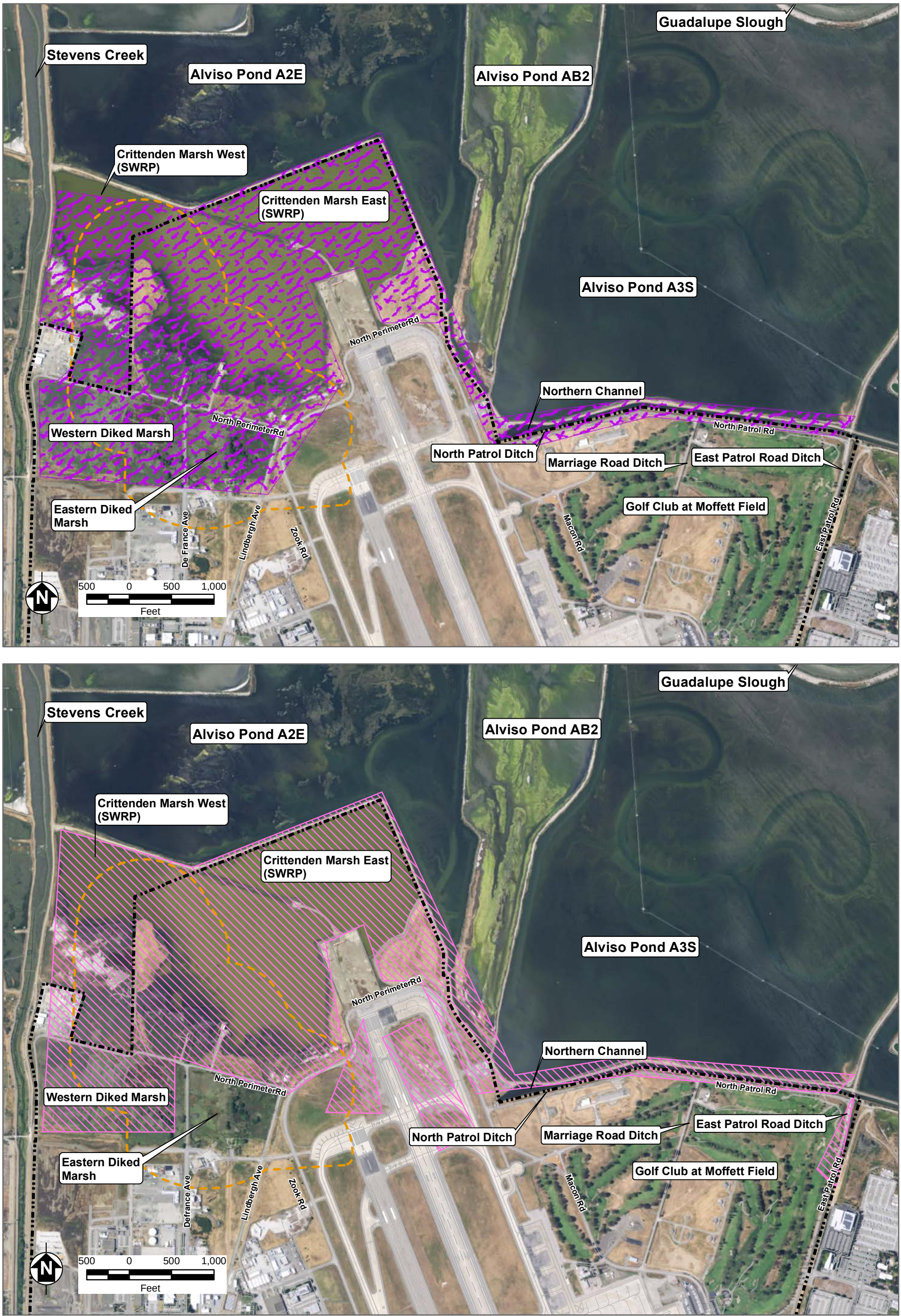
One federally listed mammal has the potential to occur in the Action Area and is described below.

4.2.1 Salt Marsh Harvest Mouse (*Reithrodontomys raviventris subsp. raviventris*)

4.2.1.1 Species and Life History

The USFWS designated the salt marsh harvest mouse as endangered in 1970 (35 FR 16047). No critical habitat is designated for the salt marsh harvest mouse. There are two subspecies: *R. r. halicoetes* is the northern subspecies that inhabits the marshes of San Pablo and Suisun bays; *R. r. raviventris* is the southern subspecies that inhabits the marshes of Corte Madera, Richmond, and South San Francisco Bay. The two subspecies are restricted to salt and brackish marshes and have suffered extensive habitat loss and degradation; the southern subspecies has experienced the most loss, with less than 10 percent of its historical range acreage remaining. Nearly all of the habitat that remains is deficient in its structural suitability (USFWS 2010a).

The salt marsh harvest mouse depends on dense vegetative cover, with pickleweed as their preferred habitat. They are seldom found in cordgrass or alkali bulrush. Salt marsh harvest mice are critically dependent on both vegetative cover and uplands to escape to during periods of high water. They spend a considerable portion of their lives in the vegetation canopy, and they may move to adjoining uplands during the highest winter tides. Salt marsh harvest mice are active mainly at night, with some activity during daylight hours. The mice feed on leaves, seeds, stems, and in winter, fresh green grasses and are capable of drinking pure seawater but generally prefer brackish water. Salt marsh harvest mice can swim, in contrast to the western harvest mouse, and their home range is between 0.37 and 0.52 acre (USFWS 2010a and 2013).



NASA Ames

Action Area

Federally Listed Species Area of Potential Occurrence

California (Ridgway's) Clapper Rail

Salt Marsh Harvest Mouse

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 13
Areas of Potentially Occurring Federally Listed Species – California Clapper Rail and Salt Marsh Harvest Mouse
Biological Assessment for AOI 14 Removal Action

12/18/2017 H:\Tetra tech\NASA\NASA_GIS\Interim Draft BA Figs\13_BIO_Species11X17_Mouse_CCR.mxd TtEMI-BLDR angela.lortie

Breeding season for the southern subspecies of salt marsh harvest mouse is from March 1 through November 30, with females having one to two litters of four mice each per year. Nests are constructed of loose dry grasses and are built in the canopy of vegetation, often over abandoned birds' nests (USFWS 2010a). The mouse lives only 8 to 12 months, so they depend on an annual reproductive success for survival (EPA 2010).

The major threats to salt marsh harvest mouse habitat include loss of habitat (salt marsh and upland refuge) and habitat fragmentation from filling, diking, land subsidence, and changes in water salinity. Climate change and a rise in sea level, coupled with land subsidence from groundwater extraction and loss of sediment deposition from upstream dams and water diversion, also contribute to loss of salt marsh habitat. Various estimates have been made that at least 85 percent of all the tidal marshes around the bay have been filled in or otherwise destroyed in the last 150 years. Most of the remaining marshes have been back-filled or diked and as a result are narrow strips along the bay side of the levees (Shellhammer 1982). These strip marshes and most of the remaining larger marshes have lost their upper and middle zones, such that little escape cover from high tides is available (Josselyn 1983). Most marshes of South San Francisco Bay are strip-like and as such support few salt marsh harvest mice (USFWS 2010a). In the southern end of South San Francisco Bay, the combination of subsidence caused by excessive groundwater extraction and the freshening of that part of the bay by massive amounts of non-saline, treated, sewage effluent has changed the salt marsh vegetation in those areas to brackish and freshwater plant communities with species such as bulrushes, cattails, and pepperweed. Some recent evidence suggests that salt marsh harvest mice use adjacent habitat beyond high-quality pickleweed more than previously thought. Saline to sub-saline marsh that lacks pickleweed or supports it as a minor component may be used as habitat by significant numbers of salt marsh harvest mice (USFWS 2010a). Salt marsh harvest mice in diked marshes in South San Francisco Bay have used more open and saltier pickleweed when vole (*Microtus* spp.) populations were high and then moved into denser and less salty pickleweed as vole populations declined. High densities of voles in diked salt marshes may force this species into marginal habitats or to become locally extirpated (Geissel et al. 1988).

Diked wetlands adjacent to the bay have grown in importance as the tidal marshes bayward of their outboard dikes have decreased in size and quality. Most diked marshes in South San Francisco Bay are being threatened by urban and industrial development along their borders. In addition, most of these diked marshes are not managed to provide adequate vegetative cover of halophytic species or to maintain their salinity over time (Goals Project 2000; DCE 2002). Salt marsh harvest mouse habitat in the Alviso Ponds complex is limited because most of the marshes are brackish water marshes, areas little used by the mouse, and the salt marsh that does exist has little to no high marsh or escape cover (H.T. Harvey and Associates 2005). Studies from Suisun Bay indicate that brackish marshes with a dominance of pepperweed are not used by mice. However, salt marsh harvest mice are known to rapidly re-colonize restored areas (H.T. Harvey and Associates 2005). Studies from Suisun marsh trapping indicate that salt marsh harvest mouse populations may rebound relatively quickly from depressed population levels (USFWS 2010a).

4.2.1.2 Environmental Baseline

Salt marsh harvest mice have been observed in the SWRP and Stevens Creek. Figure 13 shows areas on NASA Ames where the salt marsh harvest mouse could potentially occur. No data were found on the population density or current distribution of salt marsh harvest mouse in the Action Area or NASA Ames. The USFWS recovery plan shows distribution of the mouse north of the Moffett Airfield, throughout the SWRP (USFWS 2013). In 1985, no salt marsh harvest mice were found during 300 trap nights in Crittenden Marsh, and in 1987, no mice were found in Sunnyvale Baylands Park (3.5 miles southeast of AOI 14) during 540 trap nights (Goals Project 2000). One individual was captured at the SWRP (northeastern portion) during three nights of trapping in 1991 (Pomeroy 1991), and one individual was trapped in the SWRP (Crittenden Marsh) on July 27, 1994, during 300 trap nights in July, August, and September 1994 (Layne and Harding-Smith 1995). An anecdotal observation of a potential salt marsh harvest mouse in the pickleweed of the SWRP was made during a pre-construction survey for the interim action silt fence installation (Alderete 2013b). CNDDB has records of the salt marsh harvest mouse occurring 1.45 miles northeast and 2.45 miles east at Guadalupe Slough and 2.6 miles northwest at Mayfield Slough (CDFW 2016). Other populations of the southern subspecies occur throughout South San Francisco Bay, but as a whole, the southern subspecies populations are generally small and isolated compared with the probable historical pattern of distribution and abundance (USFWS 2013).

A review of facility resource documents and historical survey data indicate no salt marsh harvest mouse trapping has occurred along the haul route, and no anecdotal observations of mice have been recorded in those areas. Halophytic vegetation occurs in the brackish Northern Channel and North Patrol ditches and could potentially support salt marsh harvest mice. The SWRP currently supports pickleweed and may also support salt marsh harvest mice. The 1994 survey report noted that the complete and prolonged submergence of pickleweed within the SWRP during wet years has potentially detrimental effects on the salt marsh harvest mouse (Layne and Harding-Smith 1995).

4.3 SPECIES CONSIDERED BUT ELIMINATED

The Proposed Action will exert no effects on federally listed plants, invertebrates, reptiles, fish, or amphibians because none occur in the Action Area. The following species have been eliminated from further consideration in the BA because they are not likely to occur in the Action Area, and the Proposed Action is not likely to adversely affect these species.

California Red-Legged Frog: The federally threatened California red-legged frog (*Rana draytonii*) inhabits lowlands and foothills in or near permanent sources of deep fresh water with dense, shrubby, or emergent riparian vegetation and may aestivate in rodent burrows or cracks during dry periods. The Action Area has no suitable habitat for this species, and previous surveys have documented no California red-legged frogs or suitable habitat at NASA Ames (Scott and Alderete 2001). Water sources at NASA Ames are too saline or seasonal, and water quality is low.

California Tiger Salamander: The Central Valley species of California tiger salamander (*Ambystoma californiense*) is federally listed threatened; the Santa Barbara and Sonoma County populations are federally listed endangered. This species is restricted to grasslands and low foothills with seasonal water sources for breeding. The Action Area has no suitable habitat for this species, and previous surveys have documented no California tiger salamanders or suitable habitat at NASA Ames (Scott and Alderete 2001). Water sources at NASA Ames are too saline or seasonal, and water quality is low.

Vernal Pool Tadpole Shrimp: Vernal pool tadpole shrimp (*Lepidurus packardi*) are federally endangered and require vernal pools for all stages of their life cycle. No vernal pools occur within the Action Area or NASA Ames (ERT 2015).

Delta Smelt: Delta smelt (*Hypomesus transpacificus*) are federally threatened and occur in San Francisco Bay. The Action Area has no surface hydrologic connection with the bay and no suitable habitat for this species. Navy IR Site 25 SWRP is completely cut off from tidal input, and Northern Channel is a storm channel managed for stormwater flow that only flows east into Moffett Channel and ultimately Guadalupe Slough; water control structures (gates and pumps) prevent backflow from the bay into Northern Channel (ERT 2015).

Steelhead: Steelhead (*Oncorhynchus (=salmo) mykiss*) are federally threatened. This species requires freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Steelhead can be found throughout San Francisco Bay when migrating and can be found locally in Stevens Creek (CDFW 2016; EDAW et al. 2007). The Action Area has no surface hydrologic connection with the bay or Stevens Creek and no suitable habitat for this species.

Bay Checkerspot Butterfly: The Bay checkerspot butterfly (*Euphydryas editha bayensis*) is federally threatened and occurs on native grasslands on serpentine soils in the vicinity of San Francisco Bay. *Plantago erecta* is the primary host plant (CDFW 2016; USFWS 2009). The Action Area has no suitable habitat for this species, and *Plantago erecta* has not been recorded on site (ERT 2015; SAIC 1999).

San Bruno Elfin Butterfly: The San Bruno elfin butterfly (*Callophrys mossii bayensis*) is federally endangered and inhabits coastal grassy mountainous areas near San Francisco Bay, on steep north-facing slopes at elevations greater than 500 feet above MSL and that contain populations of host plant stonecrop (*Sedum spathulifolium*) (CDFW 2016; USFWS 2010b). The Action Area has no suitable habitat for this species, and stonecrop has not been recorded on site (SAIC 1999).

California Seablite: California seablite (*Suaeda californica*) is federally endangered. The 2010 USFWS 5-Year Review notes that this species is likely extirpated from the San Francisco Bay area; its last confirmed occurrence in the San Francisco Bay area was from a 1958 collection (USFWS 2010c). The CNDDB record was from a 1971 Wicksten collection from the salt flats of Palo Alto and notes that this location is likely extirpated (CDFW 2016). Four locations of reintroductions are within San Francisco Bay, with none in the vicinity of the Action

Area (USFWS 2013). Previous vegetation surveys of the project footprint and a recent site walk confirmed no presence of this species in the project footprint (Alderete 2013b).

5.0 ANALYSIS OF EFFECTS AND DESCRIPTION OF THE MANNER IN WHICH THE ACTION MAY AFFECT LISTED AND/OR PROPOSED SPECIES AND/OR CRITICAL HABITAT

This section identifies the potential direct and indirect effects of the proposed Removal Action (Pilot Study, Full-Scale Investigation, and Removal) at NASA Ames AOI 14 FSFA on the listed species and their habitat. "Direct effects" are direct or immediate effects of the Proposed Action on the species or its habitat. "Indirect effects" are those caused by the Proposed Action but occur later in time and are reasonably certain to occur. Direct stressors introduced by the Pilot Study and Full-Scale Investigation sampling and Removal include the following: noise, human disturbance (including visual disturbance), vibration, and alteration of habitat. Indirect effects that could also occur from these same stressors may affect prey availability. Stressors introduced by the Pilot Study and the Full-Scale Investigation are similar in effect and would vary only by intensity. That is, an adverse effect as a result of the Pilot Study would vary in magnitude and intensity from the same adverse effect of the Full-Scale Investigation. The Pilot Study will have effects that would be of reduced intensity because that aspect of the project is shorter in duration, but it would not differ materially in terms of the overall effect determinations below. Because the Pilot Study is shorter and less intense relative to the Full-Scale Investigation, the risks of adverse effects are lower but not materially different; therefore, effects determinations for both are categorized the same. Impacts listed below address both sampling phases as one evaluation; effects of the Removal are addressed separately.

In light of the range of potential start dates detailed in Section 2.0, effects were evaluated based on the target May 2017 start for the Pilot Study and Full-Scale Investigation and target October 2017 start for the Removal. Regardless of the start dates, the total maximum duration of work is approximately 14 months, to be determined based on sampling data and the amount of contaminated soil and sediment requiring removal. A start date between May and October for sampling, with excavation in October, would have meant that work is conducted during a portion of the 2017 breeding season and most of the 2018 breeding season for birds and the salt marsh harvest mouse. A start date of September 2017 for sampling, with excavation in the late fall would have meant that work is conducted during the end of the 2017 breeding season for the mouse and most of the 2018 breeding season for birds and the mouse. Based on updated project schedule information, a start date of January 2018 for sampling, and spring 2018 for excavation and continuing until fall of 2018 would mean that work is conducted through the breeding season for birds and for the salt marsh harvest mouse. The revised schedule and updated project planning does not affect conclusions. Effects conclusions are the same for all four species, regardless of the exact project start date. Similarly, effects conclusions are the same for all four species regardless of short-term increases in haul removal which may take place during dry periods, should such an opportunity for accelerated removal occur. In this scenario, any period of intense haul removal would increase the magnitude of effects in the short term but would decrease the overall duration of excavation. Effects conclusions are the same for all four species, regardless of whether the haul rate is 32 loads per day and a longer duration, or if it were to include up to 20 days (no more than

5 consecutive days at a time) of more intense removal efforts and a resultant shorter project duration.

5.1 DIRECT AND INDIRECT ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

In this section, the direct and indirect environmental consequences (effects) of the Proposed Action are evaluated for the western snowy plover, California least tern, California clapper rail, and salt marsh harvest mouse. The likelihood of occurrence and effects are analyzed for the sampling phases, as discussed above, and for the Removal. Following the analysis of effects, an effect determination is made for each species, as defined under the ESA.

As stated above, effects may be categorized as one or more of the following under the ESA: beneficial, having no effect, having a potential to affect but unlikely to adversely affect, or having a potential to affect and likely to adversely affect. The effect determinations depend on the likelihood of the Proposed Action to result in a take of a species requiring consultation (individual effects) and the potential of the effect to jeopardize the continued existence of the species (population-level effects). An organism's potential to recover from injury, take, or effects is a function of several factors such as its existing health and fitness, habitat conditions, and food availability. Baseline conditions at NASA Ames for the species evaluated in this BA are taken into account for the effects analyses, as are conservation measures.

5.1.1 Birds

Three federally listed bird species could occur in the Action Area; potential effects from project activities on these species are addressed below. Nesting birds are generally more sensitive to disturbance, noise, and human presence than non-nesters, and costs to reproductive success are more of a concern when stressors occur during nesting season. The effects below are written with nesting birds in mind; instances in which effects differ for non-nesting birds are identified where applicable.

5.1.1.1 Western Snowy Plover

Historical survey records at NASA Ames indicate that western snowy plovers could nest within the SWRP, given suitable habitat. Most sightings of plovers at NASA Ames have been during the winter months on the levees (Layne and Harding-Smith 1995). A survey conducted by NASA in December 2013 recorded two western snowy plovers in the salt flats of the SWRP (Alderete 2013a).

<u>Pilot Study and Full-Scale Investigation Sampling</u>

Pilot Study sampling will occur during 10 days of 10-hour work shifts with three teams using one direct-push drill each to collect 270 soil borings from three areas on the upland fill peninsula of the FSFA (Figures 4 through 7). Full-Scale Investigation sampling will occur over a 6-week period

and will involve direct-push drill rigs collecting samples from 420 to 930 soil borings in the upland fill peninsula. Up to 30 soil samples will be collected from the fill slopes and SWRP bottom using hand augers.

Direct Effects

Pilot Study and Full-Scale Investigation sampling could have direct effects on western snowy plovers such as noise and visual disturbances (for example, from human or equipment presence) that could elicit a startle response and alter their foraging patterns or result in abandonment of nests, if they were present in the Action Area. Western snowy plovers are not likely to occur within the footprint of sampling (Pilot Study or Full-Scale) on the upland fill peninsula (FSFA); the weed-dominated upland is not a preferred habitat type for plovers, and none have been recorded in previous listed species surveys. The upland fill peninsula and fill slopes are not suitable habitat for the plover. Sampling that occurs in the SWRP bottom will be done by hand, in close proximity to the fill slopes, an area that has no historical records of western snowy plover presence. It is unlikely that plovers would forage within the sampling footprint during sampling because noise and visual disturbances would deter them.

Direct effects on western snowy plovers that may be present in the Action Area at the time of sampling could occur from noise-generating activities. Maximum noise levels from Pilot Study and Full-Scale Investigation sampling are projected to be a combined maximum of 94.4 A-weighted decibels (dBA) (based on three drill rigs at 89 dBA, one hand auger at 84 dBA, and one generator at 81 dBA [Table 3]) at 50 feet from sampling; this noise level is anticipated to be generated during times when objects like concrete or asphalt are encountered that would require hammering, and is estimated to occur during approximately 5 percent of the overall effort. Geophysical surveying at the site has indicated artificial fill, which varies in thickness across the FSFA, and is a heterogeneous mixture of gravel, sand, silt, clay, and miscellaneous construction debris. Construction debris consists of reinforced concrete, asphalt, and metal (rebar, I-beams, and metal debris. Bedrock would not be encountered because the AOI 14 FSFA is atop San Francisco Bay mud. Applying the inverse square law that noise levels decrease 6 dBA per doubling of distance from the source, wildlife within approximately 400 feet of the sampling activities are expected to be exposed to noise levels of 76.3 dBA, and wildlife within approximately 800 feet of sampling would be exposed to noise levels of 70.3 dBA (Tontechnick-Rechner 2016).

Potential effects of noise on avian species include behavioral and physiological effects, masking of communication and listening, hearing damage (permanent threshold shift), and temporary hearing loss (temporary threshold shift). Noise thresholds vary by species, and no species-specific threshold data were found for western snowy plovers. General effects of noise on birds that would apply to increased noise levels to western snowy plovers that may occur in the Action Area include the following:

- Increased noise can mask communications by wildlife used to attract mates and defend territory. Studies indicate an increase in noise of 3 to 10 dBA corresponds to 30 to

90 percent reductions in alerting distances for wildlife, impairing their abilities to signal and listen, which are necessary for reproduction and survival (USFWS 2011).

- Increased noise and activity levels during nesting season could result in displacing birds from their nests, leaving eggs, young, and adults more susceptible to predation or environmental stress (for example, egg temperature changes, and exposure to wind and blowing sand that could result in burial of eggs).

- Repeated noise exposure is known to result in physiological stress that may affect survival and reproductive success.

- Data on noise impacts to avian species indicate that decreased densities of woodland and grassland species occur at noise thresholds of 45 and 48 dBA; songbirds are specifically sensitive to very low sound levels (about 30 dBA) (USFWS 2011).

- Escape response behavior has been recorded in crested terns (*Thalasseus bergii*) at noise levels (from aircraft) of 85 dBA, while wading birds showed no significant effect when exposed to noise levels of 55 to 100 dBA (FHWA 2004). A general threshold of response of between 27 to 61 dBA was found for road noise (FHWA 2004) on bird species.

- Studies indicate that birds are resistant to permanent auditory damage and hearing loss from noise exposure when exposed to high-intensity impulse noise. Birds can tolerate continuous (up to 72 hours) exposure to noises up to 110 dBA without experiencing hearing damage or permanent threshold shift. Temporary threshold shift (temporary loss of hearing that can last a few seconds to days), however, can occur from continuous noise levels between 93 and 110 dBA (Dooling and Popper 2007).

Based on these data, generation of short-term pulses of noise ranging from 76.3 dBA (at 400 feet from the source) to 94.4 dBA (based on three drill rigs at 89 dBA, one hand auger at 84 dBA, and one generator at 81 dBA at 50 feet from the source [Table 3]) within the Action Area would not result in a permanent threshold shift; however, a temporary threshold shift could occur in western snowy plovers continuously present at 50 feet from the source, which is unlikely. Noise and visual disturbances at the FSFA would likely deter western snowy plovers from foraging or roaming within 50 feet of the source. However, increased noise within the 700-foot buffer would mask communications that support reproduction and survival. Sampling activities may directly affect western snowy plover foraging behavior; noise and visual disturbances could induce minor startle responses and temporary interruption of foraging. However, based on NASA historical records and the more recent SFBBO surveys that indicate low likelihood of western snowy plover occurrence in the Action Area, noise would likely impact only a small number of individuals should they be present.

Western snowy plovers that use the habitat within the Action Area for forage, dispersal, and rest, would be expected to be harassed by sampling activities. Nesting western snowy plovers are not likely to occur within the Action Area during Pilot Study sampling which is scheduled to occur in

January 2018, outside of the nesting season. The Full-Scale Investigation, originally scheduled for May 2017 and now likely to commence in February 2018 with a duration of up to 6 weeks, will occur mostly outside of the nesting season. In the unlikely event that open habitat is available in the SWRP and nests are initiated within the Action Area, direct effects on western snowy plovers could occur from noise and visual disturbances generated from sampling activities, which in turn could result in nest abandonment. Historical survey data indicate that this area is not commonly used for nesting. The AOI 14 FSFA upland fill peninsula is not preferred nesting habitat. Nesting within the SWRP would require that the water levels were low enough to expose salt panne. Water levels within the SWRP are typically high during spring and early summer, inundating salt panne habitat and precluding nesting. Previous surveys in this area indicate that the Action Area is not commonly used by breeding western snowy plovers, likely attributable to the high water levels. Most observations of western snowy plovers in the area of the SWRP have been during the winter months and of birds roosting on levees surrounding the SWRP; more recently (in 2013), two birds were sighted in December roosting in the salt flats (Layne and Harding-Smith 1995; Alderete 2013). However, Crittenden Marsh West had two hatched nests in 2014 and one predated nest in 2015, so nesting within the Action Area, though unlikely, could occur (Pearl et al. 2015).

Vibrations generated from drilling equipment are listed in Tables 2 and 3. Vibrations are expected to be short term and of moderate frequency in a localized area. Vibrations are not expected to propagate far from the source because ground vibration decreases progressively from hard rock to weak or soft soils (New Hampshire Department of Transportation 2012). The materials in the FSFA are mostly a mixture of debris and soft soil. These materials are intermixed and inconsistent and thus do not easily transmit vibrations. Additionally, the soft bay mud and sand of the SWRP would further buffer transmission of vibrations. Western snowy plovers are not expected to occur within the immediate project footprint because noise and visual disturbances will likely deter them from foraging or nesting adjacent to the FSFA. Therefore, no direct effects of vibration on western snowy plovers are anticipated.

Although unlikely to occur in the Action Area, the proposed conservation measures outlined in Section 2.5 are included to reduce the intensity of the anticipated effect in the event that western snowy plovers are present during sampling activities. The conservation measures would further reduce the likelihood of adverse effects on western snowy plovers, should they be present. The following conservation measures would apply: BIO-19 (minimize perches within project footprint); BIO-20 (install anti-perch devices along the perimeter fence of the SWRP); and BIO-27, BIO-28, and BIO-29 (survey and monitor behavior, and enforce a stop work zone). Additionally, conservation measure BIO-13 (noise-reducing devices) would minimize adverse effects from noise-generating activities.

Indirect Effects

Indirect effects are effects caused by or resulting from the Proposed Action and that may occur later in time but are reasonably certain to occur. No indirect effects would occur from Pilot or Full-Scale Investigation sampling because sampling is temporary and would not result in habitat loss or degradation or reduction of food sources. Beneficial indirect effects would occur from removal of contaminants from sediment, soil, and the food chain.

Removal

Removal activities were originally expected to start in October 2017 and continue through August 2018. Removal activities will include mobilization, excavation, final grading and restoration, and demobilization. Removal activities are now scheduled to begin in spring of 2018, at a time when the SWRP is commonly inundated and lacks suitable nesting habitat for western snowy plovers. A review of historical imagery commonly shows open water in the SWRP during June (in 2003, 2009, 2010, 2013, 2014, and 2015) (Google Earth Pro 2016). Work will be conducted up to 7 days per week, during daylight hours only, from approximately 7:00 a.m. to 6:00 p.m. depending on the time of year and amount of available daylight, or as specified by the USFWS-approved biologist. Removal may involve water diversion or partial localized dewatering of the SWRP, as detailed in Section 2.1.3.

Direct Effects

Noise from construction activities during Removal activities would be temporary but not considered short term because it would be consistent, continuous, and over a relatively long duration (12 months); as such, noise effects were analyzed based on continuous exposure thresholds. The combined maximum noise output from the Removal at the AOI 14 FSFA is expected to range from 94.1 dBA (Phase A) to 94.7 dBA (Phase B) to 95.4 dBA (Phase C) at 50 feet from the source (Table 4). This noise is expected to be continuous for the duration of the Removal (12 months). Applying the inverse square law that noise levels decrease 6 dBA per doubling of distance from the source, wildlife within approximately 400 feet of the Removal activities could be exposed to noise levels of 76.0 to 77.3 dBA, and wildlife within 800 feet of Removal activities could be exposed to noise levels of 70.0 to 71.3 dBA (Tontechnick-Rechner 2016). Temporary threshold shift (temporary loss of hearing that can last a few seconds to days) can occur from continuous noise levels between 93 to 110 dBA (Dooling and Popper 2007). Based on the data for temporary and permanent threshold shifts detailed above, the generation of 77.3 dBA (at 400 feet) to 95.4 dBA (at 50 feet) noise levels within the Action Area would not result in permanent threshold shift; a temporary threshold shift could occur in western snowy plovers that were continually present at 50 feet from the source, which is unlikely. The noise and visual disturbances at the FSFA would likely deter western snowy plovers from foraging or roaming within 50 feet of the source. However, the increased noise within the 700-foot buffer would mask communications that support reproduction and survival. Removal activities may have direct effects on western snowy plover foraging behavior; noise and visual disturbances could present minor startle responses and temporary interruption of foraging.

Vibrations from construction equipment are listed in Table 4. Vibrations during the Removal are expected to be of moderate frequency and in a localized area. Vibrations are not expected to propagate far from the source because ground vibration decreases progressively from hard rock to weak or soft soils. The materials in the FSFA are mostly a mixture of debris and soft soil. These materials are intermixed and inconsistent and so do not easily transmit vibrations. Additionally, the soft bay mud and sand of the SWRP would further buffer transmission of vibrations. Western snowy plovers are not expected to occur within the immediate project footprint because noise and visual disturbances will likely deter them from foraging or nesting adjacent to the FSFA, and they

are not likely to occur along haul routes. Therefore, no direct effects from vibration are anticipated for western snowy plovers.

The Removal may require water diversion or localized dewatering of the SWRP (detailed in Section 2.1.3), which is yet to be determined and will be based on areas within the SWRP bottom that are identified through sampling results to require removal. It will also depend on water levels within the SWRP at the time of excavation. The SWRP eventually dries up by mid- to late summer, depending on winter rains. Dewatering may include placement of temporary dams within the SWRP that would direct water away from the areas requiring excavation, thereby reducing the need for localized dewatering.

In the event of dewatering, salt panne that is inundated would become exposed and made available for nesting plovers. SFBBO attributed the low nesting at Crittenden Marsh West in 2015 to high water levels and associated lack of exposed salt panne habitat throughout the nesting season, compared with available habitat (at Crittenden East) in 2014 (Pearl et al. 2015). Ongoing project activities would likely deter nest initiation in the Action Area based on noise and visual disturbances. However, creation of salt panne habitat from dewatering activities could create opportunities for nesting during off-work hours. The following conservation measures would reduce the intensity of the anticipated effect, in the event that western snowy plovers occur in the Action Area: BIO-19 (removal of predator perches) and BIO-27 (requires a biological monitor to survey daily for the presence of individuals and nests and to monitor incubating behavior, and BIO-29 requires enforcement of a stop-work zone). These measures would avoid and minimize adverse effects to western snowy plovers, as would the other conservation measures outlined in Section 2.5.

Water diversion or partial localized dewatering would have short-term adverse impacts on foraging plovers because it would temporarily reduce available open water foraging habitat within a portion of the SWRP. USFWS manages the ponds north of the SWRP as waterfowl production areas and maintains water levels that support foraging. The dewatering that could occur would be temporary and would have a minimal impact on overall available foraging habitat.

Western snowy plovers are not likely to occur in the area of the haul route. Ground vibrations generated from haul traffic are anticipated to be localized and would not reach the SWRP. Adverse effects to the western snowy plover are not likely to occur from noise or vibrations generated from increased traffic along the haul route.

Indirect Effects

Beneficial indirect effects of the Removal would occur from removal of contaminated soil and sediment, and improvement of habitat conditions. The AOI 14 FSFA and SWRP would be restored to increase salt marsh habitat, with restoration goals to create a sustainable site that supports native species (Section 2.1.3). The resultant increase in salt marsh habitat and lowering of the elevations of the FSFA would provide additional foraging and potentially additional nesting area, depending on the amount of salt panne that is created. Additionally, the removal of contaminants that could bioaccumulate in plover tissues and eggs via the conveyance of contaminants through the food

chain, would be a long-term enhancement to the ecosystem and an indirect benefit to western snowy plovers.

Conclusion

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect a small number of western snowy plovers, based on the potential that some individuals may be collocated with project activities in the Action Area. This conclusion is based on historical records of western snowy plovers nesting within the SWRP and project-related noise and visual disturbances that could disrupt foraging, nest incubation, and rearing of young. Western snowy plovers that may use the habitat within the Action Area for foraging, dispersing, and rest would be expected to be harassed by project activities. However, the effects are not considered adverse on a population level. Effects are temporary, occurring over the course of one breeding season; the effects are not considered adverse on a population level, and there will be an overall beneficial effect in the long term to both the species in the area and the habitat because the Proposed Action will remove contaminated soil and sediment, providing a long-term enhancement to the ecosystem and benefit to the plover. The resultant final grading plan will increase the acreage of salt marsh and thereby increase the amount of habitat for foraging, roosting, and breeding.

Disturbance to the western snowy plover during project activities would be minimized by implementing conservation measure BIO-13 (noise-reducing devices), BIO-19 (removal of predator perches), and BIO-27, BIO-28, and BIO-29 (biological surveys, monitoring, and enforce a stop work zone). Additionally, BIO-20 (anti-perch devices along the perimeter fence of the SWRP) would be a long-term benefit to western snowy plovers by reducing predator perch habitat.

5.1.1.2 California Least Tern

Historical listed species surveys at NASA Ames have not recorded California least terns within the SWRP, but they do occur north of the Action Area in the USFWS waterfowl production ponds (Layne and Harding-Smith 1995). California least terns are a migratory species that commonly forage in the flooded ponds north of the SWRP during post-breeding staging for migration, late June through August.

Pilot Study and Full-Scale Investigation Sampling

Direct Effects

California least terns are not likely to occur within the Action Area during the Pilot Study and Full-Scale Investigation because they do not typically arrive in the area until late June. The Pilot Study, originally scheduled for May 2017, will occur in January 2018; the Full-Scale Investigation will likely occur in February 2018. No direct effects would occur to California least terns from sampling because California least terns are not likely to occur in, or in the vicinity of, the Action Area.

Indirect Effects

No indirect effects from Pilot Study or Full-Scale Investigation sampling would occur because sampling is temporary and would not result in habitat loss or alteration, or reduction of food sources.

Removal

Direct Effects

California least terns could occur in (or in the vicinity of) the Action Area during the Removal. Excavation activities could have direct effects to California least terns that may occur in (or in the vicinity of) the Action Area, such as noise and visual disturbances that could elicit a startle response and alter their foraging patterns. A review of historical imagery commonly shows open water in the SWRP for the month of June (years 2003, 2009, 2010, 2013, 2014, and 2015) (Google Earth Pro 2016). Open water habitat is typically minimal to absent at the SWRP in the late summer and fall months, during years of normal precipitation. On arrival, they commonly occur in the vicinity, in the waterfowl production areas. Noise from construction activities could present minor startle responses and temporary interruption of foraging. The effect in the waterfowl production areas would likely be so low as to be negligible. The flooded ponds where California least terns commonly occur are 800 to 1,300 feet from the AOI 14 FSFA peninsula. Visual disturbances are not likely at this distance, and noise would attenuate with increasing distance, from to 71.3 dBA at 800 feet to 67.1 dBA at 1,300 feet from the source (Tontechnik-Rechner 2016). Additionally, the available open water foraging habitat of the USFWS waterfowl production areas is substantially larger than the SWRP and would offset temporary disturbances. Vibrations generated from construction equipment are anticipated to be localized and would likely not reach the waterfowl production foraging areas, based on distance, substrate, and levees that would buffer the horizontal transmission of vibration frequencies. However, California least terns that may use the habitat within the Action Area for foraging, dispersing, and migrating would be expected to be harassed by project activities.

California least terns are not likely to occur along the haul route due to the lack of suitable habitat in this area. Adverse effects to the California least tern are not likely to occur from increased haul traffic.

Indirect Effects

Beneficial indirect effects of the Removal would occur from improvement of habitat conditions. The AOI 14 FSFA and potentially adjacent areas within the SWRP (if excavation is necessary within the SWRP) would be restored to increase salt marsh habitat. Additionally, the removal of contaminants that could bioaccumulate in tern tissues and eggs via conveyance of contaminants through the food chain would be a long-term enhancement to the ecosystem and an indirect benefit to California least terns.

No adverse indirect effects from the Removal would occur because excavation and grading are temporary and would not result in habitat loss or reduction of food sources for California least terns. In the event that water diversion or partial localized dewatering is necessary to conduct excavation within the SWRP, it would likely occur during the early summer months, when California least terns would not be present in the Action Area.

Conclusion

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect California least terns. This conclusion is based on the potential for California least terns to occur within (or in the vicinity of) the Action Area during the time of excavation activities. California least terns that use the habitat within the Action Area for foraging, dispersing, and migrating are expected to be harassed by project activities. However, the effects are not considered adverse on a population level. The adjacency of large foraging areas north of the SWRP may offset temporary disruptions to foraging area that might be available in the SWRP, and the temporary nature of the Proposed Action would result in an overall improvement to the habitat and food chain. Implementation of conservation measures outlined in Section 2.5 will minimize impacts to the California least tern, particularly BIO-13 (noise-reducing devices), BIO-19 (removal of predator perches), and BIO-27, BIO-28, and BIO-29 (biological surveys, monitoring, and enforce a stop work zone). Additionally, BIO-20 (anti-perch devices along the perimeter fence of the SWRP) would be a long-term benefit to California least terns by reducing predator perch habitat. Additionally, the Proposed Action would provide a long-term benefit to the California least tern from removal of contaminants that could accumulate in the food chain.

5.1.1.3 California Clapper Rail

Historical listed species surveys at NASA Ames have documented California clapper rails within the SWRP in 1992 and 1993 (Orton-Palmer and Takekawa 1992; Burns and Harding-Smith 1993). More recent surveys have not detected California clapper rails at NASA Ames; the survey reports indicate that habitat quality in and near the SWRP is poor and that nesting California clapper rails are unlikely (Bumgardner Biological Consulting 2011 and 2012). A 2005 survey report of Northern Channel noted that habitat quality is low and nesting rails are unlikely; no rails were detected during the 2005 survey (Alderete 2005b). However, rails regularly occur in Stevens Creek, approximately 1,200 feet west of the AOI 14 FSFA peninsula and could use the SWRP to forage.

Pilot Study and Full-Scale Investigation Sampling

Direct Effects

The Proposed Action may have direct effects to California clapper rails that occur in the Action Area. Survey records indicate that California clapper rails are unlikely to occur in the Action Area. In the unlikely event that they do occur in the Action Area, Pilot Study and Full-Scale Investigation sampling could have minor direct effects from noise and visual disturbances that could in turn

elicit a startle response and alter foraging patterns. Natural tidal creeks are their preferred habitat; Stevens Creek, which is tidal, is approximately 1,200 feet west of the AOI 14 FSFA peninsula. The available foraging habitat provided by Stevens Creek would likely offset minor and temporary disturbances to foraging that might occur in the SWRP.

California clapper rails that occur in Stevens Creek would be partially shielded from noise and visual disturbances by the distance from the noise source and by creek banks. Visual disturbances are not likely at a 1,200-foot distance, and noise would attenuate to 66.8 dBA at 1,200 feet from the source. Based on data for temporary and permanent threshold shifts detailed in Section 5.1.1.1, noise levels of 66.8 dBA at 1,200 feet would not result in temporary or permanent threshold shifts. However, the increased noise could mask communications that support reproduction and survival. Vibrations generated from drilling equipment are anticipated to be localized and would likely not reach Stevens Creek based on distance, substrate, and levees that would buffer the horizontal transmission of vibration frequencies.

Indirect Effects

No indirect effects from Pilot Study or Full-Scale Investigation sampling would occur because sampling is temporary and would not result in habitat loss or alteration or reduction of food sources.

Removal

Direct Effects

Minor direct effects to California clapper rails in the Action Area from noise and visual disturbances that could in turn elicit a startle response and alter foraging patterns may occur; survey records indicate that foraging in the Action Area is uncommon. California clapper rails that occur in Stevens Creek would be partially shielded from noise and visual disturbances by the distance from the noise source and by creek banks. Visual disturbances are not likely at a 1,200-foot distance, and noise would attenuate to 67.8 dBA (Phase C maximum combined noise [Table 4]) at 1,200 feet from the source. Based on data for temporary and permanent threshold shifts detailed in Section 5.1.1.1, noise levels of 67.8 dBA at 1,200 feet would not result in temporary or permanent threshold shifts. However, the increased noise could mask communications that support reproduction and survival.

Vibrations generated from construction equipment are anticipated to be localized and would likely not reach Stevens Creek based on distance, substrate, and levees that would buffer the horizontal transmission of vibration frequencies.

California clapper rails are not likely to occur in the area of haul routes; no adverse effects would occur from the increased haul traffic.

Although the California clapper rail is unlikely to occur in the Action Area, the proposed conservation measures outlined in Section 2.5 are included to reduce the intensity of any anticipated effect, in the event the California clapper rail would occur in the Action Area. The conservation measures would further reduce the likelihood of adverse effects on California clapper rails, should they be present. The following conservation measures would apply: BIO-27, BIO-28, and BIO-29 (biological surveys, monitoring, and enforce a stop work zone) (requiring a biological monitor to survey daily for presence of federally listed species, which would ensure avoidance or minimization of direct effects on California clapper rails) and BIO-13 (noise-reducing devices).

Indirect Effects

Beneficial indirect effects of the Removal would occur from improvement of habitat conditions. The AOI 14 FSFA and SWRP would be restored to increase salt marsh habitat. Additionally, the removal of contaminants that could bioaccumulate in rail tissues and eggs via conveyance of contaminants through the food chain would be a long-term enhancement to the ecosystem and an indirect benefit to California clapper rails. Conservation measure BIO-20 (anti-perch devices along the perimeter fence of the SWRP) would be a long-term benefit to California clapper rails by reducing predator perch habitat in the vicinity of Stevens Creek.

No adverse indirect effects from the Removal phase would occur because of the distance between occupied habitat in Stevens Creek and the Action Area. Excavation and grading are temporary and would exert no effect on Stevens Creek habitat, and would not result in habitat loss or reduction of food sources for California clapper rails.

Conclusion

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect California clapper rails. This conclusion is based on the potential for occurrence of California clapper rails within the Action Area based on historical survey records for NASA Ames. California clapper rails that may use the habitat within the Action Area for foraging, dispersing, breeding, and rest would be expected to be harassed by project activities. However, the effects are not considered adverse on a population level. The effects of the Proposed Action would be temporary and would result in an overall beneficial effect in the long term from removal of contaminated soil, thereby improving habitat value for foraging, roosting, and breeding. Implementation of conservation measures outlined in Section 2.5 would minimize effects to California clapper rail, particularly BIO-13 (noise-reducing devices), BIO-19 (removal of predator perches), and BIO-27, BIO-28, and BIO-29 (biological surveys, monitoring, and enforce a stop work zone). Additionally, BIO-20 (anti-perch devices along the perimeter fence of the SWRP) would be a long-term benefit to California clapper rails by reducing predator perch habitat in the vicinity of Stevens Creek. Additionally, the Proposed Action would provide a long-term benefit to the California clapper rails from removal of contaminants that could accumulate in the food chain.

5.1.2 Mammals

5.1.2.1 Salt Marsh Harvest Mouse

Salt marsh harvest mice have been observed in the SWRP, MROSD property adjacent to the AOI 14 FSFA, and Stevens Creek. Surveys conducted in Crittenden Marsh in 1991 and 1994 recorded one individual each (Pomeroy 1991; Layne and Harding-Smith 1995). No mice were captured during 1985 surveys of Crittenden Marsh and Sunnyvale Baylands Park (Goals Project 2000). No salt marsh harvest mice have been recorded in the Eastern and Western Diked marshes. The SWRP currently supports pickleweed and may provide habitat for the salt marsh harvest mouse. The 1994 survey report noted that the complete and prolonged submergence of pickleweed within the SWRP during wet years has potentially detrimental effects on the salt marsh harvest mouse (Layne and Harding-Smith 1995). No data were found on the population density or current distribution of salt marsh harvest mouse in the Action Area or NASA Ames. If salt marsh harvest mice are present in the Action Area, the Removal Action would occur throughout their entire life cycle and a portion of two successive breeding seasons.

Pilot Study and Full-Scale Investigation Sampling

Direct Effects

The Pilot Study (revised schedule of January 2018) will occur outside of the salt marsh harvest mouse breeding season, which begins March 1. The Full-Scale Investigation sampling will partially occur during the salt marsh harvest mouse breeding season. Pilot Study and Full-Scale Investigation sampling could exert direct effects on the salt marsh harvest mouse in the Action Area from noise, visual disturbances, and vibration that could elicit startle and escape responses, alter foraging patterns, and induce stress, thus inducing physiologic changes and threatening reproductive success. Escape responses increase energy use and could result in displacement of mice from their home range, potentially increasing their risk of predation. Mouse dispersal could also result in direct injury or mortality (through crushing) if they dispersed underfoot or under moving equipment.

Direct effects to any salt marsh harvest mouse that may be present in the Action Area at the time of sampling could occur from noise-generating activities. Maximum noise levels from direct-push drilling equipment are projected to be a combined maximum of 94.4 dBA (based on three drill rigs at 89 dBA, one hand auger at 84 dBA, and one generator at 81 dBA [Table 3]) at 50 feet from sampling. Applying the inverse square law that noise levels decrease 6 dBA per doubling of distance from the source, wildlife within approximately 400 feet of the sampling activities could be exposed to noise levels of 76.3 dBA (Tontechnick-Rechner 2016).

Hearing loss, elevated stress hormone levels, and hypertension are documented to occur for humans and animals beginning at noise exposure levels of 55 to 60 dBA (Barber et al. 2009). The hearing range of mice is acute, with a range of 1 to 91 kilohertz (kHz); the hearing sensitivity of mammals is documented to -20 dBA (Louisiana State University 2003; FHWA 2004). No data

were found on thresholds for hearing loss for mice; however, general data for mammals indicate that noise levels of 120 dBA can result in permanent hearing damage, and levels at 95 dBA can cause temporary hearing loss (NoiseQuest 2016). Based on these values, sampling activities may not result in permanent hearing loss in mice but would likely result in temporary hearing loss in individuals in close proximity to sampling activities. It is likely that noise and visual disturbances would deter mice from coming within close proximity. Conservation measures BIO-24 (vegetation clearing) and BIO-25 (exclusion fencing) would prevent their presence near sampling activities, and BIO-13 (noise-reducing devices) would minimize noise generated during sampling activities. However, individuals and nests that may occur within 50 feet of activities would be exposed to noise levels that could result in temporary hearing loss and decrease in reproductive success.

Adverse direct effects from sampling are expected to occur from noise and vibrations from drill rigs, which could result in reproductive failures or declines. Studies on the effects of noise on mice reproduction have shown that exposure to noise at 70 to 90 dBA for 1 hour each day during gestation decreased reproductive efficiency by decreasing live birth rates and increasing the number of stillborn pups (Rasmussen et al. 2009). Audiogenic stressors in mice have been linked to hypertension, cardiac hypertrophy, altered electrolyte metabolism, changed immune response, altered estrus cycles, decreased fertility, and an increase of prematurely terminated pregnancies (Rasmussen et al. 2009). Based on projected noise levels of 76 dBA at 400 feet from the source, adverse effects to salt marsh harvest mice are likely to occur if nests are present within 400 feet of the FSFA.

Masking is a significant problem for reproductive, territorial, and alarm messaging, and it affects the successful perception of motion such as that produced by predators or footfall, which in turn may have effects on mouse survival. Studies have shown that a noise increase of 3 dBA, which is just perceptible to humans, corresponds to a 50 percent loss of listening area for wildlife. Noise increases of 3 to 10 dBA correspond to 30 and 90 percent reductions in alerting distances (Barber et al. 2009).

Vibrations generated from drilling equipment are listed in Tables 2 and 3. Vibrations are expected to be short-term and of moderate frequency in a localized area. Vibrations are not expected to propagate far from the source because ground vibration decreases progressively from hard rock to weak or soft soils. Salt marsh harvest mice that may occur in the pickleweed habitat near the FSFA may have direct adverse effects from vibration. Studies show that both noise and vibration induce stress in animals, and mice are more sensitive to vibration than humans (Norton et al 2011). Anecdotal reports of the effects of vibration include a reduction in mouse breeding efficiency, reductions in food intake and weight gain, and behavioral modifications. In other animals, low-level whole-body vibration causes cardiovascular effects in dogs and swine, avoidance behavior in poultry, physiologic changes in rats, and behavioral changes and increases in stress-related hormones in swine. No information is available to determine the frequency ranges at which rats or mice perceive low-level vibration (Norton et al 2011). Although there are no comparative values of vibration thresholds in the wild, results from laboratory studies on the effects of vibration on mice indicate that vibrations in the range of 31 to 100 Hz should be avoided (Rabey et al. 2015).

Removal of the protective cover of pickleweed (0.02 acre) will temporarily reduce available habitat. Pickleweed will be mitigated at a 3:1 ratio, but the temporal loss will adversely affect available habitat, cover, and escape refuge for mice during high water periods. Installation of exclusion fence will result in temporary loss of upland refuge habitat for the mouse. The upland area of the FSFA and primary staging area encompasses approximately 5.6 acres. This area would be kept mowed and enclosed with exclusion fence for the duration of the Removal Action, except in the case of significant lag time, during which openings will be made to facilitate movement of mice across the upland/wetland interface.

Indirect Effects

Adverse indirect effects include the short-term temporal loss of habitat, forage, and escape cover from removal of pickleweed and vegetation from the upland fill peninsula. Escape responses that result in increased energy utilization have indirect effects on reproductive success and foraging success because the energy budget for the mouse will be reduced, which reduces the ability to forage and also reduces the energy reserves that go toward successful reproduction and rearing.

Removal

Direct Effects

The Removal was expected to start in October 2017 and continue through August 2018 (based on sampling data and the amount of contaminated soil and sediment requiring removal), and occur over a portion of two breeding seasons. Based on the updated project schedule, the Removal is expected to take place over one breeding season, with a spring 2018 start and fall 2018 finish. Removal activities could have direct effects on salt marsh harvest mice that may occur in the Action Area from noise, visual disturbances, and vibration that could elicit startle and escape responses, alter foraging patterns, and induce stress-affecting physiologic changes and reproductive success. Escape responses increase energy use and could result in dispersal of mice to areas not normally inhabited, potentially increasing their risk of predation and death by crushing underfoot or under equipment.

Noise from construction activities would occur over a relatively long duration (12 months), so noise effects were analyzed based on continuous exposure thresholds. The combined maximum noise output from the Removal at the AOI 14 FSFA is expected to range from 94.1 (Phase A, Table 4) to 95.4 dBA (Phase C, Table 4) at 50 feet from the source. This noise is expected to be relatively continuous for the duration of the Removal (12 months). Noise generation may be marginally less, depending on the quantity and types of equipment running concurrently. The maximum potential noise output is used for analyzing impacts. Applying the inverse square law that noise levels decrease 6 dBA per doubling of distance from the source, wildlife within approximately 400 feet of the sampling activities could be exposed to noise levels of 76.0 to 77.3 dBA (Tontechnick-Rechner 2016). Based on these values, Removal activities may not result in permanent hearing loss in mice but would likely result in temporary hearing loss in individuals in close proximity to sampling activities, although it is likely that noise and visual disturbances would deter mice from coming within close proximity. Conservation measures BIO-24

(vegetation clearing) and BIO-25 (exclusion fencing) would prevent their presence near Removal activities, and BIO-13 (noise-reducing devices) would minimize noise generated during the Removal. However, individuals and nests that may occur within 50 feet of activities would be exposed to noise levels that could result in temporary hearing loss and decrease in reproductive success.

Based on the recommendation that vibrations in the range of 31 to 100 Hz should be avoided and because most vibrations generated during the Removal range (individually) from 30 to 46 Hz (Table 4), adverse direct effects to the mouse will likely occur from vibrations generated at the FSFA (Rabey et al. 2015). However, vibrations are not expected to propagate far from the source; salt marsh harvest mice that may occur in the pickleweed habitat near the FSFA would be most likely to suffer direct adverse effects from vibration. Adverse effects would be similar to those detailed above for sampling.

Temporal loss of pickleweed habitat will adversely affect the mouse by decreasing available cover, nesting habitat, and forage. Approximately 0.60 acre of additional pickleweed will be removed during the Removal, for a total of 0.62 acre removed during the Removal Action (sampling and excavation) (Figure 8 and Table 6). The loss of pickleweed would be temporary until vegetation cover restores. The final amount of pickleweed impacted by the Removal Action will be documented by the USFWS-approved biologist.

Temporary loss of upland habitat for escape refuge during high water will adversely affect the mouse. The secondary staging area (N217A) encompasses approximately 1.65 acres and may be fenced off for mice during the Removal. This would be in addition to the temporary loss of upland habitat at the FSFA (5.60 acres), for a total temporary loss of 7.25 acres of upland refuge during the Removal. Pickleweed will be mitigated at a 3:1 ratio; at least 1.86 acres of pickleweed will be restored on site. To accommodate restoration of pickleweed, the upland habitat of the FSFA (approximately 5.60 acres) will be reduced—a permanent loss. The amount of upland that would be permanently lost is unknown at this time and will be determined based on sampling data and the amount of contaminated soil and sediment requiring excavation. The site conceptual final grading and restoration plan depicts a final grading that increases pickleweed and transitional habitat but decreases upland habitat (Figure 9). The Removal Action boundary of the FSFA peninsula currently has steep slopes and sparse transitional habitat. The upland portion of the FSFA is dominated by invasive species (fennel and non-native grasses); upland restoration would include invasive species control and native revegetation. Increases in pickleweed and transitional habitat are a long-term benefit to the mouse.

Table 6: AOI 14 FSFA Removal Action Estimated Habitat Loss and Disturbance

Habitat	Temporary Loss (Acres)		Permanent Loss (Acres)		Restored (Acres)
	Pilot Study and Full-Scale Investigation	Removal	Pilot Study and Full-Scale Investigation	Removal	
Pickleweed	0.02	0.60	0	0	≥1.86
Upland	1.65	5.60	0	TBD	TBD

Note:

TBD = To be determined

Increased haul traffic along North Perimeter Road could result in direct injury or mortality from crushing. Studies of small mammals (white-footed mice [*Peromyscus leucopus*] and eastern chipmunks [*Tamias striatus*]) indicate that densities were not lower near roadways. However, both species were less likely to cross the road than travel the same distance away from the roads, with traffic volume (and associated noise level) having no influence (Barber et al. 2009). Roadways may act as barriers for most small mammals, with noise being of lesser importance (FHWA 2004). The haul route along North Perimeter Road is not immediately adjacent to pickleweed habitat; vegetated uplands are on either side of the road and range from 25 to 240 feet wide.

Construction traffic noise in the area of the haul routes would increase; noise levels would be intermittent through the day. Noise levels are estimated to be 76 dBA at 50 feet (Table 4). Communications would be temporarily masked at this level and temporary hearing loss would not likely occur. Vibrations from the increased haul traffic would increase locally; dispersal would be minimized by the mitigating effect of the central peninsula and N217A peninsula, which would buffer horizontal transmission of vibration frequencies.

The Removal may require water diversion or partial localized dewatering within the SWRP, which is yet to be determined and will be based on water levels and the areas within the SWRP that require removal. If WATS water is diverted from entering the SWRP, the mouse would benefit from lack of inundation and increased availability of pickleweed in the surrounding SWRP. The SWRP eventually dries up by mid- to late summer, depending on winter rains. Dewatering would be localized to excavation areas. The presence of dams could temporarily alter foraging and dispersal patterns of salt marsh harvest mouse; the effects would be temporary and localized to the areas immediately around the dams and so would be minimal.

Indirect Effects

Adverse indirect effects from Removal activities would be likely to occur from noise and vibrations from the drill rigs that could result in reproductive failures or declines. Adverse indirect effects would also include the short-term temporal loss of habitat, forage, and escape cover from removal of pickleweed and vegetation from the upland fill peninsula. Areas devoid of vegetation would act as barriers to dispersal; mice travelling through these areas would be more visible to

predators. Escape responses that result in increased energy utilization have indirect effects on reproductive success and foraging success because the energy budget for the mouse will be reduced, which reduces ability to forage and also reduced energy reserves for successful reproduction and rearing.

The improvement of habitat conditions by removal of contaminated soil and increase in salt marsh acreage would provide beneficial indirect effects. The restoration of salt marsh and transitional habitats would provide an increase in habitat for foraging and nesting. Additionally, removal of contaminants that could bioaccumulate in mouse tissues and offspring via conveyance of contaminants through the food chain would be a long-term enhancement to the ecosystem and an indirect benefit to the salt marsh harvest mouse.

Conclusion

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect an unknown number of salt marsh harvest mice based on the likelihood that some individuals would be present in the Action Area and potentially present throughout their entire life cycle. The number of individuals may be small based on historical records of salt marsh harvest mice within the SWRP, and mice that would collocate with the Proposed Action are also likely reduced as a result of project-related noise, vibration, visual disturbances, and temporary habitat disturbance that would likely disrupt foraging, nesting, and rearing of young. However, effects are adverse because of the project duration relative to the expected life expectancy for the mouse and the degree of expected effects from stressors detailed above to a mouse should it be present. The mouse lives at maximum 1 year in the wild and generally less than 8 months (EPA 2010), and project activities will occur over a duration equal to an entire life cycle of the mouse and over two successive breeding seasons. Effects are not considered adverse on a population level because the Action Area is within the larger area of Crittenden Marsh, which would provide other sites for breeding and foraging (USFWS 2013). Other populations occur throughout South San Francisco Bay, with the next closest records occurring in Guadalupe Slough, approximately 1.5 miles east of the Action Area. There will be an overall beneficial effect in the long term to both the species in the area and to the habitat because the Proposed Action will remove contaminants from soil, providing a long-term enhancement to the ecosystem and benefit to the mouse. The resultant final grading plan will increase the acreage of salt marsh and thereby increase the amount of habitat for foraging, cover, and breeding.

Disturbance to the salt marsh harvest mouse during project activities will be minimized by implementing the general conservation measures outlined in Section 2.5, and specifically salt marsh harvest mouse measures BIO-26, BIO-27, and BIO-28, which address biological surveys and monitoring, enforcement of a stop-work zone, vegetation removal, and exclusion fencing to prevent mice from entering the work area. BIO-20 (installation of anti-perch devices along the SWRP) will have a long-term benefit by reducing predator perch habitat. Effects on the salt marsh harvest mouse from noise-generating activities at the FSFA will be minimized by implementing conservation measure BIO-13 (noise-reducing devices).

6.0 CUMULATIVE EFFECTS ON THREATENED AND ENDANGERED SPECIES OR CRITICAL HABITATS

Per 50 CFR §402.02, cumulative effects are "those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation." The Action Area includes federal property (NASA Ames) and a portion of MROSD property. There are no state or private activities planned to occur in the Action Area and thus no cumulative effects are anticipated. Regional projects that may contribute effects to species that occur in the Action Area include the South Bay Salt Ponds Restoration Project, San Francisco Estuary Invasive *Spartina* Control Project, and Planetary Ventures Bay View Parcel Development. However, these regional projects have a federal nexus and have gone through consultation with USFWS for effects to species, and are not considered for cumulative effects.

Climate change may contribute to overall cumulative effects on species that use salt marsh habitat. Numerous scientific models focus on effects of climate change and sea level rise under various scenarios. Based on historical trends, there is general agreement that temperatures and climatic variability will increase but less agreement on projections of precipitation trends (Lawson et al. 2010). Under medium- to medium-high greenhouse gas emissions conditions, models predict that mean sea level will rise 3.3 feet to 4.6 feet by year 2100 (Heberger et al. 2009). Disruption of weather patterns is attributed to climate change, which may result in habitat and vegetation community shifts and losses and may favor invasive species, parasites, and diseases. Sea level rise may result in overtopping of levees and inundation of habitat that supports the species addressed in this BA. Species adaptation and dispersal may be challenging for those species with smaller habitat ranges. Additive effects of climate change may contribute adverse effects to the species addressed in this BA.

7.0 CONCLUSION AND DETERMINATION OF EFFECTS FOR SPECIES AND DESIGNATED CRITICAL HABITAT

Potential for the AOI 14 Removal Action (including the Pilot Study, Full-Scale Investigation, and Removal) to affect species requiring Section 7 of the ESA consultation in the Action Area is summarized in Table 7. Section 5 contains the full supporting analyses for these effect determinations. No designated critical habitat is in the Action Area.

Table 7: Summary of Effects of AOI 14 FSFA Pilot Study and Full-Scale Investigation Sampling, and Removal

Proposed Action Category of Effect	Western Snowy Plover	California Least Tern	California Clapper Rail	Salt Marsh Harvest Mouse
Pilot Study and Full-Scale Investigation	■	■	■	■
Removal	■	■	■	■
Effects Conclusion	■	■	■	■

Notes:

■ Likely to adversely affect.

As indicated in Table 7, the Proposed Action may affect and is likely to adversely affect California least terns, California clapper rails, western snowy plovers, and salt marsh harvest mice. The Proposed Action is expected to exert a long-term beneficial effect on all species addressed in this BA, from removal of sediment contaminated with chemicals that could bioaccumulate in the food chain. The determinations of effects and the bases of these determinations are summarized below.

7.1 WESTERN SNOWY PLOVER

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect a small number of western snowy plovers based on the likelihood that some individuals would be present in the Action Area. This conclusion is based on historical records of western snowy plovers nesting within the SWRP and roosting on adjacent levees, and the likelihood that they will be harassed by project activities. Project-related noise and visual disturbances would likely disrupt foraging, nest incubation, and rearing of young. Effects will be temporary, occurring over the course of one breeding season; the effects are not considered adverse on a population level, and there will be an overall beneficial effect in the long term to both the species in the area and the habitat because the Proposed Action will remove contamination from soil, providing a long-term enhancement to the ecosystem and benefit to the plover. The resultant final grading plan will increase the acreage of salt marsh and thereby increase the amount of habitat for foraging, roosting, and breeding. Implementation of conservation measures outlined in Section 2.5 will minimize effects of the Proposed Action on the western snowy plover.

7.2 CALIFORNIA LEAST TERN

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect California least terns. This conclusion is based on the potential for California least terns to occur within the Action Area during excavation activities. California least terns that use the habitat within the Action Area for foraging, dispersing, and migrating would be expected to be harassed by project activities. However, the effects are not considered adverse on a population level and the temporary nature of the Proposed Action would also result in an overall improvement to the habitat and food chain. Additionally, the adjacency of large foraging areas north of the SWRP may offset

temporary disruptions to foraging that might be available at the SWRP, and implementation of conservation measures outlined in Section 2.5 will minimize effects of the Proposed Action on the California least tern.

7.3 CALIFORNIA CLAPPER RAIL

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect California clapper rails. This conclusion is based on the potential for California clapper rails to occur within the Action Area during sampling and excavation which could disrupt patterns of forage, dispersal, breeding, and rest. California clapper rails that use the habitat within the Action Area would be expected to be harassed by project activities. However, the effects are not considered adverse on a population level and the temporary nature of the Proposed Action would result in an overall improvement to the habitat and food chain from removal of contaminated soil. Additionally, the Proposed Action will result in an increase in the acreage of salt marsh and pickleweed habitat, thereby improving habitat value for foraging and roosting. Implementation of conservation measures outlined in Section 2.5 will minimize effects of the Proposed Action on the California clapper rail.

7.4 SALT MARSH HARVEST MOUSE

Pursuant to the ESA, the Proposed Action may affect and is likely to adversely affect the salt marsh harvest mouse. This conclusion is based on the likelihood that some number of individuals are expected to be present in the Action Area during the Proposed Action, and since the short life cycle of the mouse (one year) means that the Proposed Action will occur over a duration equal to the entire life span of any mouse that is present during project operations. The project will affect an unknown number of individual mice. This number of affected mice is expected to be small based on historical records of salt marsh harvest mouse within the SWRP, therefore the effects are not considered adverse at a population level. However, because the project-related noise, vibration, visual disturbances, and temporary habitat disturbance would likely disrupt foraging, nesting, and rearing of young, the evaluation for the Proposed Action is that it may affect and is likely to adversely affect the mouse. There will be a long-term beneficial effect to both the species in the area and the habitat because the Proposed Action will remove contaminants from soil, providing a long-term enhancement to the ecosystem and benefit to the mouse; additionally, the resultant final grading plan will increase the acreage of salt marsh and thereby increase the amount of habitat for foraging, cover, and breeding. Nonetheless, the Proposed Action may affect the mouse and the effects determination is based on these project actions.

8.0 REFERENCES

Alderete, C. 2005a. Site 27 Superfund Vegetation Survey on the Northern Channel in December 2005. December.

Alderete, C. 2005b. Ames Research Center California Clapper Rail (*Rallus longistrostris obsoletus*) Survey for Superfund Site 27 Northern Channel. April.

Alderete, C. 2013a. Email correspondence between Christopher Alderete, Leidos Wildlife Biologist, and Hugo Hoffman, NASA Environmental Division, regarding AOI 14 silt fence installation western snowy plover presence/absence survey. December 18.

Alderete, C. 2013b. Biological Survey for NASA Ames Research Center AOI 14 Silt Fence Installation on 11/7/13. Prepared for NASA Ames Research Center.

Barber, J., K. Crooks, and K. Fristrup. 2009. "The costs of chronic noise exposure for terrestrial organisms." *Trends in Ecology and Evolution*, Volume 25, Number 3. September.

Barbour, M.G., T. Keeler-Wolf, and A.A. Schoenherr. 2007. *Terrestrial Vegetation of California, 3rd edition*. University of California Press, California.

Botti, F., D. Warenycia, and D. Becker. 1986. "Utilization by salt marsh harvest mice *Reithrodontomys raviventris halicoetes* of a non-pickleweed marsh." California Department of Fish and Game 72: 62-64.

Bumgardner Biological Consulting. 2011. Letter report to David Kelly, Recovery Permit Coordinator, U.S. Fish and Wildlife Service (USFWS), regarding results of California clapper rail surveys conducted in 2011 at locations associated with Installation Remediation (IR) Site 25, Naval Air Station Moffett Field, California. May 4.

Bumgardner Biological Consulting. 2012. 2012 California Clapper Rail and California Black Rail Survey Report for Installation Remediation Site No. 25 Moffett Field Naval Air Station, Santa Clara County, California. June.

Burns, E.G. and E.K. Harding-Smith. 1993. Ecology of the California Black Rail (*Laterallus jamaicensis coturniculus*) at Naval Air Station Moffett Field, 1993. October.

California Department of Transportation (Caltrans). 2014. *California Manual on Uniform Traffic Control Devices for Streets and Highways*.

California Department of Fish and Wildlife (CDFW). 2016. California Natural Diversity Database, Biogeographic Data Branch. Search of listed and sensitive species occurrences in vicinity of AOI 14 Former Soil Fill Area project. October.

California Department of Water Resources. 2016. "California Data Exchange Center—Precipitation, Rainfall Maps from DWR/CNRFC, SF Bay Area." Accessed on November 17, 2016. http://cdec.water.ca.gov/precip_maps/.

Chesser, R. T., R.C. Banks, C. Cicero, J. L. Dunn, A. W. Kratter, I. J. Lovette, A. G. Navarro-Siguenza, P. C. Rasmussen, J. V. Remsen Jr., J. D. Rising, D. F. Stotz, and K. Winker. 2014. *Fifty-Fifth Supplement to the American Ornithologists' Union Check-list of North American Birds*. The Auk: October 2014, Volume 131, Number 4, pages CSi-CSxv.

Design, Community and Environment (DCE). 2002. NASA Ames Development Plan Final Programmatic Environmental Impact Statement. July.

Dooling, R. J. and A.N. Popper. 2007. "The Effects of Highway Noise on Birds." Prepared for the California Department of Transportation, Division of Environmental Analysis. September.

Earth Resources Technology, Inc. (ERT). 2015. Environmental Resources Document, NASA Ames Research Center, Moffett Field, California. March.

ERT. 2017. 2016 Annual Self-Monitoring Report, West-Side Aquifers Treatment System, Regional Groundwater Remediation Program, Order No. R2-2012-0012, NPDES Permit Number CAG912002. February.

EDAW, Philip Williams and Associates, Ltd., H.T. Harvey and Associates, Brown and Caldwell, and Geomatrix. 2007. South Bay Salt Pond Restoration Project Final Environmental Impact Statement/Report. Volume 1. Submitted to U.S. Fish and Wildlife Service and California Department of Fish and Game. December.

Federal Highway Administration (FHWA). 2004. *Synthesis of Noise Effects on Wildlife Populations*. Publication No. FHWA-HEP-06-016. September.

Foster Wheeler Environmental Corporation. 2003. Draft Eastern Diked Marsh Portion of Site 25 Biological Assessment. Prepared for Southwest Division Naval Facilities Engineering Command. June.

Geisel, W.H., H.S. Shellhammer and H.T. Harvey. 1988. "The ecology of the salt marsh harvest mouse (*Reithrodontomys raviventris*) in a diked salt marsh." *Journal of Mammalogy*. Volume 69, pages 696-703.

Gilbane Federal. 2016. Final Vegetation Restoration Completion Report—Year 3, Installation Restoration Site 25, Former NAS Moffett Field, Moffett Field, California. June.

Goals Project. 2000. "Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish and wildlife." Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

Google Earth Pro. 2016. Review of historical aerial imagery for NASA Ames Research Center, area of IR Site 25 stormwater retention pond. Accessed November 17, 2016.

Heberger, M., H. Cooley, P. Herrera, P.H. Gleick, and E. Moore. 2009. The Impacts of Sea Level Rise on the California Coast. Pacific Institute, California Climate Change Center. CEC-500-2009-024. May.

H.T. Harvey and Associates. 2005. South Bay Salt Pond Restoration Project, Biology and Habitats Existing Conditions Report. March.

ITSI Gilbane. 2012. Biological Assessment for IR Site 25 Former Naval Air Station Moffett Field, California. January.

Jones and Stokes. 2004. *Transportation-and Construction-Induced Vibration Guidance Manual*. Prepared for California Department of Transportation, Noise, Vibration, and Hazardous Waste Management Office, Sacramento, California. June.

Josselyn, M. 1983. "The Ecology of San Francisco Bay Tidal Marshes: A Community Profile." U.S. Fish and Wildlife Service, Division of Biological Services, Washington D.C.

Lawson, D.M., H.M. Regan, P.H. Zedler, and J. Franklin. 2010. "Cumulative Effects of land use, altered fire regime and climate change on persistence of *Ceanothus verrucosus*, a rare, fire-dependent plant species." *Global Change Biology*. Vol. 16. Pgs. 2518-2529.

Layne, V.L. and E.K. Harding-Smith. 1995. Sensitive Species Surveys at Moffett Field, 1994. August.

Leidos. 2016. Memo to Kim Finch, NASA, from Jessica Degner, Leidos, and Chris Alderete, Leidos, re: AOI 14 Pre-Removal Action Site Work Preliminary Assessment and Initial USFWS Coordination Efforts. July 13.

Louisiana State University. 2003. "How Well Do Dogs and Other Animals Hear?" Frequency Hearing Ranges in Dogs and Other Species. http://www.lsu.edu/deafness/HearingRange.html

McBroom, J. 2015. California Ridgway's Rail Surveys for the San Francisco Estuary Invasive *Spartina* Project 2015. Prepared for the State Coastal Conservancy. September.

National Aeronautics and Space Administration (NASA). 2011. NASA Ames Research Center Fuel Line Demolition Project Biological Assessment. October.

NASA. 2013. Letter to Mr. Ryan Olah, USFWS Division Chief, requesting initiation of emergency formal consultation for silt fence installation at AOI 14 Former Soil Fill Area, in response to emergency conditions at the site. September 25.

NASA. 2016. NASA Geographic Information Systems shapefile of pickleweed survey boundary, "Pickleweed_Extent," surveyed July.

New Hampshire Department of Transportation. 2012. "Ground Vibrations Emanating from Construction Equipment, Final Report." FHWA-NH-RD-12323W. September 8. https://www.nh.gov/dot/org/projectdevelopment/materials/research/projects/documents/FHWA-NH-RD-12323W.pdf.

NoiseQuest. 2016. http://www.noisequest.psu.edu/noiseeffects-wildlife.html Accessed November 17, 2016.

Norton, J., W. Kinard, and R. Reynolds. 2011. Comparative Vibration Levels Perceived Among Species in a Laboratory Animal Facility. *Journal of the American Association for Laboratory Animal Science*. Volume 50(5). September.

Orton-Palmer, A. E. and J.E. Takekawa. 1992. Breeding Census for the California clapper rail (*Rallus longirostris obsoletus*) at Naval Air Station Moffett Field and Guadalupe Slough, 1992. September.

Pearl, B., K. Tokatlian, and J. Scullen. 2015. Western Snowy Plover Monitoring in the San Francisco Bay, Annual Report, 2015. Prepared for Don Edwards San Francisco Bay National Wildlife Refuge and California Department of Fish and Wildlife. December 31.

Pomeroy, D. R. 1991. Results of Preliminary Salt Marsh Harvest Mouse Surveys, 22 through 26 July, 1981 at Naval Air Station, Moffett Field, Midpeninsula Open Space District, National Aeronautics and Space Administration, Ames Research Center, Santa Clara County, California.

Rabey, K., Y. Li, N. Norton, R. Reynolds, and D. Schmitt. 2015. "Vibrating Frequency Thresholds in Mice and Rats: Implications for the Effects of Vibrations on Animal Health." A*nnals of Biomedical Engineering*. Volume 43, Issue 8. August.

Rasmussen, S., G. Glickman, R. Norinsky, F. Quimby, and R. Tolwani. 2009. "Construction Noise Decreases Reproductive Efficiency in Mice." *Journal of the American Association for Laboratory Animal Science*. Volume 48(4). July.

Robinson-Nilsen, C., K. Tokatlian, J. Scullen, and C. Burns. 2013. Western Snowy Plover Monitoring in the San Francisco Bay, Annual Report, 2013. Prepared for Don Edwards San Francisco Bay National Wildlife Refuge and California Department of Fish and Wildlife. December 20.

SAIC. 1999. Vegetation Surveys and Mapping at Moffett Field, California. Prepared for NASA Ames Research Center, Moffett Field, California. November.

Scott, N. J. and C. Alderete. 2001. Amphibian Survey of Moffett Field, Santa Clara County, California, with Focus on the California Red-Legged Frog (*Rana aurora draytonii*) and the California Tiger Salamander (*Ambystoma californiense*). July.

Shellhammer, H.S. 1982. "Mammalian Species, *Reithrodontomys raviventris*." *The American Society of Mammologists.* No. 169: 1-3.

Signal Communications Corporation. 2016. Sound Level Guide. Accessed October 20, 2016. http://www.sigcom.com/pdf/Sound%20Level%20Guide.pdf .

Tetra Tech. 2015. Area of Investigation 14 Engineering Evaluation/Cost Analysis, NASA Ames Research Center, Moffett Field, CA. September.

Tetra Tech. 2016a. Final Area of Investigation 14 Geophysical Survey Report, NASA Ames Research Center, Moffett Field, CA. November.

Tetra Tech. 2016b. Final Area of Investigation 14 Action Memorandum, NASA Ames Research Center, Moffett Field, CA. November.

Tetra Tech. 2016c. Email correspondence between Angela Lortie, Tetra Tech biologist, and Christopher Alderete, Leidos Wildlife Biologist, regarding management of Burrowing Owl Preserves at NASA Ames Research Center. November 18.

Tetra Tech. 2016d. Telephone conversation between Angela Lortie, Tetra Tech biologist, and Christopher Alderete, Leidos Wildlife Biologist, regarding stormwater management and hydrology of the Northern Channel, as observed during IR Site 27 remediation work that involved de-watering the North Patrol and Northern Channel ditches.

Tetra Tech. 2016e. Telephone conversation between Angela Lortie, Tetra Tech biologist, and Carmen Leong, Don Edwards Wildlife Refuge biologist, regarding management of Alviso Pond A3, north of North Patrol Road. November 18.

Tetra Tech. 2017. *Area of Investigation 14 Removal Action Work Plan*, National Aeronautics and Space Administration Ames Research Center, Moffett Field, CA. December 2017.

Tokatlian, K., J. Scullen, and C. Burns. 2014. Western Snowy Plover Monitoring in the San Francisco Bay, Annual Report, 2014. Prepared for Don Edwards San Francisco Bay National Wildlife Refuge and California Department of Fish and Wildlife. December 31.

Tontechnik-Rechner. 2016. Damping of sound level (decibel) versus distance. http://www.sengpielaudio.com/calculator-distance.htm. Site accessed October 20, 2016.

U.S. Army Corps of Engineers (USACE). 2009. Mapped Waters of the U.S. Subject to Section 404 of the Clean Water Act, Ames Research Wetlands Map, Moffett Field, Santa Clara County. October 8.

U.S. Department of Transportation. 2006. "*Construction Noise Handbook*." DOT-VNTSC-FHWA-06-02. August. https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

U.S. Environmental Protection Agency (EPA). 2010. Endangered Species Facts, Salt Marsh Harvest Mouse. https://www.epa.gov/sites/production/files/2013-08/documents/salt-marshharvest-mouse.pdf

U.S. Fish and Wildlife Service (USFWS). 2006. California Least Tern (*Sternula antillarum browni*) 5-Year Review Summary and Evaluation. Carlsbad Fish and Wildlife Office. September.

USFWS. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*). In two volumes. Sacramento, California. xiv + 751 pages.

USFWS. 2009. Bay Checkerspot Butterfly (*Euphydryas editha bayensis*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. August.

USFWS. 2010a. Salt marsh harvest mouse (*Reithrodontomys raviventris*) 5-Year Review: Summary and Evaluation. USFWS Sacramento Fish and Wildlife Office, Sacramento, California. February.

USFWS. 2010b. San Bruno Elfin Butterfly (*Callophrys mossii bayensis*) and Mission Blue Butterfly (*Icaricia icarioides missionensis*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. February.

USFWS. 2010c. *Suaeda californica* (California sea-blite). 5-Year Review: Summary and Evaluation. Ventura Fish and Wildlife Office. February.

USFWS. 2011. *Effects of Noise on Wildlife*. http://ulpeis.anl.gov/documents/dpeis/references/pdfs/USFWS_2011c.pdf.

USFWS. 2012a. Biological Opinion on the Proposed Doherty Drive Bridge Replacement Project in the City of Larkspur, Marin County, California. April 12.

USFWS. 2012b. 50 CFR Part 17, Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Pacific Coast Population of the Western Snowy Plover; Final Rule. June 19. GIS shapefile available at: http://ecos.fws.gov/ecp/report/table/critical-habitat.html

USFWS. 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Region 8, USFWS, Sacramento, California. August.

USFWS. 2015. USFWS Bay-Delta Fish and Wildlife Office Species Account for California Ridgway's Rail (*Rallus obsoletus obsoletus*). July.

USFWS. 2016a. Formal Consultation on the San Francisquito Creek Flood Reduction, Ecosystem Restoration, and Recreation Project, from San Francisco Bay to Highway 101, in the City of East Palo Alto, San Mateo County, and the City of Palo Alto, Santa Clara County, California (U.S. Army Corps of Engineers file number 2013-00030S). January 15.

USFWS. 2016b. Official species list of threatened and endangered species that may occur at NASA Ames Research Center AOI 14 Former Soil Fill Area. Requested by NASA via USFWS Information for Planning and Consultation (IPaC) website, November 1.

USFWS. 2017. Formal Consultation on the NASA Ames Research Center Area of Investigation 14 Non-Time-Critical Removal Action, Moffett Field, Santa Clara County, California (NASA Reference #: JQ: 204-15). October 30.

Warriner, J.S., J.E. Warriner, G.W. Page, and L.E. Stenzel. 1986. "Mating system and reproductive success of a small population of polygamous snowy plovers." *Wilson Bulletin.* 98(1): 15-37.

Western Regional Climate Center (WRCC). 2016. Period of Record Monthly Climate Summary and Total Precipitation Summary for Palo Alto, California. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6646.

Zeiner, D.C., W.F. Laundenslayer, Jr., K.E. Mayer, and M. White. 1990. *California's Wildlife, Volume II: Birds*. California Statewide Habitat Relationships System. State of California, the Resources Agency. California Department of Fish and Game. November.

9.0 LIST OF PREPARERS

Katie Henry
Bachelor of Science (B.S.), Biological Sciences
Master of Science (M.S.), Environmental Management
Years of Experience: 16
(Technical Quality Assurance/Quality Control [QA/QC])

Angela Lortie
Bachelor of Arts (B.A.), Environmental Studies
Years of Experience: 16
(Biological Resources, Resource Author)

Diane MacMillan
Bachelor of Sciences (B.S.), Chemical Engineering
Years of Experience: 16
(Project Description, QA/QC)

Jean Michaels
Bachelor of Sciences (B.S.), Chemical Engineering
Years of Experience: 29
(Project Description Author)

Ann Zoidis
Bachelor of Arts (B.A.), Geology, with Minor in Vertebrate Zoology
Master of Science (M.S.), Physiology and Behavioral Biology
Years of Experience: 30
(Biological Assessment Project Management; Biological Resources, Resource Author; QA/QC)

APPENDIX A
USFWS SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL, SUITE 8-300
SACRAMENTO, CA 95814
PHONE: (916)930-5603 FAX: (916)930-5654
URL: kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0017 November 01, 2016
Event Code: 08FBDT00-2017-E-00019
Project Name: NASA Ames Research Center AOI 14 Former Soils Fill Area

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0017
Event Code: 08FBDT00-2017-E-00019

Project Type: Superfund Site Remediation

Project Name: NASA Ames Research Center AOI 14 Former Soils Fill Area
Project Description: NASA Ames Research Center, located at Moffett Field in Santa Clara County, California, is addressing contaminated soil within Area of Investigation (AOI) 14 Former Soils Fill Area (FSFA) by implementing a Non-Time-Critical Removal Action as lead agency under the NASA Moffett Federal Facility Agreement (FFA) with EPA Region 9 and the State of California Water Quality Control Board. Work under the FFA is conducted in accordance with CERCLA requirements and guidance. AOI 14 FSFA is approximately 8 acres and located at the northern end of NASA Ames and surrounded by a stormwater retention pond. The proposed action addresses the northern portion of the FSFA where concentrations of lead, total DDT, and total PCBs exceed the cleanup goals in samples collected from 1992 through 2014. The proposed action will consist of a Pilot Study Soil Investigation, Full-Scale Site Characterization Investigation, and Removal Action which includes site restoration, summarized below.
Site characterization sampling is required prior to development of the Removal Action Work Plan, in order to define the extent of contamination and the areas requiring soil removal. The results of soil sample analyses will inform the final site design and Removal Action Work Plan; the sampling methodology will refine the areas requiring removal and will minimize the extent and duration of removal work required at the site. Site characterization sampling consists of a Pilot Study and Full-Scale Investigation. The Pilot Study is to determine the number of incremental sampling methodology (ISM) soil sampling increments to achieve appropriate confidence levels that results will be reproducible and accurate within project objectives. The Pilot Study will occur over 10 days and is proposed to occur in January 2017. The drilling subcontractor will advance 270 direct push

borings to native bay mud, estimated to be 16 feet below ground surface (bgs). The results from the Pilot Study will determine the number of soil borings required for the Full-Scale Investigation. The Full-Scale Investigation will identify areas at AOI 14 FSFA where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in soil, fill, or sediment. The Full-Scale Investigation has an expected duration of 10 to 35 days and is proposed to occur in September 2017. The drilling subcontractor will advance from 484 to 968 direct push borings to native bay mud, estimated to be approximately 16 feet bgs, within twenty-two 100-foot by 100-foot investigation areas at the FSFA. The Removal Action will consist of excavation and off-site disposal of contaminated sediment, soil, and debris. Offsite disposal will occur at California Class I, II, or III landfills. Staging and laydown areas will be located in sites already graded for development, south of AOI 14. The Removal Action is expected to occur over approximately 9 months. Soil, fill, and sediment with COC concentrations less than the cleanup goals will be staged and stockpiled for use as fill for developing the final grade of the site. At the completion of the Removal Action, the site will be re-graded to elevations that support pickleweed, transitional, and upland habitats, and with gentle slope grades that minimize erosion; the site will be revegetated with native species and monitored by a qualified biologist for native revegetation, for up to 5 years. All activities will be conducted under the supervision of a qualified biologist. Project details including equipment to be used, methods, timing, and conservation measures will be detailed in the project Biological Assessment.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:

Project Coordinates: MULTIPOLYGON (((-122.06420803122457 37.42757335719065, -122.0640707029088 37.43205815512477, -122.06316089708707 37.43197636785867, -122.06242275395196 37.43091312604725, -122.06331539258825 37.429549973294044, -122.06324672777554 37.42747793346485, -122.06420803122457 37.42757335719065)))

Project Counties: Santa Clara, CA

Endangered Species Act Species List

There are a total of 12 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	**Status**	**Has Critical Habitat**	**Condition(s)**
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPSâU.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Threatened	Final designated	
Crustaceans			

Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened		
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

APPENDIX B
CNDDB AND IPaC SEARCH RESULTS

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Federal Listing Status IS (Endangered OR Threatened OR Proposed Endangered OR Proposed Threatened OR Candidate)
 AND Quad IS (Mountain View (3712241))

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Charadrius alexandrinus nivosus western snowy plover	G3T3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	0 0	124 S:1	0	1	0	0	0	0	0	1	1	0	0
Rallus longirostris obsoletus California clapper rail	G5T1 S1	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	0 5	98 S:10	2	3	0	0	0	5	5	5	10	0	0
Reithrodontomys raviventris salt-marsh harvest mouse	G1G2 S1S2	Endangered Endangered	CDFW_FP-Fully Protected IUCN_EN-Endangered	0 5	144 S:13	2	3	1	0	0	7	12	1	13	0	0
Spirinchus thaleichthys longfin smelt	G5 S1	Candidate Threatened	CDFW_SSC-Species of Special Concern	0 0	45 S:1	0	0	0	0	0	1	1	0	1	0	0
Sternula antillarum browni California least tern	G4T2T3Q S2	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List		68 S:2	0	0	0	0	0	2	2	0	2	0	0
Suaeda californica California seablite	G1 S1	Endangered None	Rare Plant Rank - 1B.1	5 5	18 S:1	0	0	0	0	1	0	1	0	0	1	0

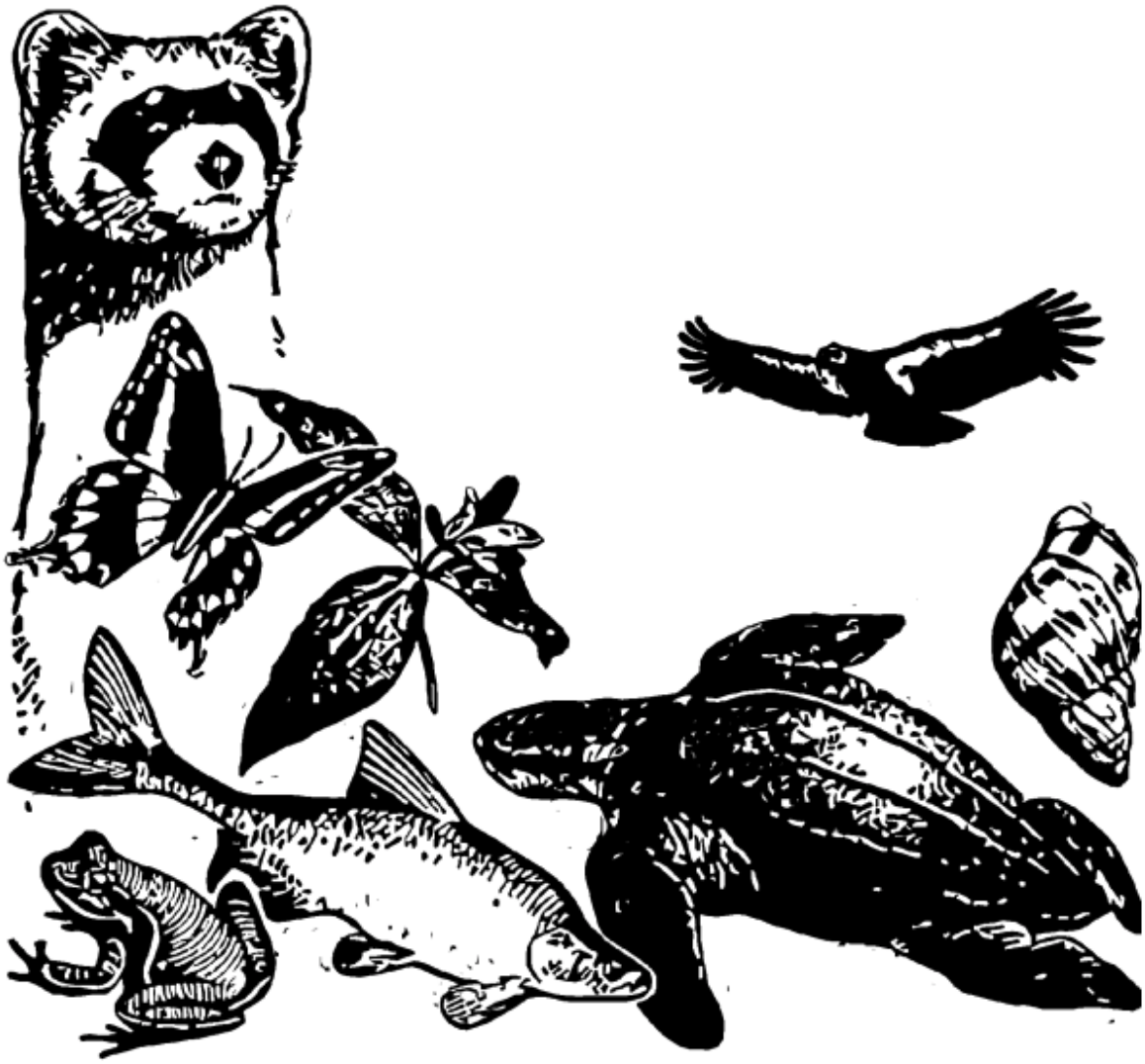
U.S. Fish & Wildlife Service

NASA Ames Research Center AOI 14

IPaC Trust Resources Report

Generated October 12, 2016 04:44 PM MDT, IPaC v3.0.9

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (https://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

Table of Contents

IPaC Trust Resources Report 1
Project Description 1
Endangered Species 2
Migratory Birds 5
Refuges & Hatcheries 9
Wetlands 10

U.S. Fish & Wildlife Service

IPaC Trust Resources Report

NAME

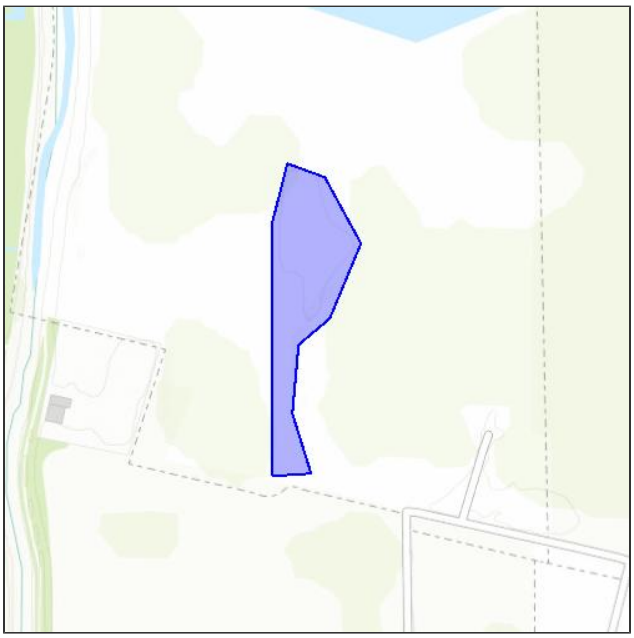
NASA Ames Research Center AOI 14

LOCATION

Santa Clara County, California

IPAC LINK

https://ecos.fws.gov/ipac/project/L7ASK-M3VUV-GMNAH-72IYE-O42UEE



U.S. Fish & Wildlife Service Contact Information

Trust resources in this location are managed by:

San Francisco Bay-delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list either from the Regulatory Documents section in IPaC or from the local field office directly.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Amphibians

California Red-legged Frog Rana draytonii — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D02D

California Tiger Salamander Ambystoma californiense — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D01T

Birds

California Clapper Rail Rallus longirostris obsoletus — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B04A

California Least Tern Sterna antillarum browni — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B03X

Western Snowy Plover Charadrius alexandrinus nivosus — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07C

Crustaceans

Vernal Pool Tadpole Shrimp Lepidurus packardi — Endangered

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K048

Fishes

Delta Smelt Hypomesus transpacificus — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=E070

Steelhead Oncorhynchus (=Salmo) mykiss — Threatened

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=E08D

Flowering Plants

California Seablite Suaeda californica — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q3AF

Insects

Bay Checkerspot Butterfly Euphydryas editha bayensis — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=I021

San Bruno Elfin Butterfly Callophrys mossii bayensis — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=I00Q

Mammals

Salt Marsh Harvest Mouse Reithrodontomys raviventris — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A03Y

Critical Habitats

There are no critical habitats in this location

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish & Wildlife Service.[1] There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

---

1. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The following species of migratory birds could potentially be affected by activities in this location:

Allen's Hummingbird Selasphorus sasin — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0LI

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Bell's Sparrow Amphispiza belli — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HE

Black Oystercatcher Haematopus bachmani — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0KJ

Black Rail Laterallus jamaicensis — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B09A

Black Skimmer Rynchops niger — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EO

Burrowing Owl Athene cunicularia — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0NC

Common Yellowthroat Geothlypis trichas sinuosa — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B080

Costa's Hummingbird Calypte costae — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JE

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Lawrence's Goldfinch Carduelis lawrencei — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0J8

Least Bittern Ixobrychus exilis
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B092

Lesser Yellowlegs Tringa flavipes — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MD

Lewis's Woodpecker Melanerpes lewis — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HQ

Long-billed Curlew Numenius americanus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06S

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JL

Nuttall's Woodpecker Picoides nuttallii — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HT

Oak Titmouse Baeolophus inornatus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MJ

Olive-sided Flycatcher Contopus cooperi — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0AN

Peregrine Falcon Falco peregrinus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FU

Rufous-crowned Sparrow Aimophila ruficeps — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MX

Short-billed Dowitcher Limnodromus griseus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JK

Short-eared Owl Asio flammeus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Snowy Plover Charadrius alexandrinus — Bird of conservation concern
Season: Breeding

Song Sparrow Melospiza melodia pusillula — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B08P

Tricolored Blackbird Agelaius tricolor — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06P

Western Grebe aechmophorus occidentalis — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EA

Whimbrel Numenius phaeopus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JN

Yellow Warbler dendroica petechia ssp. brewsteri — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EN

Yellow-billed Magpie Pica nuttalli — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0N8

Red Knot Calidris canutus ssp. roselaari

Bird of conservation concern

Season: Wintering

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0G6

Wildlife refuges and fish hatcheries

There are no refuges or fish hatcheries in this location

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

This location overlaps all or part of the following wetlands:

Freshwater Emergent Wetland

PEM1Ch

Lake

L2UBH3h

A full description for each wetland code can be found at the National Wetlands Inventory website: http://107.20.228.18/decoders/wetlands.aspx

APPENDIX H
PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN

APPENDIX H

REVISED PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN

AREA OF INVESTIGATION 14

FEBRUARY 2018

Prepared for:

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

Prepared by:

Tetra Tech
1999 Harrison Street, Suite 500
Oakland, California 94612
Telephone: (510) 302-6300

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS ..... H-iii

1.0 INTRODUCTION H-1

1.1 BACKGROUND AND SITE DESCRIPTION H-1

1.2 PROJECT DESCRIPTION H-5

1.3 BIOLOGICAL RESOURCES H-10

1.3.1 Regional Setting H-10

1.3.2 Existing Conditions in the Action Area and Other Natural Areas H-11

1.3.3 Special Status Species Potentially Occurring in the Action Area or Other Natural Areas H-16

1.3.4 Species Not Likely to Occur H-36

2.0 PROPOSED CONSERVATION MEASURES H-38

2.1 USFWS MEASURES H-39

2.2 STATE-LISTED AND SPECIAL STATUS SPECIES AND MBTA-SPECIFIC MEASURES H-39

3.0 PROPOSED RESTORATION MEASURES H-42

3.1 SITE PREPARATION H-44

3.2 SEEDING AND PLANTING H-46

3.2.1 Upland Habitat H-48

3.2.2 Transitional Habitat H-48

3.2.3 Wetland Habitat H-51

4.0 MAINTENANCE AND MONITORING H-52

4.1 MAINTENANCE H-52

4.1.1 Invasive Weed Removal H-52

4.1.2 Irrigation H-53

4.1.3 Replacement Planting H-54

4.2 MONITORING AND PERFORMANCE CRITERIA H-54

4.2.1 Monitoring and Adaptive Management H-54

4.2.2 Performance Standards for Determining Success H-57

5.0 REFERENCES H-60

FIGURES

1 AOI 14 Site Location H-3

2 AOI 14 Site Features H-4

3 Staging and Laydown Areas and Haul Routes H-6

4 Pickleweed Potentially Disturbed by Removal Action H-7

5 Vegetation Communities H-12

6 Wetlands and Waters of the U.S. and Burrowing Owl Preserves H-13

7 Areas of Potentially Occurring Federally Listed Species—Western Snowy Plover and California Least Tern H-18

8 Areas of Potentially Occurring Federally Listed Species—California Clapper Rail and Salt Marsh Harvest Mouse H-19

9 Grading and Site Restoration Conceptual Plan H-43

TABLES

1 Federal and State Listed and Species of Special Concern Potentially Occurring at NASA Ames H-20

2 Upland Habitat Plant Palette H-49

3 Transitional Habitat Plant Palette H-50

4 Wetland Habitat Plant Palette H-51

5 Restoration Monitoring and Maintenance Schedule H-57

6 Restoration Monitoring Performance Criteria H-58

ATTACHMENTS

H1 USFWS SPECIES LIST

H2 CNDDB AND IPAC SEARCH RESULTS

H3 AOI 14 USFWS BIOLOGICAL OPINION

ACRONYMS AND ABBREVIATIONS

AOI	Area of Investigation
ARAR	Applicable or relevant and appropriate requirement
BA	Biological Assessment
bgs	Below ground surface
BIO	Biological conservation measure
BMP	Best Management Practice
BO	Biological Opinion
BO-#	USFWS Biological Opinion conservation measure number
Cal-IPC	California Invasive Plant Council
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
dBA	A-Weighted Decibel
DCE	Design, Community and Environment
DDT	Dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
ERT	Earth Resources Technology, Inc.
ESA	Endangered Species Act
FFA	Federal Facility Agreement
FSFA	Former soil fill area
GPS	Global Positioning System
IAG	Investigation Area Grid
ICAM	Interim Corrective Action Measure
IPaC	Information for Planning and Consultation
IR	Installation Restoration
ISM	Incremental sampling methodology
MBTA	Migratory Bird Treaty Act
MROSD	Midpeninsula Regional Open Space District
MSL	Mean sea level

ACRONYMS AND ABBREVIATIONS (continued)

NASA	National Aeronautics and Space Administration
NASA Ames	NASA Ames Research Center
OARF	Outdoor Aerodynamic Research Facility
PCB	Polychlorinated biphenyl
ppt	Parts per thousand
PSMHRP	Protected Species Mitigation and Habitat Restoration Plan
RAWP	Removal Action Work Plan
RCRA	Resource Conservation and Recovery Act
Regional Water Board	California Regional Water Quality Control Board, San Francisco Bay Region
Removal Action	Non-Time-Critical Removal Action
SFBBO	San Francisco Bay Bird Observatory
SSFBWMP	South San Francisco Bay Weed Management Plan
SWPPP	Stormwater Pollution Prevention Plan
SWRP	Stormwater retention pond
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WATS	West-Side Aquifers Treatment System
WRCC	Western Regional Climate Center

1.0 INTRODUCTION

This Protected Species Mitigation and Habitat Restoration Plan (PSMHRP) was prepared in accordance with location-specific applicable or relevant and appropriate requirements (ARARs) identified in the Action Memorandum for Area of Investigation (AOI) 14 Former Soil Fill Area (FSFA) Non-Time-Critical Removal Action signed by National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames) in March 2017 (Tetra Tech 2016a). The AOI 14 Removal Action will be implemented in fulfillment of the NASA Moffett Federal Facility Agreement (FFA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which requires NASA to conduct immediate and long-term response actions for AOI 14. The primary purpose of the Removal Action is to prevent erosion and subsequent transport of contaminated material from AOI 14 into adjacent wetlands.

The Removal Action and all activities described in the PSMHRP are also referred to hereafter as the "project." This PSMHRP addresses federal and state-listed and fully protected species that have potential to occur in the project Action Area (as defined in Section 1.3) and natural areas along the haul routes or contractor trailer area (such as burrowing owl preserves, wetlands, and other natural areas that may serve as habitat), and prescribes mitigation and conservation measures to avoid and minimize impacts to biological resources. The Action Area, as defined by 50 CFR Section 402.02, includes "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action," and is applied herein to assess potential for occurrence of or impacts to state-listed and special status species. Federally listed species are discussed in greater detail in the project Biological Assessment (BA) (Tetra Tech 2017; Appendix G of the Removal Action Work Plan [RAWP]), which complies with the requirements of Section 7 of the Endangered Species Act (ESA) (16 United States Code [U.S.C.] 1536 [c]) and ESA guidance, and follows consultation regulations (50 Code of Federal Regulations [CFR] Part 402.12[f]). Wetlands that occur in the project Action Area (or Action Area hereafter) and along the haul routes are addressed in the PSMHRP, and also included is a conceptual site restoration and monitoring plan. Plant palettes for upland, transitional, and wetland habitat are identified, along with restoration monitoring methods. As detailed in the RAWP, the areas and volume of contaminated soil and sediment requiring excavation will be determined after further sampling is conducted. After the final excavation volume and final grades are determined, the conceptual site restoration drawing included in this PSMHRP as Figure 9 will be revised to show the final areas of restoration. The goal of the restoration is to provide pickleweed habitat for the salt marsh harvest mouse (*Reithrodontomys raviventris* subsp. *raviventris*, federally listed endangered and state-listed endangered and fully protected), at a 3:1 ratio for impacts to pickleweed incurred during Removal Action activities. The restoration will also include upland and transitional habitat. This document includes measures that will require oversight by U.S. Fish and Wildlife Service (USFWS)- and California Department of Fish and Wildlife (CDFW)-approved biologists and a restoration biologist.

1.1 BACKGROUND AND SITE DESCRIPTION

NASA Ames is located in Santa Clara County, California, approximately 35 miles southeast of San Francisco and 10 miles northwest of San Jose (Figure 1). AOI 14 is located in the northern

portion of NASA Ames and consists of three peninsulas (the FSFA, N217, and N217A) that extend into a stormwater retention pond (SWRP) that is part of Navy Installation Restoration (IR) Site 25 (Figure 2). The FSFA and N217A peninsulas were constructed by deposition of fill material on the existing surface of the SWRP. Visual observations of the ground surface of the peninsulas show that the fill material consists of soil and construction debris including concrete, rebar, and metal piping. Most of the soil in the debris fill areas is likely from construction projects at NASA Ames. Some of the soil may have originated from construction of the National Full-Scale Aerodynamic Complex wind tunnel test section (Building N221B), located approximately 1 mile south of AOI 14 in the center of the NASA Ames campus. An electrical substation was removed to construct the test section. Soil from this substation site may have contained polychlorinated biphenyls (PCBs) from leaks in the electrical equipment, and this soil may have been deposited at the FSFA. In addition, soil materials from other sources may have been added to the FSFA over time.

The Navy completed a remedial action at the IR Site 25 SWRP in December 2012, consisting of sediment excavation and associated habitat restoration; post-excavation annual salt marsh monitoring began in 2013 and will continue for up to 5 years (ITSI Gilbane 2012). In 2013, the U.S. Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) Order (RCRA-7003-09-2013-0002) requiring NASA to conduct immediate and long-term response actions for AOI 14. The stated purpose of the RCRA Order was to stabilize and address soil contaminated with PCBs, pesticides, and metals that threatened to discharge pollutants into surrounding Navy IR Site 25, which includes the SWRP that serves as actual and potential habitat for several ecological receptors, including special status species. In December 2013, NASA implemented an Interim Corrective Action Measure (ICAM) by installing a silt fence barrier around the perimeter of the FSFA peninsula to prevent potential soil erosion from the peninsula into the SWRP. The silt fence barrier was not placed around the N217 and N217A areas because of the depths and limited extents of contamination in these areas. NASA continues monthly inspections of the ICAM and annual sediment sampling surrounding the ICAM and submits quarterly inspection reports to EPA and the California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board). NASA, EPA, and the State of California (through the Regional Water Board) signed the NASA Moffett FFA on March 11, 2015. EPA terminated the RCRA Order on the effective date of the NASA Moffett FFA. Remedial activities for AOI 14 are now being implemented by NASA, as the lead agency under the NASA Moffett FFA, in accordance with CERCLA. EPA and the Regional Water Board are the lead regulatory agencies.

The primary purpose of the Removal Action is to prevent potential erosion and subsequent transport of contaminated material from AOI 14 into adjacent wetlands. NASA intends the Removal Action to be the final action at AOI 14. Risks to all potential human or ecological receptors were evaluated and will be addressed in the Removal Action. The Removal Action consists of site sampling to further refine the proposed limits of excavation using incremental sampling methodology (ISM), excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. The approximate length of time required to remove the contaminated soil and sediment will depend on results of site sampling, but the Removal Action (sampling, analysis, excavation, and habitat restoration) is estimated to take up to 14 months.

AOI 14

NASA Ames

Notes:

AOI	Area of Investigation
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

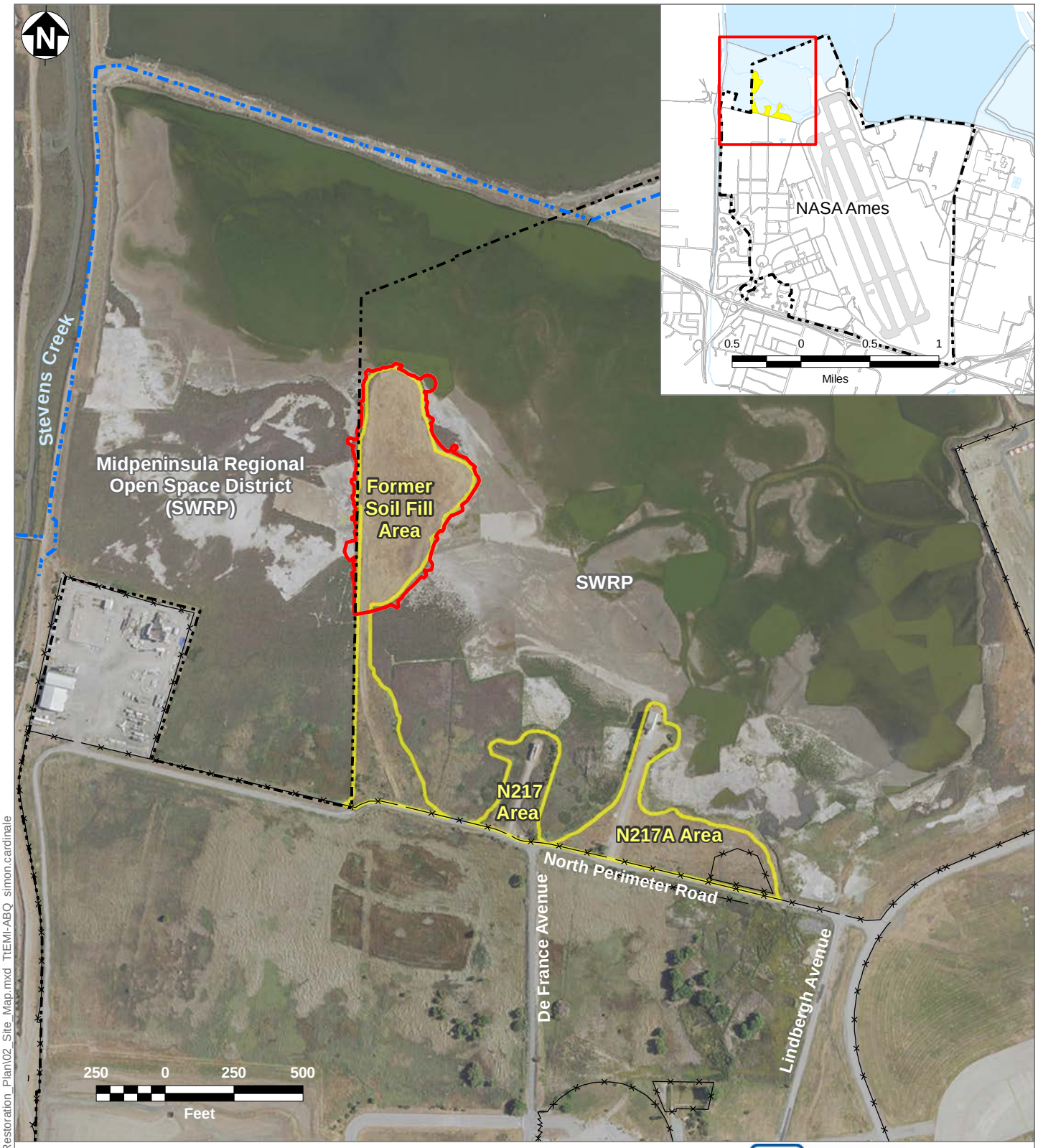
NASA Ames Research Center
Moffett Field, California

Figure 1

AOI 14 Site Location

Protected Species Mitigation and Habitat Restoration Plan

2017-03-16 V:\NASA\Projects\011_Mitigation_Restoration_Plan\01_Site_Location.mxd TtEMI-AL simon.cardinale



AOI 14

AOI 14 Former Soil Fill Area Removal Action Boundary (Based on Toe and Bottom of Slope and Geophysical Survey Results)

NASA Ames

Bay Trail

Fence

Notes:

AOI	Area of Investigation
IR	Installation Restoration
NASA Ames	National Aeronautics and Space Administration Ames Research Center
SWRP	Stormwater retention pond

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 2

AOI 14 Site Features

Protected Species Mitigation and Habitat Restoration Plan

3/10/2017 V:\NASA\Projects\011_Mitigation_Restoration_Plan\02_Site_Map.mxd TtEMI-ABQ simon.cardinale

Ecological monitoring and maintenance will be conducted for 5 years following completion of the excavation, or until success criteria are met, to ensure the effectiveness of the habitat restoration. After excavation, the site will be suitable for unrestricted use. Activities to occur during implementation of the Removal Action are detailed in the RAWP.

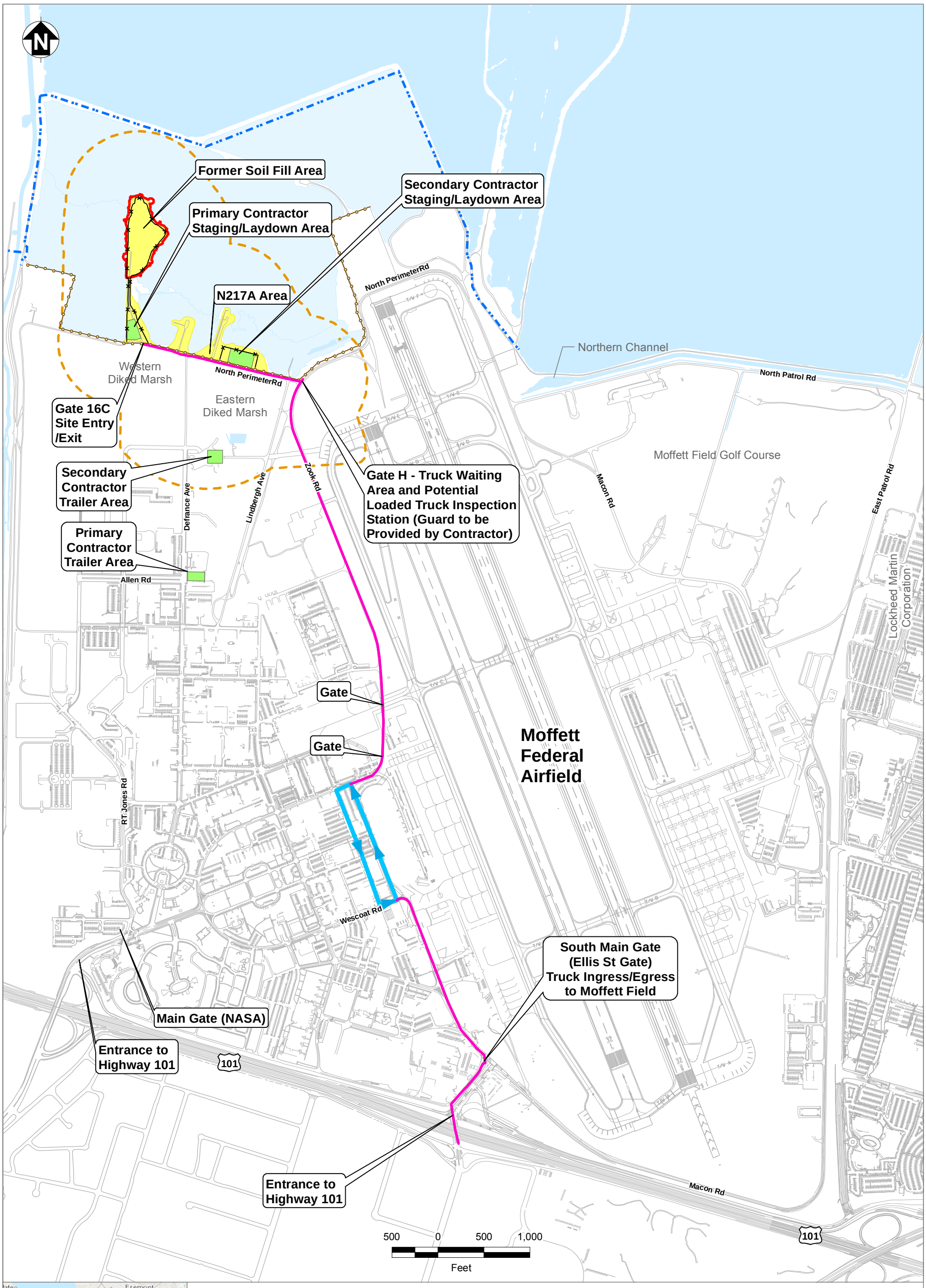
The FSFA is approximately 8 acres, and ground surface elevations vary from approximately 4 feet above mean sea level (MSL) at the southern end of the peninsula to 11 feet above MSL at the northern end. The surface of the SWRP in the area surrounding the FSFA varies from approximately MSL to -0.5 foot below MSL. The FSFA is not currently used, and access to the peninsula is restricted by the NASA Ames security fence to the south and the SWRP on all other sides. There is a public trail (Bay Trail) on the northern and eastern sides of the Navy IR Site 25 SWRP and on the northern and western sides of the Midpeninsula Regional Open Space District (MROSD) property (Figure 2).

1.2 PROJECT DESCRIPTION

The Removal Action (the project) consists of the following activities at the FSFA: soil and sediment sampling, excavation and offsite disposal of soil and sediment with concentrations of contaminants exceeding cleanup goals, segregation and off-site disposal of construction and demolition debris, and restoration of the excavated area to appropriate habitat. Monitoring and maintenance of restored habitat will be performed to ensure the effectiveness of the restoration. The Removal Action addresses the northern portion of the FSFA where concentrations of lead, total dichlorodiphenyltrichloroethane (DDT), and total PCBs exceed cleanup goals. This area is estimated to be 6 acres (270,000 square feet) with an estimated fill volume of 65,000 cubic yards. Based on a geophysical survey conducted at the FSFA, artificial fill may extend to depths as great as 18 feet below ground surface (bgs) in the northern portion of the site and may be as shallow as 4 feet bgs in the southern portion of the site (Figure 2) (Tetra Tech 2016b). "Project footprint" as used herein refers to the approximately 8-acre Removal Action area plus approximately 4 feet beyond the Removal Action area exclusion fence to include vegetation/pickleweed removal areas (Figure 4), the approximately 0.5-acre primary project staging and laydown area, and the approximately 1.0-acre secondary project staging and laydown area (Figure 3).

During soil and sediment sampling, a field team and three direct-push technology drilling teams will be on site. Sampling will occur in two phases, a Pilot Study followed by a Full-Scale Investigation. Sampling is anticipated to begin in winter 2018.

After samples are analyzed, soil or sediment with concentrations of contaminants exceeding cleanup goals will be permanently removed and disposed of at an appropriate off-site facility. The removal will include mobilization, excavation, final grading, and restoration (addressed herein). The duration of excavation will depend on the amount of contaminated soil and sediment requiring removal but could take up to 10 months. Excavation is targeted to begin in spring or summer 2018. Haul routes and staging, laydown, and contractor trailer areas are shown on Figure 3. Conservation measures to be implemented throughout the Removal Action are detailed in Section 2.0.



12/19/2017 V:\NASA\Projects\011_Mitigation_Restoration_Plan\03_Haul_Route.mxd TtEMI-ABQ simon.cardinale

ICAM Silt Fence (Existing)
Anti-Perch Locations
Exclusion Fence*
Topographic Contour (0.5-foot interval)

Investigation Area Grid
Apparent artificial fill boundary inferred from geophysical survey
Removal Action Boundary

Pickleweed† undisturbed by Removal Action
Pickleweed† disturbed by both the Pilot Study and Full-Scale Investigation (0.02 acres)
Pickleweed† potentially disturbed by Removal (0.6 acres)

Notes:

*	The final layout of exclusion fence for the Removal is to be determined. Layout depicted here is applicable to the Pilot and Full-Scale Investigation.
†	Pickleweed depicted is based on mapped extent in July 2016, 100 feet out from FSFA boundary (NASA 2016).
AOI	Area of Investigation
FSFA	Former Soil Fill Area
ICAM	Interim corrective action measure
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 4

Pickleweed Potentially Disturbed by Removal Action

Protected Species Mitigation and Habitat Restoration Plan

4/17/2017 V:\NASA\Projects\011_Mitigation_Restoration_Plan\04_pickleweed_disturbed.mxd TtEMI-ABQ simon.cardinale

Pickleweed that is disturbed during the Removal Action will be mitigated at a 3:1 ratio as required for impacts to salt marsh harvest mouse and stated in the project BA (Tetra Tech 2017; Appendix G of the RAWP) and USFWS Biological Opinion (BO) (Attachment H-3; USFWS 2017). Areas of anticipated pickleweed disturbance are shown on Figure 4. Based on the current understanding of the extent of the Removal Action, up to 0.62 acre of pickleweed is expected to be disturbed; based on a 3:1 mitigation ratio, a minimum of 1.86 acres of pickleweed habitat will be restored. Restoration activities will begin soon after final grading, as detailed in Section 3.0. Details of the sampling and removal can be found in the main text of the RAWP.

Activities related to biological monitoring and minimization of impacts to protected species are detailed in Section 2.0 and in the BO (Attachment H-3; USFWS 2017).

The Pilot Study will include pre-activity biological surveys, vegetation removal, installation of an exclusion fence, and installation of anti-perch devices, as detailed in the BO (Attachment H-3). Biological surveys and vegetation removal will be conducted according to the requirements of the BO conservation measures and the additional state requirements in Section 2.2. The perch deterrents will remain in place after the Removal Action.

In addition to the species surveys detailed in the BO and Section 2.2, prior to conducting the Pilot Study, pickleweed cover and condition will be surveyed along the slopes of the FSFA and using a handheld Global Positioning System (GPS) instrument. Pickleweed condition (height and a visual estimate of cover [as a percentage]) will be recorded and photographically documented. Plant species observed within the Removal Action boundary will be recorded, and conditions atop the peninsula will be photo-documented. To document pre-impact conditions, at least three transects will be surveyed within the pickleweed habitat along the slopes of the peninsula. The upland vegetation has been mowed; no transects are required in the upland. A biologist skilled in California native and invasive plant identification will conduct a walking reconnaissance of the upland and transitional areas and document plant species as feasible.

Prior to project activities, and to be continued on an ongoing basis as determined necessary by the USFWS- or CDFW-approved biologist, exclusion material will be placed at entrances of burrows atop the FSFA peninsula to prevent burrowing owls from establishing nests. Prior to installing exclusion material, the USFWS- or CDFW-approved biologist will inspect the burrows for presence of wildlife, including eggs and young, to ensure they do not become trapped in the burrows.

No more than 5 days prior to sampling, a surveyor will conduct a detailed topographic survey of the area within the Removal Action boundary; the surveyor will also survey and stake the corners of the sampling IAGs for the entire FSFA. Drilling locations for the Pilot Study IAGs will be marked in the field with wooden stakes, and the locations will be indicated on a map. To discourage use by raptors for perching, wooden stakes will follow the requirements of the BO and will be removed immediately after completion of the project.

The installation of a temporary exclusion fence and removal of vegetation from FSFA slopes will follow the requirements of the BO. The layout of the exclusion fence will be marked in the field

with stakes no higher than 3 feet to guide vegetation removal. Fencing layout stakes will be removed after vegetation is removed. Pickleweed removal areas will be surveyed using a handheld GPS instrument to record the areas of impact. The layout of the exclusion fence and estimated areas of pickleweed removal for the Pilot Study are depicted on Figures 3 and 4. The areas of pickleweed shown on Figure 4 are based on a July 2016 survey of pickleweed within 100 feet of the FSFA (NASA 2016).

The Full-Scale Investigation will include biological surveys and additional vegetation removal along footpaths. Biological surveys and vegetation removal will be conducted according to the requirements of the BO and the additional state requirements in Section 2.2. Hand-auger borings on FSFA peninsula slopes and in the SWRP in areas of pickleweed will be conducted in the presence of a USFWS-approved biologist. The exclusion fence layout and vegetation clearing (4-foot buffer from the fence line) conducted for the Pilot Study may exclude some single-sample hand-auger areas along the slopes. Sampling along the slopes will occur in the presence of a USFWS-approved biologist. To minimize disturbance, no pickleweed will be removed from these areas. For safe access to hand-sampling areas within the SWRP bottom, the exclusion fence will be modified to create an opening and connection to the silt fence, and if necessary to prevent slips, trips, and falls, pickleweed may be cleared from a small swath (less than 10 feet wide) to create a footpath to the sample area. Access areas and pickleweed removal are shown on Figure 4. Pickleweed removal areas will be surveyed using a handheld GPS instrument.

The removal (including mobilization, excavation, final grading, and restoration) will follow the requirements of the BO and the additional conservation measures detailed in Section 2.2. Prior to excavation, biological surveys, vegetation removal, and exclusion fence realignment will be conducted according to the requirements of the BO and the additional conservation measures detailed in Section 2.2.

The exclusion fence constructed before the Pilot Study may be relocated based on the anticipated excavation area, after ISM sampling results are evaluated. The ICAM silt fence will remain in place unless it hinders removal activities; if it does hinder activity, the existing silt fence will be relocated farther outside the work area. In this case, the ICAM silt fence will be modified with Visqueen sheeting to act as the exclusion fence, depending on the location of removal activities in relation to the existing silt fence.

Prior to excavation, pickleweed will be hand-removed from areas requiring excavation and within 4 feet of the exclusion fence, under the supervision of the USFWS-approved biologist, and will follow the requirements of the BO (USFWS 2017). Pickleweed removal areas will be surveyed with a handheld GPS instrument. Pickleweed will not be removed from areas of the FSFA that do not require disturbance. The areas of pickleweed potentially disturbed by sampling and excavation activities are shown on Figure 4.

Other areas of the project footprint will be cleared and grubbed as necessary, including laydown or staging areas and upland areas of the FSFA. All clearing and grubbing activities will be conducted under the supervision of a USFWS-approved biologist. Clearing and grubbing may include removal of large bushes and surface debris such as concrete blocks, rebar, and asphalt.

Areas that will not be excavated for off-site disposal or to create the final site grade will not be disturbed, except to remove debris that may pose a health and safety risk (such as exposed rebar).

A USFWS-approved biologist will monitor mobilization, excavation, and loading activities and will provide guidelines to minimize impacts on the surrounding habitat. Conservation measures are detailed in the BO (Attachment H-3), and additional state species measures are detailed in Section 2.0.

Restoration site monitoring and maintenance will be conducted for 5 years (or until success criteria are met) after final grading and site revegetation.

1.3 BIOLOGICAL RESOURCES

The following sections describe the regional setting and biological resources of the Action Area for the project, which, as defined by 50 CFR Section 402.02, includes "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action," and is applied herein to assess potential for occurrence of or impacts to state-listed and special status species. The Action Area encompasses the approximately 9.5-acre project footprint (the approximately 8-acre Removal Action area plus approximately 4 feet beyond the Removal Action area exclusion fence to include vegetation/pickleweed removal areas, the approximately 0.5-acre primary project staging and laydown area, and the approximately 1.0-acre secondary project staging and laydown area), and an additional area extending 700 feet beyond the project footprint. The 700-foot buffer is based on anticipated project-related noise and represents a breeding season disturbance avoidance buffer for listed species. The Action Area is shown on Figure 3. Biological resources also considered in this PSMHRP and during development of conservation measures listed in Section 2.2 for special status species are natural areas within 500 feet of the haul routes and primary and secondary contractor trailer areas that may serve as potential habitat for special status species, such as wetlands and burrowing owl preserves shown on Figure 6. These natural areas are collectively referred to hereafter as "other natural areas." The contractor trailer area that will house health and safety and project management activities will be located either within the developed portion of NASA Ames (primary contractor trailer area [Figure 3]) or on an existing concrete pad within the Outdoor Aerodynamic Research Facility (OARF), south of the Eastern Diked Marsh (secondary contractor trailer area [Figure 3]). The installation and use of the contractor trailer in these areas is not anticipated to have adverse effects on listed or special status species.

1.3.1 REGIONAL SETTING

AOI 14 is located at the southern end of San Francisco Bay in an area that was historically coastal salt marsh and part of the larger San Francisco Bay Estuary. San Francisco Bay is the largest estuary on the west coast of the U.S. and supports a high diversity of wildlife despite the loss of an estimated 90 percent of historical tidal wetlands to diking, draining, and filling.

AOI 14 is composed of three upland peninsulas located within the Central Basin of the SWRP, also referred to as Crittenden Marsh (East and West). The SWRP is approximately 203 acres and is hydrologically disconnected from tidal influence; levees border the site to the north, west, and east. The area west of AOI 14 FSFA is owned and managed by MROSD. Pedestrians regularly recreate on the Bay Trail, which runs along the tops of the levees at the northern, western, and eastern perimeters of the SWRP and the levee north of North Channel, north of North Patrol Road. Stevens Creek, a tidal creek that is hydrologically connected to the bay, runs north-south and is west of the SWRP and west of the Western Diked Marsh, outside NASA Ames property (Figure 2).

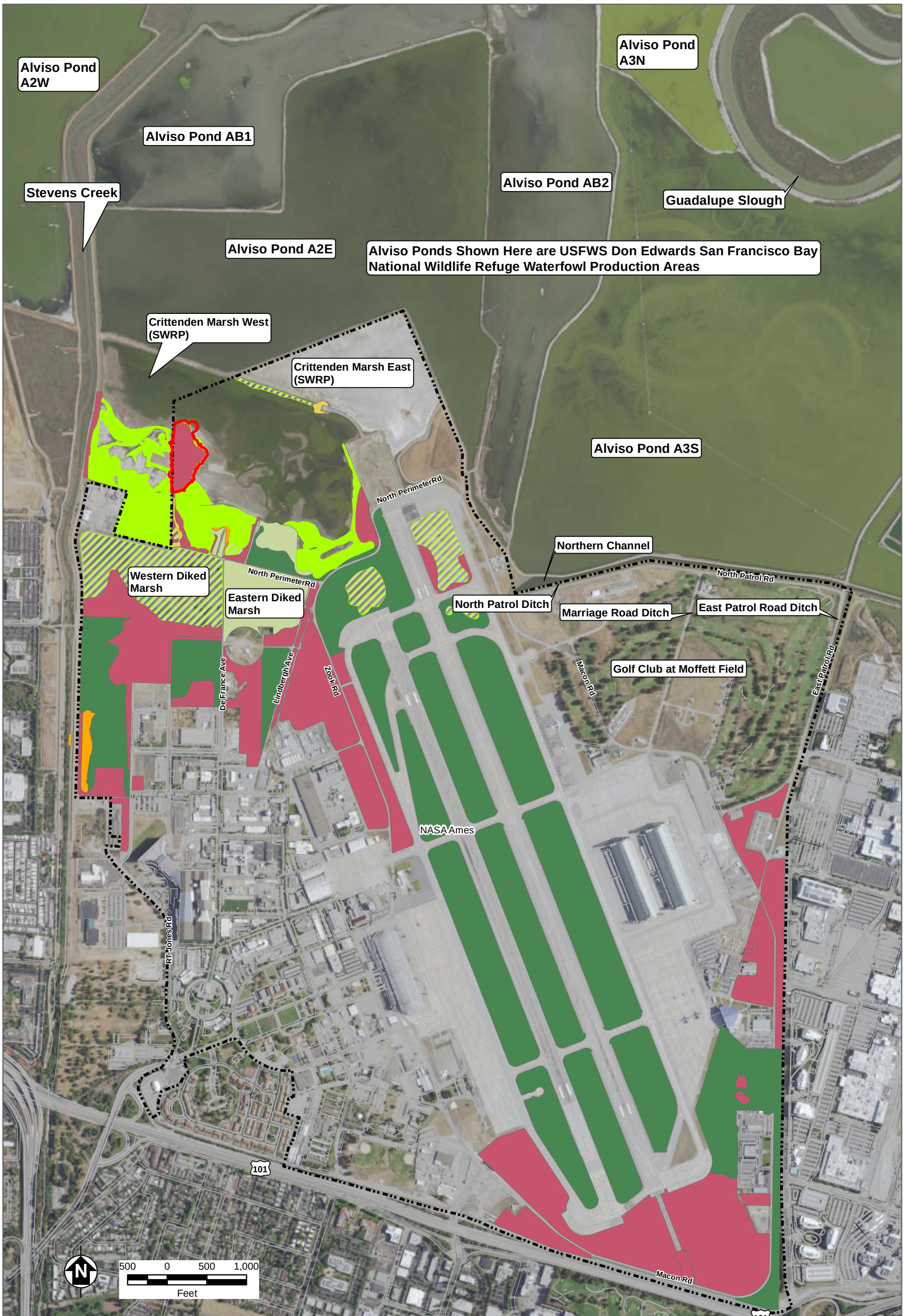
To the north of the SWRP and north of North Patrol Road are the Alviso ponds, diked ponds (formerly the Cargill Evaporation Ponds) owned by USFWS as part of the Don Edwards San Francisco Bay Wildlife Refuge complex (Figure 5). USFWS manages these ponds as waterfowl production areas that are open to tidal influence and regularly flooded. Waterfowl hunting is allowed in these areas. NASA's Moffett Field runway is southeast of the AOI 14 FSFA (Figure 3).

The San Francisco Bay area has a Mediterranean climate characterized by mild wet winters and dry warm summers. Precipitation occurs largely in the fall and winter months (usually October through April), with the greatest average rainfall occurring in January. Average annual precipitation for the region is 15.21 inches, based on data collected from September 1, 1953, to June 4, 2016, from Palo Alto. Precipitation over the last 5 years has generally been below average, with the exception of 2012, which had 16.33 inches of rain (Western Regional Climate Center [WRCC] 2016). The winter of 2016-2017 has had 15.51 inches of rain as of March 14, 2017 (Weather Underground 2017). Annual rainfall can be variable, depending on the climate cycles of El Niño and La Niña.

1.3.2 EXISTING CONDITIONS IN THE ACTION AREA AND OTHER NATURAL AREAS

Existing conditions in the Action Area and other natural areas are described below. Vegetation communities are described according to the nomenclature presented in *Terrestrial Vegetation Communities of California* (Barbour et al. 2007) and used in previous vegetation surveys conducted at NASA Ames (SAIC 1999). The vegetation communities of NASA Ames are shown on Figure 5. Industrial and commercial developed areas within the Action Area and in the vicinity of other natural areas are also shown on Figure 3. Wetlands and burrowing owl preserves are shown on Figure 6.

The top of the AOI 14 FSFA peninsula ranges in elevation from 4 feet above MSL at the south to 11 feet above MSL at the north (Figure 5). Vegetation previously recorded on site and observed by Tetra Tech staff during site walks conducted in October and November 2016 shows a dominance of non-native species including wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), fennel (*Foeniculum vulgare*), bristly ox-tongue (*Picris echioides*), teasel (*Dispacus* spp.), Italian thistle (*Carduus pycnocephalus*), and pepperweed (*Lepidium latifolium*) (Alderete 2013a). The slopes and the toe of the slope along the perimeter of the peninsula have a dominance of pickleweed and sparse occurrence of alkali heath (*Frankenia salina*), saltgrass (*Distichlis spicata*), and seaside heliotrope (*Heliotropium curassavicum*), species typical of coastal salt marsh habitat.



Removal Action Boundary

NASA Ames

Vegetation Communities

Coastal salt marsh

Coyote brush scrub

Weed dominated area

Seasonal salt marsh and transition

Fresh and brackish water marsh

Isolated seasonal marsh

Non-native grassland

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
IR = Installation Restoration
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
USFWS = U.S. Fish and Wildlife Service

Source: Adapted from NASA GIS databases using vegetation communities, Leidos mapped pickelweed (2016), and IR Site 25 vegetation mapping (2012) layers.

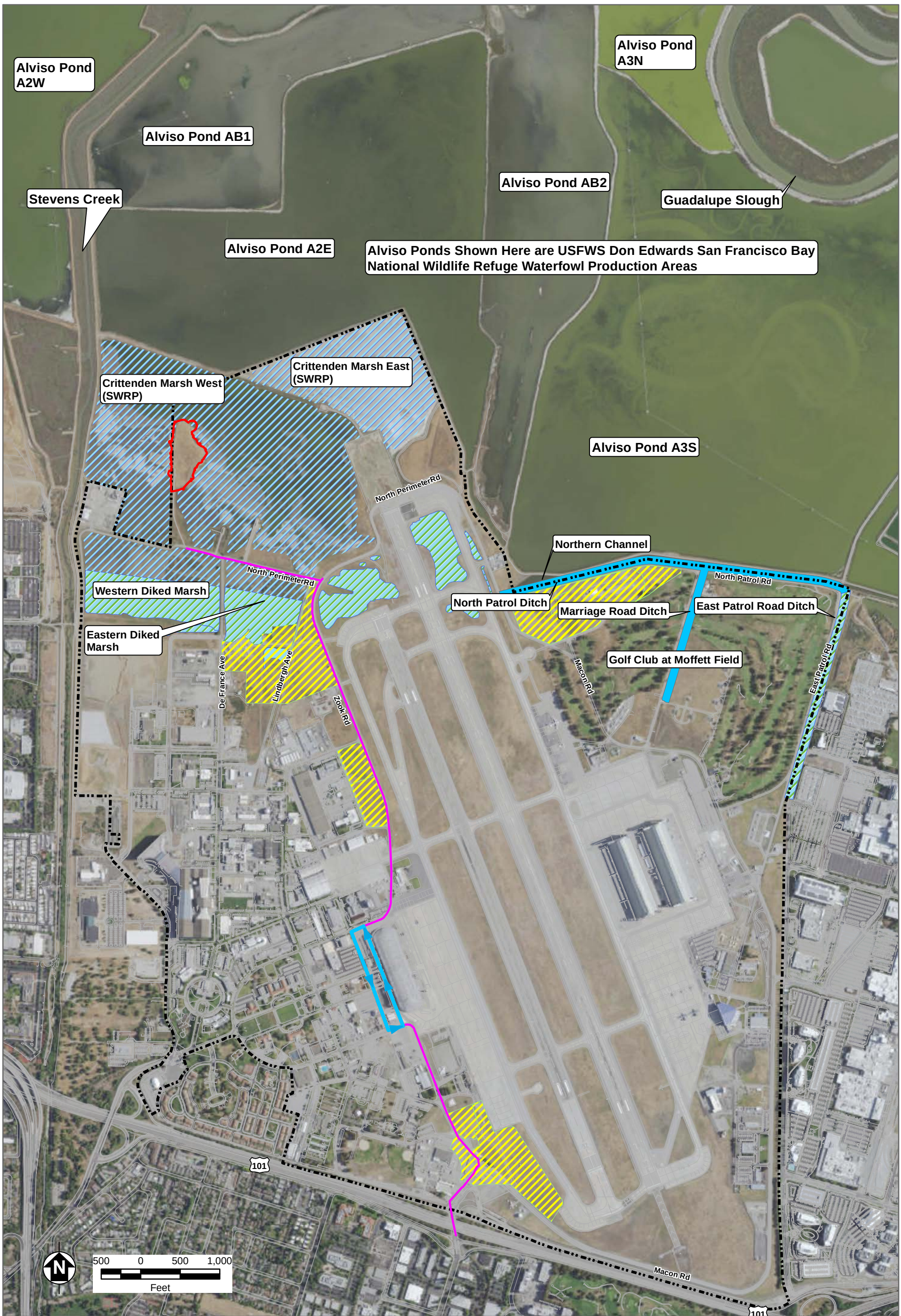
TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 5
Vegetation Communities

Protected Species Mitigation and Habitat Restoration Plan

4/7/2017 H:\Tetra tech\NASA\NASA_GIS\SHRMP Figs\5_SHRMP_VegCommunities_11X17REV.mxd TtEMI-BLDR angela.lortie



NASA Ames
Removal Action Boundary
Burrowing Owl Preserve
Waters of the U.S. (2009)
Wetlands (2009)
Wetlands and Waters of the U.S. (1989)
One-Way Traffic
Two-Way Traffic

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
USFWS = U.S. Fish and Wildlife Service

(Year) denotes verification of delineation by U.S. Army Corps of Engineers (USACE)

Sources: NASA Ames GIS database, NASA Ames Development Plan Environmental Impact Statement (Design, Community and Environment 2002), and NASA Ames Environmental Resources Document (Earth Resources Technology, Inc. 2015).

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 6
Wetlands and Waters of the U.S. and Burrowing Owl Preserves
Protected Species Mitigation and Habitat Restoration Plan

4/7/2017 H:\Tetra tech\NASA\NASA_GIS\SHRMP Figs\6_SHRMP_Wetlands11X17REV.mxd TtEMI-BLDR angela.lortie

The SWRP is surrounded by levees that isolate it from tidal influence and the saltwater evaporation ponds to the northeast. The SWRP is approximately 203 acres and supports open water, mudflats, salt panne, and vegetated salt marsh at its fringes that is largely dominated by pickleweed. Other salt marsh species observed within the vegetated portions of the SWRP include alkali heath and saltgrass. The Navy completed sediment removal at IR Site 25 in 2012 to address unacceptable ecologic risk from PCBs, pesticides, and metals. Excavated areas of the SWRP were hydroseeded in winter 2012 and again in 2013. Areas not hydroseeded were planted with pickleweed seedlings (Gilbane Federal 2016). Three years of restoration monitoring of the seeded and planted areas were concluded in 2016.

The AOI 14 secondary staging area (N217A peninsula) has infrastructure, a dirt road leading from North Perimeter Road, and upland vegetation consisting of non-native grassland, with similar non-native species as the FSFA.

The SWRP receives stormwater runoff from the western half of the NASA Ames property, a drainage area estimated to be 1,000 acres, and also receives regular freshwater discharge from the West-Side Aquifers Treatment System (WATS) treatment plant. Storm runoff flows to a stormwater retention basin located at the southern perimeter of the Eastern Diked Marsh to settle out sediment and potential contaminants. The stormwater retention basin discharges into the Eastern Diked Marsh and is ultimately conveyed through a series of culverts under North Perimeter Road into the SWRP. Historically, stormwater flow dries up in the summer months. WATS discharges approximately 50 gallons per minute of treated groundwater into the storm drain system. The constant flow of fresh water into the SWRP results in a regularly ponded area of approximately 8 acres near the inlet at the southeastern corner of the SWRP, which supports a large patch of freshwater marsh with a monotypic stand of cattails (*Typha* spp.). Conditions within the remainder of the SWRP vary seasonally from fresh to hyper-saline as a result of winter precipitation and runoff and summer evapotranspiration. As a result of changing conditions, the areal extent of pickleweed varies year to year and lacks the vegetative and structural diversity of a natural salt marsh. The haul routes occur along paved roads, as shown on Figure 3. Vegetation communities in the areas of the haul routes include those associated with the Eastern Diked Marsh, Western Diked Marsh, and a portion of the airfield, as described below (Figure 5).

The Eastern Diked Marsh is between De France and Lindbergh Avenues and consists of fresh and brackish water marsh and non-native annual grassland (Figure 5). Large areas are dominated by invasive perennial pepperweed, which has spread into the SWRP stormwater channel and is aggressively spreading throughout the Eastern and Western Diked Marshes. Pepperweed, when left unchecked, creates a monoculture that has little to no habitat value for wildlife. Also present are pampas grass (*Cortaderia* sp.), bristly ox-tongue, fennel, Himalayan blackberry (*Rubus armeniacus*), and dock (*Rumex* sp.). Native species include patches of cattails, creeping wild rye (*Leymus triticoides*), California bulrush (*Schoenoplectus californicus*), willow herb (*Epilobium ciliatum*), nutsedge (*Cyperus eragrostis*), Baltic rush (*Juncus balticus*), and willow (*Salix* sp.). Plant species observed in the upland ruderal areas of the Eastern Diked Marsh and Western Diked Marsh include fennel, bristly ox-tongue, ripgut grass, wild oat, teasel, and pampas grass. The Eastern Diked Marsh is part of Navy IR Site 25 and was remediated by the Navy in 2003 and 2012. Vegetation in the areas of soil excavation consisted of reed grasses including tules, which are not

considered habitat for endangered species, and as such, no active restoration of the Eastern Diked Marsh areas was required. Reed grasses currently on site were passively restored (Gilbane Federal 2016).

The Western Diked Marsh is west of De France Avenue and consists of a mix of seasonal salt marsh and transition, non-native, annual grassland and weed-dominated areas (Figure 5). The seasonal salt marsh and transition habitat is at the northwestern corner of the Western Diked Marsh and contains pickleweed, Baltic rush, spearscale (*Atriplex prostrata*), and non-native grasses. Non-native grassland and weed-dominated areas have similar species composition as the Eastern Diked Marsh (SAIC 1999). In recent years, perennial pepperweed has spread throughout the Western Diked Marsh (Gilbane Federal 2016).

Weed-dominated areas along roadsides and open areas around the airfield are regularly mowed or disked (Figure 5). These areas are characterized by a dominance of non-native annual herbs and grasses including bristly ox-tongue, geranium (*Geranium dissectum*), wild oat, rabbitsfoot grass (*Polypogon monspeliensis*), English plantain *(Plantago lanceolata*), bird's foot trefoil (*Lotus corniculatus*), bromes, and barley (*Hordeum* sp.) (SAIC 1999).

NASA Ames manages several grassland areas as burrowing owl nesting habitat preserves (Figure 6). These areas are non-native annual grassland and contain species such as wild oats, bromes, rattail fescue (*Vulpia myuros*), red fescue (*Festuca rubra*), and Mediterranean rye (*Lolium multiflorum*). Preserves are managed in the following manner: supplemental artificial burrows are placed within the preserves; preserves are regularly mowed to maintain short grass; some preserves are fenced to limit access; raptor perches are removed or mitigated with bird spikes; and ground squirrels are transplanted to the preserves to repopulate these areas, many of which are devoid of ground squirrels (Tetra Tech 2016c).

1.3.2.1 Jurisdictional Wetlands and Waters of the U.S.

The U.S. Army Corps of Engineers (USACE) last conducted a wetland delineation at NASA Ames in 2009 and recorded 51.1 acres of jurisdictional wetlands and Waters of the U.S. including the following ditches shown on Figure 6: Northern Channel, North Patrol Ditch, and Marriage Road Ditch are Waters of the U.S.; East Patrol Ditch is a jurisdictional wetland. These ditches support brackish marsh habitat. Northern Channel is a storm channel managed for stormwater flow and flows east into Moffett Channel and ultimately Guadalupe Slough; water control structures (gates and pumps) prevent backflow from the bay into Northern Channel. However, the ditch salinity is influenced by seepage from the Alviso ponds, which are north of the Northern Channel and separated by a levee (Earth Resources Technology, Inc. [ERT] 2015; Tetra Tech 2016d).

Jurisdictional wetlands also include the southern halves of the Eastern Diked Marsh and Western Diked Marsh and seasonal wetlands between Zook Road and Moffett Airfield (USACE 2009). The seasonal wetlands around the airfield are slightly brackish or alkaline and support Baltic rush, creeping wild rye, cattails, spearscale, saltgrass, clustered field sedge (*Carex praegracilis*), and pepperweed. The 2009 survey area, however, did not include the northern half of the Western and Eastern Diked Marshes or any of the SWRP. These areas were previously mapped as Wetlands

and Waters of the U.S. in a wetland delineation verified by USACE in 1989 (Figure 3.9-3 of Design, Community and Environment [DCE] 2002).

The Removal Action will not result in releases of excavated sediment, other than minor incidental fallback from removal of sediment in the area of the SWRP. If sampling of the side slopes indicates that excavation is necessary, removal that occurs within the USACE jurisdictional limit will be limited to excavation only, with minimal incidental fallback. The Removal Action will not result in loss of wetland acreage and will not affect the course, location, condition, or capacity of adjacent navigable waters. The final acreage of excavation within jurisdictional wetlands and Waters of the U.S. will depend on sampling data but is estimated not to exceed 0.85 acre and will not result in a loss of wetland acreage. Silt fencing that is currently on site will remain throughout the period of excavation to prevent erosion of excavated material into the SWRP. During restoration activities, fiber rolls will be put in place until vegetative cover is established. Stormwater pollution control Best Management Practices (BMPs) will be employed to prevent migration of surface water runoff into the adjacent SWRP. Erosion control BMPs are detailed in the project Stormwater Pollution Prevention Plan (SWPPP) (Appendix F of the RAWP). These BMPs include use of berms around material storage and refueling areas, vehicle tracking controls (such as rumble strips) to prevent dirt from exiting the site, tire washes, and street sweepers to collect soil at the site exit and on the haul routes.

Impacts to pickleweed will occur in areas where aboveground vegetation is removed. However, pickleweed habitat will be mitigated on site at a 3:1 ratio, as required for impacts to salt marsh harvest mouse habitat and as stated in the project BA and BO (Tetra Tech 2017; USFWS 2017). The habitat restoration will result in an increase in wetland acreage on site. Areas of anticipated pickleweed disturbance are shown on Figure 4. Based on the current understanding of the extent of the Removal Action, up to 0.62 acre of pickleweed will be disturbed, and based on a 3:1 mitigation ratio, a minimum of 1.86 acres of pickleweed habitat will be restored. Habitat restoration is addressed in Section 3.0. The final area of pickleweed removal will be delineated after excavation and prior to restoration.

1.3.3 Special Status Species Potentially Occurring in the Action Area or Other Natural Areas

On November 1, 2016, NASA requested and received an official list of federal ESA-listed threatened and endangered species that could occur in the Action Area from the USFWS Information for Planning and Consultation (IPaC) system (USFWS 2016b). The species list provided by USFWS is included in Attachment H1. Attachment H2 provides the results of two additional searches of special status species conducted using the California Natural Diversity Database (CNDDB) and USFWS IPaC on-line planning tools. No USFWS-designated critical habitat is in the Action Area. The following sections detail special status species that could occur in the Action Area, or other natural areas (as defined in Section 1.3). Species considered but eliminated from effects evaluation based on no potential to occur are detailed in Section 1.3.4.

Figure 7 shows areas on NASA Ames where western snowy plovers (*Charadrius nivosus* subsp. *nivosus*, federally listed threatened and state-listed species of special concern) and California least

terns (*Sternula antillarum browni*, federally endangered, state endangered, and state fully protected) could occur. Figure 8 shows areas on NASA Ames where California clapper rails (*Rallus longirostris obsoletus*, federally endangered, state endangered, and state fully protected) and salt marsh harvest mice could occur. Burrowing owl preserves are shown on Figure 6. Detailed evaluations of potential effects to federally listed species are in the project BA and BO (Tetra Tech 2017; USFWS 2017). The BO concluded that the Removal Action may affect and is likely to adversely affect California least terns, California clapper rails, western snowy plovers, and salt marsh harvest mice (USFWS 2017). The Removal Action is expected to exert a long-term beneficial effect on the federally listed species addressed in the project BA resulting from removal of contaminated sediment and soil that could bioaccumulate in the food chain. The Removal Action will result in a greater area of pickleweed habitat for the salt marsh harvest mouse. The conservation measures listed in Section 2.0 would reduce the likelihood and intensity of anticipated effects in the event that federally and state-listed or special status species are present during Removal Action activities.

Table 1 lists federal and state-listed and species of special concern that have the potential to occur at NASA Ames. The list was derived from the CNDDB and USFWS IPaC database query tools. CNDDB was queried using the Mountain View quadrangle (CDFW 2016, 2017; USFWS 2016b). Table 1 includes a summary of historical records of the species in the region and at NASA Ames, and habitat suitability and potential for occurrence within the Action Area or other natural areas.

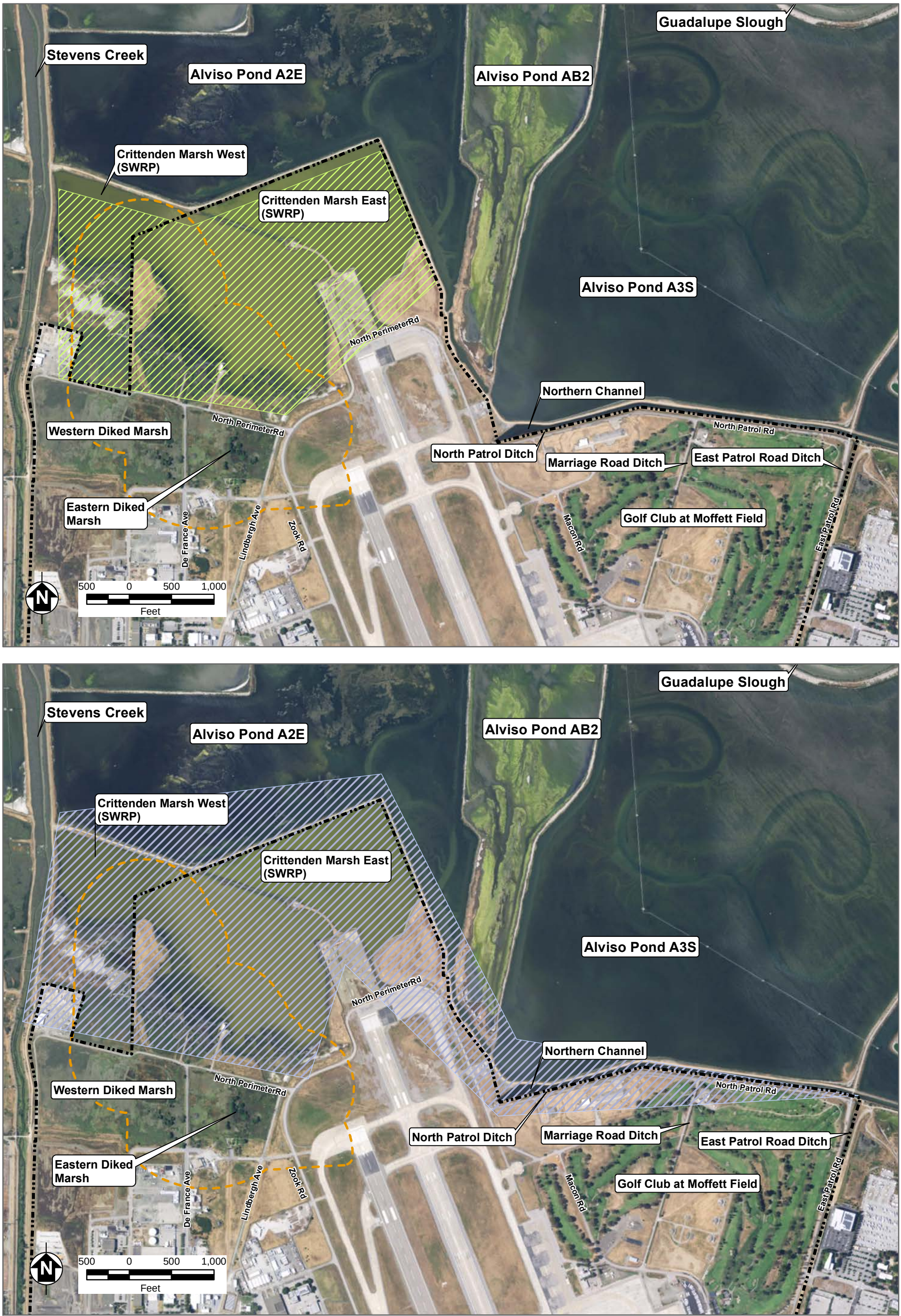
The following special status species are further addressed because they were identified as having a high potential for occurrence within the Action Area or other natural areas, in addition to the federally listed species addressed in the project BA (Appendix G of the RAWP): western pond turtle (*Emys marmorata)*, burrowing owl, California black rail (*Laterallus jamaicensis coturniculus)*, salt marsh common yellowthroat *(Geothlypis trichas sinuosa)*, Alameda song sparrow (*Melospiza melodia pusillula)*, northern harrier (*Circus cyaneus)*, and white-tailed kite (*Elanus leucurus*). Protections for other special status species that could occur in the Action Area or other natural areas are also addressed. Federal and state-listed species that have no potential to occur within the Action Area or other natural areas are addressed in Section 1.3.4.

Other species from Table 1 either have little to no potential to occur at NASA Ames, or it was determined that the effects of the Removal Action would likely be so low as to be negligible. For all species addressed in this plan, the Removal Action is expected to exert a long-term beneficial effect from removal of contaminated sediment and soil that could bioaccumulate in the food chain.

1.3.3.1 Western Pond Turtle

Status: California Species of Special Concern

Habitat and Biology: The western pond turtle is omnivorous and feeds on aquatic plant material including pond lilies, beetles, and a variety of aquatic invertebrates. Additionally, they have been known to feed on fishes, frogs, and carrion. Western pond turtles typically are associated with permanent ponds, lakes, streams, irrigation ditches, or permanent pools along intermittent streams (Zeiner et al. 1990).



NASA Ames

Action Area

Federally Listed Species Area of Potential Occurrence

Western Snowy Plover

California Least Tern

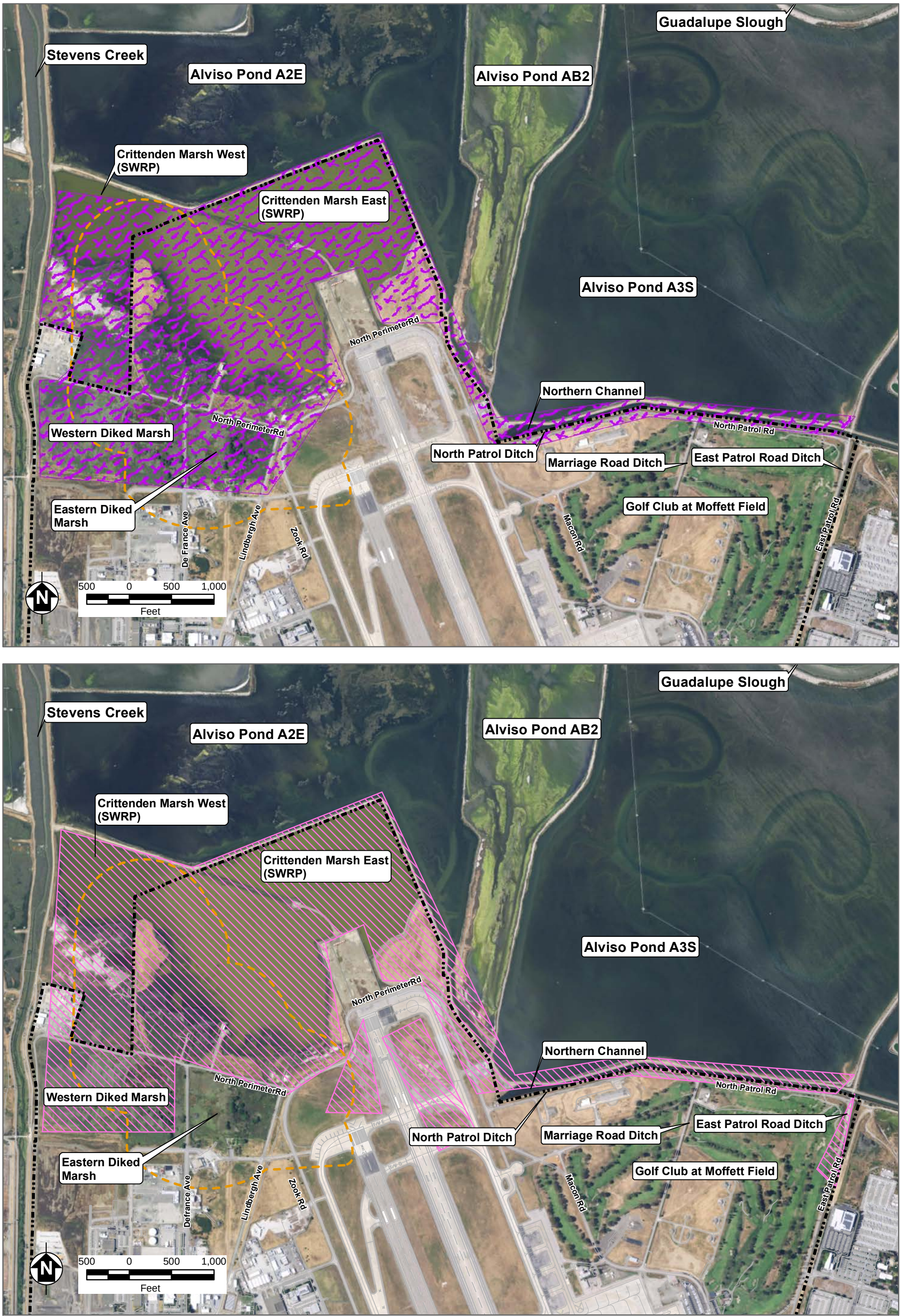
Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 7
Areas of Potentially Occurring Federally Listed Species – Western Snowy Plover and California Least Tern
Protected Species Mitigation and Habitat Restoration Plan

12/18/2017 H:\Tetra tech\NASA\NASA_GIS\SHRMP Figs\7_SHRMP_Species11X17.mxd TtEMI-BLDR angela.lortie



NASA Ames

Action Area

Federally Listed Species Area of Potential Occurrence

California (Ridgway's) Clapper Rail

Salt Marsh Harvest Mouse

Notes: AOI = Area of Investigation
GIS = Geographic Information Systems
NASA Ames = National Aeronautics and Space Administration Ames Research Center
SWRP = Stormwater Retention Pond
Source: NASA Ames GIS

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 8
Areas of Potentially Occurring Federally Listed Species – California Clapper Rail and Salt Marsh Harvest Mouse
Protected Species Mitigation and Habitat Restoration Plan

12/18/2017 H:\Tetra tech\NASA\NASA_GIS\SHRMP Figs\8_SHRMP_Species11X17_Mouse_CCR.mxd TtEMI-BLDR angela.lortie

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Birds							
Charadrius alexandrinus nivosus	Western snowy plover	Threatened	None	Species of Special Concern	Found in sandy beaches, salt pond levees and shores of large alkali lakes. For nesting, needs sandy, gravelly or friable soils.	One occurrence in the Santa Clara Valley Water District at San Francisquito Creek in 2002 (CNDDB 2017). The eBird Range Map Database does not differentiate between the snowy plover and the western snowy plover subspecies. Multiple occurrences of the snowy plover at nearby San Francisco Bay Trail-Moffett Field, Crittenden Marsh in 2015, and seven occurrences at Salt Pond A2E in 2016 (Audubon and Cornell Lab of Ornithology 2017).	**Known to occur at NASA Ames:** Survey records from NASA Ames and San Francisco Bay Bird Observatory (SFBBO) document roosting on levees in the winter and occasional (low numbers) nesting in Crittenden Marsh East and West (Layne and Harding-Smith 1995; Alderete 2013b; Tokatlian et al. 2014; Pearl et al. 2015). Suitable nesting habitat at the SWRP occurs during times when it is not inundated and has open substrate. SFBBO attributed low nesting at Crittenden Marsh West in 2015 to high water levels and lack of exposed salt panne habitat throughout the nesting season, compared with available habitat at Crittenden East in 2014, which recorded 12 nests (Pearl et al. 2015). The FSFA is in Crittenden West, which is commonly inundated during most of the nesting season.
Rallus longirostris obsoletus	Ridgway's rail (formerly the California clapper rail)	Endangered	Endangered	Fully Protected	Found in salt-water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. Is associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs.	Multiple occurrences in 2006 in neighboring Palo Alto: at the Laumeister tract and Faber tract, south of Cooley Landing and north of San Francisquito creek; at the Marshes of Palo Alto Baylands, Palo Alto Harbor, Bixby Park and Hooks Island, and at Permanente Creek at Shoreline Park in Sunnyvale (CNDDB 2017).	**Known to occur at NASA Ames:** Historical listed species surveys at NASA Ames have documented California clapper rails within the SWRP in 1992 and 1993 (Orton-Palmer and Takekawa 1992; Burns and Harding-Smith 1993). More recent surveys have not detected California clapper rails at NASA Ames; the survey reports indicate that habitat quality in and near the SWRP is poor and that nesting California clapper rails are unlikely (Bumgardner Biological Consulting 2011a and 2012). A 2005 survey report of the Northern Channel noted that habitat quality is low and nesting rails are unlikely; no rails were detected during the 2005 survey (Alderete 2005b). However, rails regularly occur in Stevens Creek, approximately 1,200 feet west of the AOI 14 FSFA peninsula and could use the SWRP to forage.
Sternula antillarum browni	California least tern	Endangered	Endangered	Fully Protected	Nests along the coast from northern Baja California to San Francisco Bay. They are colonial breeders on bare or sparsely vegetated, flat substrates: sand beaches, alkali flats, landfills or paved areas.	One occurrence in 1987 on NASA-Ames: "Pond B2 of Leslie Salt Co. Site Serves as a Post-Breeding foraging and staging area; Discovered in 1987, 68 birds used this site in 1987" (CNDDB 2016).	**Known to occur in the vicinity of NASA Ames**: Historical surveys at NASA Ames have not recorded California least terns within the SWRP, but they do occur north of NASA Ames (and the Action Area) in the USFWS waterfowl production ponds (Layne and Harding-Smith 1995). California least terns are a migratory species that commonly forage in the flooded ponds north of the SWRP during post-breeding staging for migration, late June through August.
Athene cunicularia	Burrowing owl	None	None	Species of Special Concern	Inhabits open, dry annual or perennial grasslands, scrublands and deserts characterized by low-growing vegetation. Subterranean nester, dependent upon other burrowing animals for nesting burrows. At NASA Ames, this species is known to occur in areas of open land, gravel, and semi-developed areas.	Multiple occurrences and active burrows/nests on record for NASA-AMES. SW end of Moffett Field Naval Air station/NASA Ames Research Center, north of Hwy 101 near Ellis St, Mountain View. East of Stevens Creek, 0.42 Miles NW of the Junction of Parsons Ave and Arnold Ave, Moffett Field Naval Air Station. Moffett Field Naval Air Station field NW of the tower. North end and East site of the flight line at Moffett Field Naval Air Station. Includes Golf Course at Moffett Field (CNDDB 2017). The eBird Range Map Database reports multiple sightings on Moffett Airfield property, mostly in and around the golf course in 1991, 1995, 2013 and 2016 (Audubon and Cornell Lab of Ornithology 2017).	**Known to occur at NASA Ames:** Burrowing owls occur at NASA Ames and in the vicinity of the haul routes; burrowing owl preserves are located adjacent to the haul routes (Figure 6). A robust population of breeding burrowing owls has been recorded at NASA Ames since the early 1990s; burrowing owls occur in open areas with ground squirrel burrows and in semi-developed areas and de-vegetated fence lines (Chromczak 2016). The owls require small mammal burrows for nesting. Burrowing owls have not been observed nesting atop the FSFA peninsula, but owl pellets have been observed. Conservation measure BIO-37 requires that the USFWS-approved biologist place exclusion material at entrances of burrows atop the peninsula to prevent burrowing owls from establishing nests. They could potentially forage in the grassland areas in the vicinity of the Action Area, but are not likely to occur on the FSFA and would likely avoid activity near the haul routes.

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Birds (Continued)							
Buteo swainsoni	Swainson's hawk	None	Threatened	Special Species	Breeds in grasslands with scattered trees, juniper-sage flats, riparian areas, savannahs and agricultural or ranch lands with groves or lines of trees. Requires adjacent suitable foraging areas such as alfalfa or grain fields or grasslands supporting rodent populations.	No occurrences in Mountain View Quad. CNDDB Rare find has occurrence data for Santa Clara County, in Morgan Hill Quad (23 miles SE of project site) and in San Jose West Quad (3 miles SE of project site) in Santa Clara in 1889 (CNDDB 2016). The eBird Range Map Database has sightings in Sunnyvale Baylands Park (2013) and Charleston Slough/Coast Casey Forebay (2012) (Audubon and Cornell Lab of Ornithology 2016).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded Swainson's hawk (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). They could potentially forage in the grassland areas in the vicinity of the Action Area, but are not likely to occur on the FSFA or near the haul routes.
Circus cyaneus	Northern harrier	None	None	Species of Special Concern	Inhabits coastal salt and freshwater marshes. Nests and forages in grasslands, from mountain cienagas to saltgrass in desert sink. Nests on ground in shrubby vegetation, usual at marsh edge; nest built of a large mound of sticks in wet areas.	CNDDB reports one nearby occurrence in 2004 just north of Palo Alto of Santa Clara County Airport (CNDDB 2016). The eBird Range Map Database reports multiple sightings on site from multiple locations: the San Francisco Bay Trail-Moffett Field in 2012, 2013, 2014, and 2016; NASA Ames in 2014, Moffett Field in 2012, NASA Ames Moffett Field in 2011 and in Crittenden Marsh/Moffett Field 1976 through 1985 (Audubon and Cornell Lab of Ornithology 2016).	**Known to occur at NASA Ames**: Historical species surveys at NASA Ames have documented northern harriers at Moffett Field (exact location not specified) and in the vicinity of NASA Ames, at the evaporation ponds (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Suitable nesting and foraging habitat exist in and in the vicinity of the Action Area.
Geothlypis trichas sinuosa	Salt marsh common yellowthroat	None	None	Species of Special Concern	Resident of the San Francisco Bay region, in fresh and salt water marshes. Requires thick, continuous cover down to water surface for foraging. Requires tall grasses, tule patches, willows for nesting.	Salt marsh common yellowthroat have been documented northwest of Moffett Field Naval Air Station, east of Palo Alto, NE of NASA Ames in 1985 (CNDDB 2016). Multiple nearby occurrences: in nearby Palo Alto, east of the Palo Alto Municipal Airport, Palo Alto Baylands in 2004; in the salt ponds, Guadalupe Slough and confluence of San Thomas Aquinas and Calabaza's creeks in 1999; at the end of Mayfield Slough at junction with Matadero Creek, north edge of Palo Alto Flood Basin in 1985; at the Charleston Slough just north of the Bayshore Freeway junction in 1985; and southwest of Cooley Landing in 2004 (CNDDB 2017). The eBird Range Map Database does not differentiate between the common yellowthroat and the salt marsh common yellowthroat subspecies, so it is possible that some common yellowthroat sightings were the subspecies. eBird reports multiple sightings of the common yellowthroat onsite: the Bay Trail from Shoreline to Sunnyvale water pollution control plant in 2012; the Bay Trail, Moffett Field from 2013 to 2016; and Crittenden Marsh/Moffett Field, 1976 through 1986 (Audubon and Cornell Lab of Ornithology 2017).	**Known to occur at NASA Ames**: Historical species surveys at NASA Ames have documented salt marsh common yellowthroat at the Eastern and Western Diked Marsh, in the Action Area (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Suitable nesting and foraging habitat exist in and in the vicinity of the Action Area.

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Birds (Continued)							
Laterallus jamaicensis coturniculus	California black rail	None	Threatened	Fully Protected	Inhabits freshwater marshes, wet meadows and shallow margins of saltwater marshes bordering larger bays. During breeding, rails require dense pickleweed cover with an open structure beneath the canopy to allow for movement through the pickleweed (Goals Project 2000).	One occurrence at NASA Ames: Moffett Airfield, both sides of NASA Ames Research Center Boundary Road between Zook Road and Stevens Creek, Mountain View in 2012. Two occurrences in nearby Palo Alto in 2004 and 2005 at the Palo Alto Baylands Preserve and Southwest of Cooley Landing respectively (CNDDB 2016). The eBird Range Map Database shows no occurrences onsite but has multiple sightings nearby in the Palo Alto Baylands (1998, 1999, 2003 and 2015), the Salt Ponds (2013, 2015 and 2016) and the Alviso Marina County Park (2013 through 2016) (Audubon and Cornell Lab of Ornithology 2016).	**Known to occur in the vicinity of NASA Ames**: Historical species surveys at NASA Ames have documented California black rail in the Action Area. Focused surveys conducted in 2011 and 2012 detected California black rail vocalizations in the SWRP (in 2011) and in Eastern Diked Marsh (2012) (Bumgardner Biological Consulting 2011b, 2012). This species may forage in the SWRP but nesting is unlikely as the SWRP has minimal suitable habitat and inconsistent water levels. Nesting could occur in freshwater marsh of the Eastern or Western Diked Marshes. Previous historical focused surveys at NASA Ames did not record California black rail (Burns and Harding-Smith 1993; Layne and Harding-Smith 1995; Alderete 2004). They are not likely to occur on the FSFA. They are found primarily in marshes with unrestricted tidal influence and are most often seen during very high tides when they are forced out of the lower elevation pickleweed. Very few California black rails have been recorded in diked marshes (Goals Project 2000).
Melospiza melodia pusillula	Alameda song sparrow	None	None	Species of Special Concern	Inhabits pickleweed marshes, nests in low gumweed (*Grindelia* spp.) bushes (high enough to escape high tides) and in pickleweed. Associated with upper marsh edges and higher elevation channel banks. Resident of salt marshes bordering south arm of San Francisco Bay.	Multiple occurrences in 2006 in neighboring Palo Alto: Southwest of Cooley Landing in 2004, east of the Palo Alto Municipal Airport, Palo Alto Baylands in 2004, Alviso Slough in 1947, and in Palo Alto in 1908 (CNDDB 2016). The eBird Range Map Database has sightings in nearby Palo Alto Baylands in 1986, 1997 and 2007 (Audubon and Cornell Lab of Ornithology 2016).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded the Alameda song sparrow; however, song sparrows have been observed and it is difficult to distinguish the subspecies, so it is possible that song sparrow sightings could have been the subspecies (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Suitable nesting and foraging habitat exist in and in the vicinity of the Action Area.
Rynchops niger	Black skimmer	None	None	Species of Special Concern	Nests on gravel bars, low islets and sandy beaches, in non-vegetated sites. Nesting colonies usually less than 200 pairs.	Black skimmers have been documented in salt pond AB2 in 2016 and A2E in 2015 (Audubon and Cornell Lab of Ornithology 2016). CNDDB reports one sighting in nearby Santa Clara at the island in shoreline sailing lake in 2015 (CNDDB 2016).	**Known to occur in the vicinity of NASA Ames**: Historical surveys at NASA Ames have not recorded black skimmers, but they have been documented north of NASA Ames at the USFWS waterfowl production ponds (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). They could potentially forage in the SWRP when it is inundated, but this is unlikely. They are not likely to occur on the FSFA or near the haul routes.
Elanus leucurus	White-tailed kite	None	None	Fully Protected	Coastal and valley lowlands. Nests in oak, willow, or other dense tree stands. At NASA Ames, this species has been recorded nesting in coyote brush. Nests are located near open foraging areas.	The eBird Range Map Database has sightings of white-tailed kites at NASA Ames on the AOI 14 peninsulas, and in the areas of the Eastern and Western Diked Marshes and at Stevens Creek (Audubon and Cornell Lab of Ornithology 2016). CNDDB reports five occurrences in Santa Clara County, including Stevens Creek and east of Alviso (CNDDB 2016).	**Known to occur at NASA Ames**: Historical species surveys at NASA Ames have documented white-tailed kites at NASA Ames, in the Action Area. White–tailed kites have been recorded in the Eastern Diked Marsh exhibiting courtship behavior, and nesting in coyote brush scrub at AOI 14 (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Suitable nesting and foraging habitat exist in and in the vicinity of the Action Area.

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Mammals							
Reithrodontomys raviventris	Salt marsh harvest mouse	Endangered	Endangered	Fully Protected	Only present in the saline emergent wetlands of San Francisco Bay and its tributaries. Pickleweed is their primary habitat. Does not burrow, builds loosely organized nests. Requires higher areas for flood escape.	One sighting on NASA Ames in 1991, east of Stevens Creek, 1.5 miles north of the junction of Hwy 101 and Hwy 85, Moffett Field Naval Air Station. Multiple sightings in nearby Palo Alto: east of Palo Alto marsh in 195, at the Mayfield Slough in 1975, at the Coyote Creek Marsh in 1986, at the Palo Alto Baylands in 1990, south of Coley Landing in 1991, at the Guadalupe Slough tidal marsh dike in 1990, and at the ITT marsh in 1988 (CNDDB 2016).	**Known to occur at NASA Ames**: Salt marsh harvest mice have been observed in the SWRP, MROSD property adjacent to the AOI 14 FSFA, and Stevens Creek. Surveys conducted in Crittenden Marsh in 1991 and 1994 recorded one individual each (Pomeroy 1991; Layne and Harding-Smith 1995). No mice were captured during 1985 surveys of Crittenden Marsh and Sunnyvale Baylands Park (Goals Project 2000). No salt marsh harvest mice have been recorded in the Eastern and Western Diked marshes. The SWRP currently supports pickleweed and may provide habitat for the salt marsh harvest mouse. The 1994 survey report noted that the complete and prolonged submergence of pickleweed within the SWRP during wet years has potentially detrimental effects on the salt marsh harvest mouse (Layne and Harding-Smith 1995).
Antrozous pallidus	Pallid bat	None	None	Species of Special Concern	Inhabits shrub lands, grasslands, woodlands, deserts and forests. Most common in open dry habitats with rocky areas for roosting. Roosts must protect bats from high temperatures, they are very sensitive to disturbance of roosting sites.	One occurrence in Los Altos and Mountain View in 1945 (CNDDB 2016).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded the pallid bat (ERT 2015). They could potentially forage in the Action Area or other natural areas (as defined in Section 1.3), but are not likely to inhabit any of the areas within or near the Action Area or other natural areas.
Corynorhinus townsendii	Townsend's big-eared bat	None	Candidate Threatened	Species of Special Concern	Resides throughout California in a wide variety of habitats. Most common in mesic sites. Roosts in the open, hanging from walls and ceilings. Roosting sites limiting, extremely sensitive to human disturbance.	One occurrence in the vicinity was in 1946 in Los Altos (CNDDB 2016).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded the Townsend's big-eared bat (ERT 2015). They could potentially forage in the Action Area or other natural areas, but are not likely to inhabit any of the areas within or near the Action Area or other natural areas.
Lasiurus cinereus	Hoary bat	None	None	None	Resides in open habitats or habitat mosaics with access to trees for cover and open areas or habitat edges for feeding. Roosts in dense foliage of medium to large trees and feeds primarily on moths and requires water.	Occurrences in nearby quads include on in Los Altos and Mountain View in 1990, on at Stanford University in 1909, one in Menlo Park in 1894, one in Portola Valley in 1991, one in Redwood City in 1991, and one in Woodside in 1991 (CNDDB 2017).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded the hoary bat (ERT 2015). They could potentially forage in the Action Area or other natural areas, but are not likely to inhabit any of the areas within or near the Action Area or other natural areas.
Sorex vagrans halicoetes	Salt marsh wandering shrew	None	None	Species of Special Concern	Resides in salt marshes of the south arm of San Francisco Bay. Found in medium-high marshes 6-8 feet above sea level where abundant driftwood or wrack is scattered among dense pickleweed and soils are continuously moist. They are not known to occur in diked marshes (Goals Project 2000).	One nearby occurrence, one mile SSW of Alviso in 1951, other occurrences in Alameda County (CNDDB 2016).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded salt marsh wandering shrew (Layne and Harding-Smith 1995; ERT 2015). They are not likely to occur in the SWRP, FSFA, or near the haul roads as no suitable habitat exists. The shrew has restrictive habitat requirements that are not present at the SWRP.

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Amphibians and Reptiles							
Ambystoma californiense	California tiger salamander	Threatened	Threatened	Watch List	This species inhabits lowlands and foothills in or near permanent sources of deep fresh water with dense, shrubby, or emergent riparian vegetation, and may aestivate in rodent burrows or cracks during dry periods. Needs underground refuges, especially ground squirrel burrows and vernal pools or other seasonal water sources for breeding.	Two occurrences in nearby quads, one at Lake Lagunita and surrounding Stanford Campus in 2005 and one historic occurrence at San Francisquito Creek and San Mateo County (CNDDB 2017).	**No records at NASA Ames:** The project site has no suitable habitat for this species and previous surveys have documented no California red-legged frogs on site (Layne and Harding-Smith 1995; Scott and Alderete 2001; ERT 2015). This species is unlikely to occur in the Action Area or other natural areas, as no suitable habitat exists. Water sources are saline and/or seasonal, and predators are abundant (ERT 2015).
Emys marmorata	Western pond turtle	None	None	Species of Special Concern	An aquatic turtle that resides in ponds, marshes, rivers, streams and irrigation ditches with aquatic vegetation below 6000 feet. Needs basking sites and suitable (sand banks or grassy open fields) upland habitat up to 0.5 km from water for egg-laying.	One occurrence in nearby Sunnyvale along the Bay Trail on the North Side of Moffett Field, Mountain View in 2012 (CNDDB 2016).	**Known to occur at NASA Ames**: Western pond turtles have been recorded in ditches (Marriage Road, Northern Channel and North Patrol Road) on the eastern portion of NASA Ames, approximately 0.5 mile east of the Action Area. They could potentially occur in the Eastern Diked Marsh. Historical surveys have not documented this species west of the airfield (Alderete and McGowan 2003; Alderete 2003).
Rana draytonii	California red-legged frog	Threatened	None	Species of Special Concern	The Santa Barbara and Sonoma County populations are federally listed endangered. This species requires lowlands and foothills in or near permanent sources of deep water with dense shrubby or emergent riparian vegetation. It requires 11-20 weeks of permanent water for larval development and must have access to estivation habitat. This species is restricted to grasslands and low foothills, with seasonal water sources for breeding.	Five occurrences in nearby quads; one at Matadero Creek and Deer Creek in 2001, one at San Francisquito Creek in 2001, two west of I-280, 0.5-0.6 mile SW of Bear Gulch Reservoir in 1998, and one in the creek along Walsh Road, 0.4 mile SE of Bear Gulch Reservoir in 2003 (CNDDB 2017).	**No records at NASA Ames:** Previous surveys have documented no presence of California tiger salamanders at NASA Ames (Layne and Harding-Smith 1995; Scott and Alderete 2001). Unlikely to occur in Action Area or other natural areas, as no suitable habitat exists. Water sources at NASA Ames are too saline or seasonal, and predators are abundant (ERT 2015).

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Fish							
Hypomesus transpacificus	Delta smelt	Threatened	Endangered	None	Typically found in the Sacramento-San Joaquin Delta, seasonally in Suisun Bay, Carquinez Strait, San Pablo Bay and San Francisco Bay. Seldom found at salinities >10 ppt, most often at salinities <2 ppt.	Nearest occurrence in the Mare Island quadrangle, 1 mile WSW of West Mare Island and 0.4 miles south of Highway 37 in 1998 and in San Pablo Bay in 2006 (CNDDB 2017).	**No records at NASA Ames:** Delta smelt are unlikely to occur in the Action Area or other natural areas, as no suitable habitat exists. The SWRP has no surface hydrologic connection with the Bay and no suitable habitat for this species.
Oncorhynchus (=Salmo) mykiss	Steelhead	Threatened	None	None	This species requires freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Steelhead can be found throughout the San Francisco Bay when migrating.	Nearest occurrence in Alameda Creek from Sunol Valley to the mouth at San Francisco Bay, Niles Canyon in Fremont in 1999 (CNDDB 2017).	**No records at NASA Ames:** Steelhead are unlikely to occur in the Action Area or other natural areas, as no suitable habitat exists. The SWRP has no surface hydrologic connection with the Bay and no suitable habitat for this species.
Sprinchus thaleichthys	Longfin smelt	Candidate	Threatened	Species of Special Concern	This species Is euryhaline, nektonic and anadromous. Found in open waters of estuaries, mostly in middle or bottom of water column. Prefers salinities of 15 to 30 ppt, but can be found in completely freshwater to almost pure seawater.	This species is a pelagic estuarine fish that has a range that extends from the San Francisco Bay-Delta to the Cook Inlet in Alaska. Nearest occurrence is in the South San Francisco Bay in 1995 (CNDDB 2017).	**No records at NASA Ames:** Longfin smelt are unlikely to occur in the Action Area or other natural areas, as no suitable habitat exists. The SWRP has no surface hydrologic connection with the Bay and no suitable habitat for this species.
Crustacean							
Lepidurus packardi	Vernal pool tadpole shrimp	Endangered	None	Species of Special Concern	Inhabits vernal pools commonly found in grass bottomed swales of unplowed grasslands in the Sacramento Valley containing clear to highly turbid water.	Nearest occurrences recorded in the wetland unit of Don Edwards San Francisco Bay National Wildlife Refuge, WSW of Fremont in 2004 and on the SE side of Weber Road 0.3 miles SW of the Boyce Road Junction in SW Newark in 2016 (CNDDB 2017).	**No records at NASA Ames**: No vernal pools occur in the Action Area or other natural areas, or at NASA Ames.

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Plants*							
Astragalus tener var. *tener*	Alkali milk-vetch	None	None	None	Inhabits alkali playa, valley and foothill grassland and vernal pools. Resides in low ground, alkali flats, flooded lands, annual grassland or in playas or vernal pools.	Nearest occurrence in Mayfield in 1905 (CNDDB 2017).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded alkali milk vetch (Layne and Harding-Smith 1995; SAIC 1999). This species is not likely to occur in the Action Area or other natural areas, as no suitable habitat exists.
Centromadia parryi subsp. *congdonii*	Congdon's tarplant	None	None	None	Inhabits valley and foothill grassland. It requires alkaline soils, sometimes described as heavy white clay.	One occurrence recorded at the north end of the Moffett Field golf course at the NASA Ames Research Center in 2013. Nearby occurrences include two at Shoreline at Mountain View Park in 2015, and one in the Ravenswood area of East Palo Alto in 2001 (CNDDB 2017).	**Known to occur at NASA Ames:** Historical surveys at NASA Ames have not recorded Congdon's tarplant (Layne and Harding-Smith 1995; SAIC 1999). However, ERT (2015) indicates this species was observed in several locations around the north end of the Moffett Field Golf Course, east of the Action Area. A previous vegetation survey of the FSFA in 2013, and a site walk conducted in 2016 confirmed no presence of this species (Alderete 2013a; Tetra Tech 2016e).
Chloropyron maritimum subsp. *palustre*	Point Reyes bird's-beak	None	None	None	Inhabits coastal salt marshes with pickleweed, saltgrass, jaumea (*Jaumea carnosa*), cordgrass (*Spartina* spp.) and others.	Two nearby occurrences in Cooley's Landing near Palo Alto in 1914, and in Palo Alto in 1915 (CNDDB 2017).	**No records at NASA Ames**: Historical surveys conducted at NASA Ames have not record Point Reyes bird's-beak (Layne and Harding-Smith 1995; Zippin and Engels 1997; SAIC 1999). Suitable habitat exists in the SWRP. A previous vegetation survey of the FSFA and a recent site walk confirmed no presence of this species (Alderete 2013a).
Eryngium asristulatum var. *hooveri*	Hoover's button-celery	None	None	None	Inhabits vernal pools, alkaline depressions, roadside ditches and other wet places near the coast.	Two occurrences recorded nearby, one in 1909 near the marsh to the right of Embarcadero Road in Palo Alto and one in 1907 in the foothills and pastures near Stanford University (CNDDB 2017).	**No records at NASA Ames:** Historical surveys at NASA Ames have not recorded Hoover's button celery (Layne and Harding-Smith 1995; SAIC 1999). A previous vegetation survey of the FSFA and a recent site walk confirmed no presence of this species (Alderete 2013a).
Suaeda californica	California seablite	Endangered	None	None	Is found in marshes and swamps, margins of coastal salt marshes.	The 2010 USFWS 5-Year Review notes that this species is likely extirpated from the San Francisco Bay area; its last confirmed occurrence in the San Francisco Bay area was from a 1958 collection (USFWS 2010a). One CNDDB record from a 1971 Wicksten collection from the salt flats of Palo Alto notes that this location is likely extirpated (CDFW 2016).	**No records at NASA Ames**: Historical surveys conducted at NASA Ames have not record California seablite (Layne and Harding-Smith 1995; Zippin and Engels 1997; SAIC 1999). Suitable habitat exists in the SWRP. A previous vegetation survey of the FSFA and a recent site walk confirmed no presence of this species (Alderete 2013a).

Table 1: Federal and State Listed and Species of Special Concern with Potential to Occur at NASA Ames

Scientific Name	Common Name	Federal List	California List	California Fish and Wildlife Status	Habitat	Regional Occurrence Records (CNDDB or eBird)[1]	NASA Ames Occurrence Records and Habitat Suitability in the Action Area or Other Natural Areas
Insects							
Callophrys mossli bayensis	San Bruno elfin butterfly	Endangered	None	None	This species inhabits coastal grassy mountainous areas near San Francisco Bay, mainly in the vicinity of San Bruno Mountain, San Mateo County, on steep north-facing slopes within the fog belt above 500 feet elevation that contain populations of host plant (*Sedum spathulifolium*).	Nearest occurrences are in San Francisco South quadrangle, just east of Pacifica on a dirt road on the south end of Milagra Ridge recorded in 1977 and on San Bruno Mountain in 2004 (CNDDB 2017).	**No records at NASA Ames**: The Action Area and other natural areas have no suitable habitat for this species.
Euphydryas editha bayensis	Bay checkerspot butterfly	Threatened	None	None	This species occurs on native grasslands on outcrops of serpentine soils in the vicinity of San Francisco Bay. *Plantago erecta* is the primary host plant, *Orthocarpus densiflorus* and *Orthocarpus purpurscens* are the secondary host plants.	Nearest occurrence in the Jasper Ridge Biological Preserve at Stanford University in Palo Alto in 1997 (CNDDB 2017).	**No records at NASA Ames**: The Action Area and other natural areas have no suitable habitat for this species.

CNDDB = California Natural Diversity Database
FSFA = Former Soil Fill Area
NE = northeast
NW = northwest
ppt = parts per thousand
SE = southeast
SSW = south-southwest
SW = southwest
SWRP = stormwater retention pond
USFWS = U.S. Fish and Wildlife Service
WSW = west-southwest

Notes:

[1] Species listed in Table 1 were derived from a USFWS species list request using IPaC and a CNDDB search in October 2016 and January 2017 using the Mountain View Quadrangle to query the database.

* All plants listed in Table 1 are California Native Plant Society (CNPS) List 1B species. Species having a CNPS rank of 1B are rare, threatened, or endangered in California and beyond.

The western pond turtle requires basking sites such as rocks, partially submerged logs, mats of floating vegetation, or open mud banks and hibernation areas that are colder and underwater in bottom mud. Two distinct habitats are thought to be used for reproduction; along large slow-moving streams, eggs and nests are constructed in sandy banks, whereas along foothill streams, females may move considerable distances to find a suitable nest site. Nests have been observed in soil types from sandy to very hard; soil must be at least 10 centimeters deep and have a high internal humidity for eggs to develop and hatch properly (Zeiner et al. 1990).

Western pond turtles are mostly diurnal, but twilight and nocturnal activity has been observed. Where climates are warm, western pond turtles are active all year; however, they hibernate during cold periods in other climates. The home range is typically restricted except for occasional long-distance movements for egg laying, in response to drying of local bodies of water or other factors (Zeiner et al. 1990).

The western pond turtle is the only abundant native turtle in California. Clutches typically consist of 3 to 11 eggs and are laid from March to August depending on local conditions. A variety of vertebrate predators such as bullfrogs, garter snakes, certain fishes, wading birds, and some mammals prey on hatchlings and juveniles (Zeiner et al. 1990).

Range: The western pond turtle's habitat extends throughout California, from west of the Sierra-Cascade crest and except the Mojave Desert, the Mojave River and its tributaries. They are associated with permanent or nearly permanent water, at elevations ranging from near sea level to 4,690 feet above MSL and occur in a wide variety of habitat types (Zeiner et al. 1990).

CNDDB/RareFind Records: One occurrence was noted in nearby Sunnyvale along the Bay Trail on the northern side of Moffett Field, Mountain View in 2012 (CNDDB 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Western pond turtles have been recorded in ditches (Marriage Road, Northern Channel, and North Patrol Road) on the eastern portion of NASA Ames, approximately 0.5 mile east of the Action Area. They could potentially occur in the Eastern Diked Marsh. Increased human activity and haul traffic in the area of the Eastern Diked Marsh will likely deter western pond turtles from coming within close proximity of project activities. Noise and vibration from increased haul traffic would mask communications and could disrupt foraging behavior. Turtles that attempt to cross the road in front of haul traffic could be crushed.

Conservation measures stipulated in the USFWS BO (Attachment H-3) for the protection of federally listed species will also benefit state-listed and special status species and their habitats. Measures such as limiting work to daylight hours and restrictions on haul traffic will avoid and minimize impacts to the western pond turtle. No ground disturbance or vegetation removal will occur in the Eastern Diked Marsh or Western Diked Marsh. Environmental awareness training (BIO-4, Section 2.2) will be provided for all staff, which will include information about the western pond turtle and warnings to obey speed signs, stay on paved roads, and restrict idling to less than 5 minutes.

1.3.3.2 Burrowing Owl

Status: California Species of Special Concern

Habitat and Biology: Burrowing owls are mostly insectivores; however, they also eat small mammals, reptiles, birds, and carrion. The owls hunt from perches and typically hover, hawk, dive, and hop after prey on the ground. Burrowing owls use subterranean burrows constructed by other burrowing animals for roosting and nesting cover. Their nesting burrows are typically lined with pellets, debris, grass, feathers, and excrement. Breeding occurs from March through August, with a peak in April and May. Clutch sizes range from 2 to 10, with an average of 5 to 6 eggs. The young emerge from the burrow around 2 weeks and fly by 4 weeks, and they are semi-colonial (Zeiner et al. 1990).

Burrowing owls thermo-regulate by moving between perches in the sun, shade, or in burrow when hot. They have year-long circadian activity consisting of hunting day or night and frequently perching or stands at burrow entrance in daytime. Burrowing owls typically are residents in California; however, some from the northern parts of the range may winter to the south, and there may be some movement downslope in winter (Zeiner et al. 1990).

Habitat destruction, including conversion of grassland to agriculture, and poisoning of ground squirrels has resulted in a reduction in the population in recent decades, first noted in the 1940s. Prairie falcons, red-tailed hawks, Swainson's hawks, ferruginous hawks, northern harriers, golden eagles, foxes, coyotes, and domestic dogs and cats have been known to prey on the burrowing owl. In addition, auto collisions may be a significant cause of mortality (Zeiner et al. 1990).

Range: The burrowing owl lives year-round in open dry grassland and desert habitats; in grass, forb, and open shrub stages of pinyon-juniper; and in ponderosa pine habitats. It has been found present on offshore islands and at elevations up to 5,250 feet above MSL in Lassen County. Once historically common, numbers of burrowing owls have markedly reduced in recent decades, with decline and local extirpations in central and southern California. Agricultural areas in the Central and Imperial valleys support breeding populations (Zeiner et al. 1990).

CNDDB/RareFind/eBird Records: Current CNDDB and eBird Range Map Database records indicate multiple sightings and nests at Moffett and in surrounding locations. Multiple sightings and nests on record at NASA Ames include: southwestern end of Moffett Field Naval Air Station/NASA Ames, north of Highway 101 near Ellis Street, Mountain View; east of Stevens Creek, 0.42 miles northwest of the Junction of Parsons Avenue and Arnold Avenue, Moffett Field Naval Air Station; Moffett Field Naval Air Station field, northwest of the tower at the northern end and eastern side of the flight line at Moffett Field Naval Air Station (Audubon and Cornell Lab of Ornithology 2016; CNDDB 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Burrowing owls have not been observed nesting atop the FSFA peninsula, but owl pellets have been observed. They could potentially forage in the grassland areas in the vicinity of the

Action Area and other natural areas, but are not likely to occur on the FSFA and would likely avoid activity near the haul roads. Figure 6 shows the locations of burrowing owl preserves at NASA Ames. Two preserves are located along the haul routes on Zook Road. The secondary contractor trailer area (Figure 3) is also located near a burrowing owl preserve. The primary contractor trailer area near the intersection of Allen Road and De France Avenue is preferred (Figure 3); however, NASA Ames may direct the contractor to use the secondary area if other facility activities preclude use of the primary location. The contractor trailer area will include a diesel-fueled generator or a tie-in to the local NASA Ames power supply to provide electricity to the trailer. Temporary sanitation facilities will be installed near the trailer and at additional locations at the laydown areas and FSFA as necessary. The contractor trailer area will remain for the duration of the Removal Action. Increased human activity and haul traffic in the area of the burrowing owl preserves will likely deter owls from coming within close proximity of project activities. Noise and vibration from increased haul traffic would mask communications and could disrupt foraging behavior. Owls or owlets that attempt to cross the road in front of haul traffic could be crushed.

Conservation measures stipulated in the USFWS BO (Attachment H-3) for the protection of federally listed species will also benefit state-listed and special status species and their habitats. Measures such as limiting work to daylight hours and restrictions on haul traffic will avoid and minimize impacts to the burrowing owl. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. Environmental awareness training (BIO-4, Section 2.2) will be provided for all staff, which will include information about the burrowing owl and warnings to obey speed signs, stay on paved roads, and restrict idling to less than 5 minutes. Conservation measure BIO-14 requires that the CDFW-approved biologist place exclusion material at entrances of burrows atop the peninsula to prevent burrowing owls from establishing nests. No ground disturbance or vegetation removal will occur in the burrowing owl preserves. At the discretion of the CDFW-approved biologist, in the event that nests are observed in close proximity to the haul routes, temporary wildlife exclusion fencing may be placed along the road edge to act as a visual and safety barrier to the owls (conservation measure BIO-13).

1.3.3.3 California Black Rail

Status: State Threatened, Fully Protected

Habitat and Biology: The California black rail typically inhabits saltwater, brackish, and freshwater marshes, and they require water depths of about 1 inch that do not fluctuate during the year, with dense vegetation for nesting habitat. They prefer pickleweed-dominated vegetation in the San Francisco Bay wetlands. Larger wetlands are more likely to support populations that will persist for longer periods of time. California black rails typically produce clutches of three to eight eggs (Goals Project 2000).

Range: Over 90 percent of California black rails occur in the tidal salt marshes of the northern San Francisco Bay region, primarily in Suisun and San Pablo Bays (Spautz et al. 2005). Other, smaller populations occur in the San Francisco Bay, outer Coast of Marin County, freshwater

marshes in the foothills of the Sierra Nevada and in the Colorado River Area (Goals Project 2000). Over 80 percent of the California black rail's historical tidal marsh habitat has been lost, in addition to habitat fragmentation and degradation which have led to species decline (Spautz et al. 2005).

CNDDB/RareFind/eBird Records: One occurrence was recorded at NASA Ames in 2012: Moffett Airfield, both sides of NASA Ames boundary road between Zook Road and Stevens Creek, Mountain View, and two occurrences were recorded in nearby Palo Alto in 2004 and 2005 at the Palo Alto Baylands Preserve and southwest of Cooley Landing, respectively (CNDDB 2016). The eBird Range Map Database shows no occurrences on site but has multiple sightings nearby in the Palo Alto Baylands (1998, 1999, 2003, and 2015), salt ponds (2013, 2015, and 2016) and Alviso Marina County Park (2013 through 2016) (Audubon and Cornell Lab of Ornithology 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Focused surveys conducted in 2011 and 2012 detected California black rail vocalizations in the SWRP (in 2011) and in Eastern Diked Marsh (2012) (Bumgardner Biological Consulting 2011b, 2012). This species may forage in the SWRP but nesting is unlikely as the SWRP has minimal suitable habitat and inconsistent water levels. Nesting could occur in freshwater marsh of the Eastern or Western Diked Marshes. Previous historical focused surveys at NASA Ames did not record California black rail (Burns and Harding-Smith 1993; Layne and Harding-Smith 1995; Alderete 2004). They are not likely to occur on the FSFA. They are found primarily in marshes with unrestricted tidal influence and are most often seen during very high tides when they are forced out of the lower elevation pickleweed. Very few California black rails have been recorded in diked marshes (Goals Project 2000).

Minor direct effects to California black rails in the Action Area from noise and visual disturbances that could in turn elicit a startle response and alter foraging patterns may occur but are unlikely; survey records indicate that California black rail foraging in the Action Area is uncommon. California black rails are not likely to occur in the area of haul routes; no adverse effects would occur from the increased haul traffic. Although the California black rail is unlikely to occur in the Action Area or other natural areas, the conservation measures outlined in Section 2.0 are included to reduce the intensity of any anticipated effect, in the event the California black rail would occur. Conservation measures stipulated in the USFWS BO (Attachment H-3) for the protection of federally listed species will also benefit state-listed and special status species and their habitats. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. Installation of anti-perch devices would be a long-term benefit to the California black rail by reducing predator perch habitat. No ground disturbance or vegetation removal will occur in the Eastern Diked Marsh or Western Diked Marsh. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about the California black rail. Conservation measure BIO-9 requires a biologist (will be a USFWS- and/or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds.

1.3.3.4 Salt Marsh Common Yellowthroat

Status: California Species of Special Concern

Habitat and Biology: The salt marsh common yellowthroat is one of 12 subspecies of the common yellowthroat and is an insectivorous warbler that occupies thick vegetation in fresh and brackish wetlands in the San Francisco Bay area. This species occurs in salt marsh in the winter. Breeding occurs from early March through July. Nests are built of grasses woven around supporting vegetation and typically no higher than 24 inches off the ground (Layne and Harding-Smith 1995; Goals Project 2000).

Range: The salt marsh common yellowthroat breeds in fresh and brackish marsh areas of San Francisco Bay and is considered a resident species, although specimens have been collected outside the breeding range, indicating some may migrate. During the breeding season, they can be found in marshes from Sonoma, Napa, Solano, Marin, and Santa Clara Counties. In the winter, this species can be found from San Francisco Bay south to San Diego (Layne and Harding-Smith 1995; Goals Project 2000).

CNDDB/RareFind/eBird Records: Salt marsh common yellowthroats have been documented northwest of Moffett Field Naval Air Station, east of Palo Alto, and northeast of Ames Research Center in 1985 (CNDDB 2016). Multiple nearby occurrences were recorded in nearby Palo Alto, east of the Palo Alto Municipal Airport, Palo Alto Baylands in 2004; in the salt ponds; Guadalupe Slough and confluence of San Thomas Aquinas and Calabaza's creeks in 1999; at the end of Mayfield Slough at junction with Matadero Creek, north edge of Palo Alto Flood Basin in 1985; at the Charleston Slough just north of the Bayshore Freeway junction in 1985; and southwest of Cooley Landing in 2004 (CNDDB 2017). The eBird Range Map Database does not differentiate between the common yellowthroat and salt marsh common yellowthroat subspecies, so it is possible that some of the common yellowthroat sightings were the subspecies. eBird reports multiple sightings of the common yellowthroat on site: the Bay Trail from Shoreline to the Sunnyvale water pollution control plant in 2012; the Bay Trail, Moffett Field from 2013 to 2016; and Crittenden Marsh/Moffett, 1976 through 1986 (Audubon and Cornell Lab of Ornithology 2017).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Suitable nesting and foraging habitat exists in and in the vicinity of the Action Area and other natural areas. Historical species surveys at NASA Ames have documented salt marsh common yellowthroat at the Eastern and Western Diked Marsh (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). The conservation measures outlined in Section 2.0 are included to reduce the intensity of effects to salt marsh common yellowthroat. Conservation measures stipulated in the USFWS BO (Attachment H-3) for the protection of federally listed species will also benefit state-listed and special status species and their habitats. Increased noise and visual disturbances will occur from the haul traffic routed along North Perimeter Road and Zook Road. Noise levels from haul traffic are estimated to be 76 A-weighted decibels (dBA) at 50 feet and would temporarily mask communications and may disrupt foraging patterns by eliciting startle responses. BO conservation measures that address noise reduction and haul traffic restrictions will

reduce the effects of noise on communications and foraging behavior. Measures that address state species surveys and protections are detailed in Section 2.2 and will also avoid and minimize impacts to nesting birds. No ground disturbance or vegetation removal will occur in the Eastern Diked Marsh or Western Diked Marsh. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about special status species that may occur and warnings to obey speed signs, stay on paved roads, and restrict idling to less than 5 minutes. The installation of anti-perch devices along the perimeter fence of the SWRP would also be a long-term benefit to the salt marsh common yellowthroat by reducing predator perch habitat. Conservation measure BIO-9 requires a biologist (will be a USFWS- or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds.

1.3.3.5 Alameda Song Sparrow

Status: California Species of Special Concern

Habitat and Biology: The Alameda song sparrow occurs in marsh areas of San Francisco Bay where tidal flow is unimpeded by levees, although levees may occasionally be used for perching. Breeding territories are held all year and include upper marsh edges and higher-elevation channel banks with shrubs in the vicinity. Nests are built on marsh vegetation or low gumweed (*Grindelia* spp.) just above the highest high tide elevations (Goals Project 2000).

Range: The Alameda song sparrow is a year-round resident of South San Francisco Bay marshes and is one of three distinct subspecies of song sparrow that occur in the San Francisco Bay Area (Goals Project 2000).

CNDDB/RareFind/eBird Records: Multiple occurrences were recorded in 2006 in neighboring Palo Alto, southwest of Cooley Landing in 2004, east of the Palo Alto Municipal Airport, Palo Alto Baylands in 2004, Alviso Slough in 1947, and in Palo Alto in 1908 (CNDDB 2016). The eBird Range Map Database has sightings in nearby Palo Alto Baylands in 1986, 1997 and 2007 (Audubon and Cornell Lab of Ornithology 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Suitable nesting and foraging habitat exists in and in the vicinity of the Action Area and other natural areas. Historical surveys at NASA Ames have not recorded the Alameda song sparrow; however, song sparrows have been observed, and it is difficult to distinguish the subspecies, so it is possible that song sparrow sightings could have been the subspecies (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Based on their preferred nesting habitat, it is unlikely that Alameda song sparrows would initiate a nest within the Removal Action boundary. However, in the event that song sparrows would occur in the vicinity of Removal Action boundary, the conservation measures detailed in Section 2.0 and the USFWS BO (Attachment H-3) would reduce the intensity of effects. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. The

installation of anti-perch devices along the perimeter fence of the SWRP would also be a long-term benefit to the Alameda song sparrow by reducing predator perch habitat. Conservation measure BIO-9 requires a biologist (will be a USFWS- or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about special status species.

1.3.3.6 Northern Harrier

Status: California Species of Special Concern

Habitat and Biology: The norther harrier breeds throughout North America and Eurasia. Nests are built on the ground, usually in tall dense clumps of vegetation, either alone or in loose colonies. The northern harrier diet consists mostly of small mammals, birds, frogs, small reptiles, crustaceans, insects, and, rarely, fish.

Range: The northern harrier breeds from northern Alaska to the northern peninsula of Baja, Mexico, and winters from Canada south to the Caribbean islands.

CNDDB/RareFind/eBird Records: CNDDB reports one nearby occurrence in 2004 just north of Palo Alto of Santa Clara County Airport (CNDDB 2016). The eBird Range Map Database reports multiple sightings on site from multiple locations: the San Francisco Bay Trail-Moffett Field in 2012, 2013, 2014, and 2016; NASA Ames in 2014, Moffett Field in 2012, NASA Ames Moffett Field in 2011; and in Crittenden Marsh/Moffett Field in 1976 through 1985 (Audubon and Cornell Lab of Ornithology 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Historical species surveys at NASA Ames have documented northern harriers foraging at Moffett Field and in the vicinity at the evaporation ponds (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). Suitable nesting and foraging habitat exists in and in the vicinity of the Action Area and other natural areas. Based on their preferred nesting habitat, it is unlikely that northern harriers would initiate a nest within the Removal Action boundary. However, in the event that this species occurs in the vicinity of Removal Action boundary, the conservation measures detailed in Section 2.0 and the USFWS BO (Attachment H-3) would reduce the intensity of effects. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. Conservation measure BIO-9 requires a biologist (will be a USFWS- and/or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds and raptors. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about special status species.

1.3.3.7 White-Tailed Kite

Status: Fully Protected

Habitat and Biology: The white-tailed kite inhabits rolling foothills and valley lowlands or marshes near deciduous woodlands. White-tailed kites nest from February through October in oak, willow, or other dense tree stands near open foraging areas. At NASA Ames, this species has been recorded nesting in coyote brush. The white-tailed kite diet consists mostly of small mammals, birds, small reptiles, insects, and amphibians.

Range: The white-tailed kite is a yearlong resident of California, showing nomadic behavior in response to prey abundance.

CNDDB/RareFind/eBird Records: CNDDB reports five occurrences in Santa Clara County, including Stevens Creek and east of Alviso (CNDDB 2016). The eBird Range Map Database has sightings of white-tailed kites at NASA Ames on the AOI 14 peninsulas, and in the areas of the Eastern and Western Diked Marshes and at Stevens Creek (Audubon and Cornell Lab of Ornithology 2016).

Habitat Suitability and Potential for Occurrence in the Action Area or Other Natural Areas: Historical species surveys at NASA Ames have documented white-tailed kites at NASA Ames. Suitable nesting and foraging habitat exist in and in the vicinity of the Action Area and other natural areas. White-tailed kites have been recorded in the Eastern Diked Marsh exhibiting courtship behavior, and nesting in coyote brush scrub at AOI 14 (Layne and Harding-Smith 1995; Alderete 2004; ERT 2015). To prevent nest initiation and the potential for take under the Migratory Bird Treaty Act (MBTA), coyote brush at the secondary contractor staging area (Figure 3) was cut prior to nesting season in 2017. In the event that this species occurs in the vicinity of Removal Action boundary, the conservation measures detailed in Section 2.0 and the USFWS BO (Attachment H-3) would reduce the intensity of effects. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. Conservation measure BIO-9 requires a biologist (will be a USFWS- and/or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds and raptors. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about special status species.

1.3.3.8 Protections for Other Special Status Species that Could Potentially Occur within the Action Area or Other Natural Areas

The remaining species listed in Table 1 either have little to no potential to occur at NASA Ames, or it was determined that the effects of the Removal Action would be temporary and likely be so low as to be negligible. For example, for bats or birds such as the Swainson's hawk and black skimmer, the Removal Action will not result in removal or disturbance of nesting habitat.

Although species may forage in the SWRP or the Eastern and Western Diked Marsh and noise and visual disturbances from the Removal Action may disrupt foraging behavior, the effects would be temporary. Nonetheless, the conservation measures listed in Section 2.0 and the USFWS BO (Attachment H-3) will afford protections to special status species that may occur in or in the vicinity of the Action Area or other natural areas during project activities. Vegetation removal and ground disturbance will be limited to the FSFA peninsula. BO conservation measures that address noise reduction and haul traffic restrictions will reduce the effects of noise on communications and foraging behavior. Conservation measure BIO-9 requires a biologist (will be a USFWS- and/or CDFW-approved biologist) to survey for bird nests within the Action Area and all natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6) and to monitor for disruption of incubation activities. BIO-10 details work limit buffers for nesting birds and raptors. Environmental awareness training (conservation measure BIO-4) will be provided for all staff, which will include information about special status species. The installation of non-lethal anti-perch devices along the SWRP perimeter fence will reduce perching habitat for predators and will benefit songbirds and small mammals that may occur in the area. The Removal Action and habitat restoration will increase the amount of wetland and pickleweed habitat on site and will include restoration of upland habitat within the FSFA. Lastly, the Removal Action is expected to exert a long-term beneficial effect on all species addressed in this plan, resulting from removal of contaminated sediment and soil that could bioaccumulate in the food chain.

1.3.4 SPECIES NOT LIKELY TO OCCUR

The following species from Table 1 have been eliminated from further consideration in this plan because they are not likely to occur in the Action Area or other natural areas, and the project is not likely to adversely affect these species.

California Red-Legged Frog: The federally threatened and species of special concern California red-legged frog (*Rana draytonii*) inhabits lowlands and foothills in or near permanent sources of deep fresh water with dense, shrubby, or emergent riparian vegetation and may aestivate in rodent burrows or cracks during dry periods. The Action Area and other natural areas have no suitable habitat for this species, and previous surveys have documented no California red-legged frogs or suitable habitat at NASA Ames (Scott and Alderete 2001). Water sources at NASA Ames are too saline or seasonal (ERT 2015).

California Tiger Salamander: The Central Valley distinct population segment of California tiger salamander (*Ambystoma californiense*) is federally and state-listed threatened; the Santa Barbara and Sonoma County populations are federally listed endangered. This species is restricted to grasslands and low foothills with seasonal water sources for breeding. The Action Area and other natural areas have no suitable habitat for this species, and previous surveys have documented no California tiger salamanders or suitable habitat at NASA Ames (Scott and Alderete 2001). Water sources at NASA Ames are too saline or seasonal (ERT 2015).

Vernal Pool Tadpole Shrimp: Vernal pool tadpole shrimp (*Lepidurus packardi*) are federally endangered and a species of special concern, and require vernal pools for all stages of their life cycle. No vernal pools occur within the Action Area and other natural areas, or NASA Ames (ERT 2015).

Delta Smelt: Delta smelt (*Hypomesus transpacificus*) occur in San Francisco Bay and are federally threatened and state endangered. The Action Area and other natural areas have no surface hydrologic connection with the bay and no suitable habitat for this species. The Navy IR Site 25 SWRP is completely cut off from tidal input, and Northern Channel is a storm channel managed for stormwater flow that only flows east into Moffett Channel and ultimately Guadalupe Slough; water control structures (gates and pumps) prevent backflow from the bay into Northern Channel (ERT 2015).

Steelhead: Steelhead (*Oncorhynchus [=salmo] mykiss*) are federally threatened. This species requires freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Steelhead can be found throughout San Francisco Bay when migrating and can be found locally in Stevens Creek (CDFW 2016; EDAW et al. 2007). The Action Area and other natural areas have no surface hydrologic connection with the bay or Stevens Creek and no suitable habitat for this species.

Bay Checkerspot Butterfly: The Bay checkerspot butterfly (*Euphydryas editha bayensis*) is federally threatened and occurs in native grasslands on serpentine soils in the vicinity of San Francisco Bay. *Plantago erecta* is the primary host plant (CDFW 2016; USFWS 2009). The Action Area and other natural areas have no suitable habitat for this species, and *Plantago erecta* has not been recorded on site (ERT 2015; SAIC 1999).

San Bruno Elfin Butterfly: The San Bruno elfin butterfly (*Callophrys mossii bayensis*) is federally endangered and inhabits coastal grassy mountainous areas near San Francisco Bay, on steep north-facing slopes at elevations greater than 500 feet above MSL and that contain populations of host plant stonecrop (*Sedum spathulifolium*) (CDFW 2016; USFWS 2010b). The Action Area and other natural areas have no suitable habitat for this species, and stonecrop has not been recorded on site (SAIC 1999).

California Seablite: California seablite (*Suaeda californica*) is federally endangered and has a California Rare Plant Rank of 1B.1 (plants rare, threatened, or endangered in California and elsewhere). The 2010 USFWS 5-Year Review notes that this species is likely extirpated from the San Francisco Bay area; its last confirmed occurrence in the San Francisco Bay area was from a 1958 collection (USFWS 2010a). One CNDDB record from a 1971 Wicksten collection from the salt flats of Palo Alto notes that this location is likely extirpated (CDFW 2016). Four locations of reintroductions are within San Francisco Bay, with none in the vicinity of the Action Area or other natural areas (USFWS 2013). Previous vegetation surveys of the project footprint and a recent site walk confirmed no presence of this species (Alderete 2013a).

Salt Marsh Wandering Shrew: The salt marsh wandering shrew (*Sorex vagrans halicoetes*) is a state species of special concern. This species requires continuously moist soils and dense pickleweed with driftwood or wrack on which to build nests. This species has not been recorded at NASA Ames and is not known to occur in diked marshes (Layne and Harding-Smith 1995; ERT 2015; Goals Project 2000). If this species were to occur in Crittenden Marsh, the conservation measures targeted for salt marsh harvest mouse would similarly afford protections to the shrew. Additionally, the removal of contaminated soil and sediment would benefit any shrews that could occur, by removal of contaminants from the food chain and the increased pickleweed habitat created from site restoration.

2.0 PROPOSED CONSERVATION MEASURES

The conservation measures detailed below and in the USFWS BO (Attachment H-3) are incorporated into the project description and are considered part of the Removal Action (sampling, analysis, excavation, and restoration). The measures were developed to avoid and minimize effects to protected species, including both federal- and state-listed and special status species. Measures developed in conjunction with the USFWS specifically for federally listed species were formalized in the project BO and in Attachment H3 (USFWS 2017). State species measures detailed in Section 2.2 were developed in conjunction with CDFW specifically for state-listed and special status species, and incorporate CDFW recommendations and requirements for additional protection of species and habitats. The measures detailed in Section 2.2 are additional protections; the BO conservation measures take precedence in all cases and for all activities. NASA, as the lead agency, is responsible for ensuring that the project work adheres to the conservation measures of the BO and this *Protected Species Mitigation and Habitat Restoration Plan* (PSMHRP).

The project footprint and Action Area referenced in the measures below are defined in Sections 1.2 and 1.3 (respectively), and are as follows: The Action Area encompasses the approximately 9.5-acre project footprint (the approximately 8-acre Removal Action area plus approximately 4 feet beyond the Removal Action area exclusion fence to include vegetation/pickleweed removal areas, the approximately 0.5-acre primary project staging and laydown area, and the approximately 1.0-acre secondary project staging and laydown area), and an additional area extending 700 feet beyond the project footprint. The Action Area is shown on Figure 3 and the vegetation/pickleweed removal areas are shown on Figure 4. The final project footprint will be based on the results of site characterization sampling, which may result in a smaller excavation footprint, but not larger than what is depicted in Figure 4. Wetlands and burrowing owl preserves located in the vicinity of the haul routes are depicted on Figure 6.

Federally or state-listed and special status species that could occur at NASA Ames would also benefit from additional BMPs detailed in the project SWPPP (Appendix F of the RAWP), which is designed to minimize pollution, contain contamination, and control erosion. The SWPPP includes general spill containment procedures and requirements, and the contractor will develop and implement site-specific material management and spill containment procedures to ensure that any accidental spills will not enter natural areas. The SWPPP details decontamination procedures and requirements; equipment decontamination will occur in uplands, and decontamination fluids

will be contained and prevented from entering natural areas and jurisdictional wetlands and Waters of the U.S.

2.1 USFWS MEASURES

Conservation measures required for protection of federally listed species are detailed in the USFWS BO (Attachment H-3). Those measures detail the roles and responsibilities of NASA and the USFWS-approved biologist, general conservation measures, habitat restoration measures and restoration performance criteria, and species-specific measures for the salt marsh harvest mouse, western snowy plover, California least tern, and California clapper rail.

2.2 STATE-LISTED AND SPECIAL STATUS SPECIES AND MBTA-SPECIFIC MEASURES

The general conservation measures detailed in the BO (Attachment H-3) (BO-6 through BO-21) will also benefit and protect state-listed and special status species and their habitats. Other additional conservation measures specific to state-listed and special status species not included in the BO are detailed below.

BIO-1 At least 15 days prior to the onset of any construction-related activities or species survey activities, NASA shall submit to the CDFW for approval the name(s) and credentials of biological monitors it requests to conduct activities specified for this project.

BIO-2 The CDFW-approved biologist(s) will have stop-work authority in the event of non-compliance with the conservation measures, and if deemed necessary to protect state-listed and special status species.

BIO-3 In addition to the reporting requirements stipulated in the BO, the CDFW-approved biologist will report findings to NASA daily. The qualified biologist shall complete a monitoring report for each day of monitoring that will include the date, location, biologist's name, remedial activities occurring, listed and special status species observed, species behavior in relation to remedial activities, and any corrective measures taken to protect such species. NASA will submit the biological monitoring reports to CDFW weekly for the duration of project activities. Sightings of any listed or sensitive animal species shall be reported to CNDDB (https://www.wildlife.ca.gov/Data/CNDDB).

BIO-4 In addition to the environmental awareness training requirements stipulated in the BO (BO-3), the training module will include information on compliance with state regulations (California Endangered Species Act and California fully protected species statutes) and measures to protect state special status species (California black rail, white-tailed kite, burrowing owl, nesting birds, and rare plants). Due to the difficulty of field identification to species level, any mouse sighted will trigger

the conservation measures for the salt marsh harvest mouse, and those measures will remain in place until the mouse leaves of its own volition. Vegetation removal methods will also be addressed and will detail requirements of the BO, and field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

BIO-5 In addition to the BO requirements to prevent spread of invasive species detailed in BO-12, foot traffic will use upland routes covered with pavement or bare ground to the maximum extent practicable, avoiding areas of native vegetation.

BIO-6 In addition to the vehicular traffic requirements stipulated in the BO (BO-14), the CDFW-approved biologist will delineate appropriate areas along the haul routes for pullouts; pullouts will avoid the burrowing owl preserves shown on Figure 6.

BIO-7 In addition to the notification requirements for wildlife injury or mortality stipulated in the BO (BO-21), NASA will report the incident to CDFW within 24 hours of its occurrence by telephone and email. NASA will follow up with written notification to CDFW within 5 working days of the incident by providing a hardcopy of the incident report. For injured wildlife, NASA will contact Wildlife Emergency Services (866-945-3911 [866-WILD-911]) for assistance in locating the nearest appropriate licensed local wildlife rehab center for transport and medical care.

BIO-8 In addition to the vegetation clearing requirements stated in the BO (BO-27), vegetation removal that is to be conducted by hand (pickleweed areas and vegetation within 50 feet of pickleweed) will use non-motorized hand tools.

BIO-9 **Wildlife Surveys**: The USFWS- and/or CDFW-approved biologist will conduct surveys for state-listed and special status species. Survey areas will include the project footprint, Action Area (which includes a 700-foot buffer that extends beyond the project footprint), and all other natural habitats occurring within 500 feet of the haul routes and contractor trailer area (wetlands and burrowing owl preserves shown on Figure 6 in the PSMHRP). The contractor trailer area will be surveyed upon initial setup and as needed, as determined by the biologist. Haul routes that are in developed areas and not within 500 feet of habitat will not be surveyed.

Surveys will occur according to the following schedule: pre-construction surveys will be conducted within 14 days prior to onset of project activities or return to work activities; surveys will be repeated no more than 3 days prior to work activities or project restart and then at least twice weekly during the nesting season (February 1 to September 15) to identify active nests.

BIO-10 **Work Limit Buffers**: If nesting birds are observed during focused surveys, CDFW and USFWS shall be notified and the nest locations identified on a map. No project activity shall occur near identified active nests for the following species and buffer distances until the young have fledged (as determined by a USFWS- or CDFW-approved biologist) or until the NASA receives authorization from CDFW and USFWS to proceed:

- 500 feet of an active white-tailed kite nest
- 250 feet for other raptor nests
- 500 feet for California black rail nests
- 600 feet for burrowing owl nests
- 100 feet for other non-listed birds protected under the MBTA.

If the USFWS- or CDFW-approved biologist and CDFW determine the project activities are not likely to adversely affect the nest, CDFW may authorize NASA to proceed. The USFWS- or CDFW-approved biologist shall remain on site during work activities to monitor the activity of the nesting birds. If the birds behave normally, the USFWS- or CDFW-approved biologist shall monitor them twice per week to ensure that the status has not changed. If the birds change their behavior as a result of work activities, the USFWS- or CDFW-approved biologist shall continue to monitor the birds as work activities are altered or relocated a greater distance (as feasible) from the nest until the birds behave normally. The USFWS- or CDFW-approved biologist shall then monitor the birds twice per week to ensure that the status does not change. The impact of construction activity on nesting birds depends on whether the birds can see the activity, their tolerance for visual movement, and levels and duration of construction-related noise. Through consultation with CDFW, measures will be developed to minimize further impacts to nesting birds. Buffers may be modified depending on results of nest monitoring and whether the project activity is affecting behavior. If activities result in "take" under the MBTA due to abandonment, the USFWS migratory bird office will be contacted to determine the appropriate course of action.

BIO-11 Vegetation containing bird nests that must be removed as a result of project implementation shall be removed during the non-nesting season (September 16 to January 31). Active nests may not be moved at any time under the MBTA.

BIO-12 At the discretion of the USFWS- or CDFW-approved biologist, in the event that active burrowing owl burrows are observed in close proximity to the haul routes, temporary wildlife exclusion fencing and/or noise barriers may be placed along the road edge to act as a visual, noise, and safety barrier to burrowing owls. All fencing

and noise barrier activities must be coordinated with the state species-experienced biologist.

BIO-13 Exclusion material will be installed at entrances of burrows atop the FSFA peninsula to prevent burrowing owls from establishing nests. Prior to installing exclusion material, the USFWS- or CDFW-approved biologist will inspect the burrows for presence of wildlife, including eggs and young, to ensure they do not become trapped in the burrows.

BIO-14 The USFWS- and/or CDFW -approved biologist will conduct surveys for state and special status plant species. If a rare plant species is observed, CDFW and USFWS will be notified and NASA will coordinate appropriate avoidance, minimization, and mitigation measures with these agencies. The USFWS- or CDFW-approved biologist will direct the contractor on how to proceed accordingly.

3.0 PROPOSED RESTORATION MEASURES

The following sections describe restoration actions to be taken to restore upland, transitional, and wetland habitats after completion of Removal Action activities. Pickleweed will be mitigated at a 3:1 ratio as required for impacts to salt marsh harvest mouse and stated in the project BA and BO (Tetra Tech 2017; USFWS 2017). Areas of anticipated pickleweed disturbance are shown on Figure 4. It is assumed that up to 0.62 acre of pickleweed will be disturbed, and based on a 3:1 mitigation ratio, a minimum of 1.86 acres of pickleweed habitat will be restored. Final acreages of impacts will be delineated after completion of excavation activities.

Proposed restoration actions described below include recommendations for site preparation, plant palettes according to habitat type, and methods for plant installation, maintenance, and monitoring. The term “restoration areas” used hereafter refers to the areas where Removal Action excavation occurs (conceptually shown on Figure 9), the access road of the FSFA, and staging and laydown areas.

Conceptual final grade elevation

Current Topographic Contour (0.5-foot interval)

Apparent artificial fill boundary inferred from geophysical survey

Removal Action Boundary

Pickleweed Restoration Area (0.5 to 3.0 ft above MSL)

Transitional Vegetation Restoration Area (3.0 to 5.0 ft above MSL)

Upland Vegetation Restoration Area (Greater than 5.0 ft above MSL)

Notes:

AOI	Area of Investigation
ft	Feet
MSL	Mean sea level
NASA Ames	National Aeronautics and Space Administration Ames Research Center

TETRA TECH

NASA Ames Research Center
Moffett Field, California

Figure 9

Grading and Site Restoration Conceptual Plan

Protected Species Mitigation and Habitat Restoration Plan

3/10/2017 V:\NASA\Projects\011_Mitigation_Restoration_Plan\09_grading_plan.mxd TtEMI-ABQ simon.cardinale

3.1 SITE PREPARATION

The final grading plan will be determined based on the amount of soil requiring removal. A site conceptual grading plan is shown on Figure 9. Site grading will minimize areas with elevations below 0.5 feet above MSL and will maximize areas with elevations suitable for wetland and transitional habitat (0.5 feet to 5 feet above MSL). The final grading plan will be designed to maximize the area of pickleweed growth to meet the 3:1 restoration requirement outlined in the project BA (Tetra Tech 2017). Site grading will incorporate wide swaths of low elevation areas (1.0 to 3.5 feet above MSL) to accommodate pickleweed growth. The pickleweed restoration area will be graded to match the elevations that currently support pickleweed in the SWRP. The excavation areas that are within the stormwater pond bottom may not be included in the pickleweed restoration acreage. Pickleweed currently occurs in the SWRP at elevations ranging from 0.5 to 3.5 feet above MSL, and along the slopes of the FSFA up to 5 feet above MSL. The transition from SWRP bottom to the upland portion of the restoration will be sloped. Slopes will be graded at a minimum 3-percent slope to promote drainage, to a maximum 25-percent slope. Final grading will create a rough, undulating surface and will avoid creating a smooth planar surface.

Micro-topography created by surface roughness promotes water infiltration and seedling establishment by creating small areas of protection from wind and sun. Natural debris such as wood or other weed-free organic litter will be spread as available, throughout the pickleweed restoration area (1.0 to 3.5 feet above MSL) to promote deposition of floating pickleweed seeds recruiting from the surrounding SWRP. Pickleweed removed during the excavation (and free of contaminants) may also be sparsely transplanted in the lower elevations (0.5 to 2 feet above MSL) to create micro-topography, added as mulch to the pickleweed restoration area surface, or incorporated into the upper 12 inches to add organic matter. The application of pickleweed mulch to the soil surface has been shown in studies to enhance overall pickleweed colonization (Miles et al. 2015).

Soil for final grades and for the seedbed will be uncontaminated soil from within the Removal Action boundary. If possible, the soil from areas dominated by natives (pickleweed, alkali heath, saltgrass, etc.) will be salvaged and stockpiled for use in final grading and restoration. Ideally, the upper six inches of soil after final grading will have fine texture and greater organic matter compared to the coarser-textured soils at depth.

Prior to planting, soil testing will be conducted in the restoration site and in areas within the SWRP that support pickleweed. Soil testing of restoration site soils for soil texture, nutrients, organic matter, nitrogen, phosphorous, potassium, pH, and salinity will support restoration success by providing information on deficiencies that would limit plant and seedling establishment and that could be readily corrected. Sample collection within SWRP wetland (pickleweed) habitat will occur in areas having at least 75 percent pickleweed cover. Soil samples will be collected from the restoration site wetland, transitional, and upland zones. Three samples will be collected from each habitat zone within the restoration area (wetland, transitional, and upland); each sample will consist of a 3-point composite, collected to a depth of 6 inches. Three 3-point composite samples will also be collected from the SWRP pickleweed areas. Samples will be sent to an agricultural laboratory to determine if soil amendments or soil import are needed. Soil samples collected from

the SWRP will provide targets for suitable nutrient levels, organic matter, and texture for the pickleweed restoration site soils.

Based on soil data from pickleweed marsh at the Point Mugu estuary in Ventura County, and on a study of controlling factors for pickleweed distribution and abundance in other California marshes, the conditions that support pickleweed are summarized below (Griffith 2010; FGL Environmental 2015; Miles et al. 2015).

Salinity: Pickleweed favors saline soils (10 to 90 parts per thousand) and vertical movement of water with wet and dry seasons. To facilitate similar conditions at the SWRP, the final restoration site topography must allow water from the SWRP to saturate the restoration site soils. Pickleweed prefers saturated but well-drained sediments, and cannot tolerate prolonged inundation. The topography must be such that prolonged ponding is avoided if possible. Due to the function and design of the SWRP to accumulate stormwater runoff, this may not be practicable during wet winters. However, grading will incorporate a variety of low to high marsh elevations to accommodate pickleweed growth during the wet and dry seasons.

Soil particle size: Final grading will incorporate soils with finer particle size such as silts and clays that increases water-holding capacity of soils, allowing water to accumulate, evaporate, and induce moderate to high salinity. Final grading will avoid using only coarse soils such as gravel and sand in the upper 6 inches. Based on soil data from the Point Mugu estuary, pickleweed grows in loam to clay loam soils. Other studies of California marshes indicate pickleweed occurs in sediments containing less than 30 percent sand. Pickleweed areas of the FSFA that are slated for excavation and that contain clean (of contaminants) soils could be salvaged and incorporated into the final grading as they likely contain finer grained soil particles. Alternately, fine-grained soils (that are clean of contaminants) may be imported.

Nutrient-rich water: Pickleweed favors nutrient-rich water inputs. The final grading will accommodate some influx of nutrient-rich water from the SWRP by incorporating a variety of low to high marsh elevations to support pickleweed during the wet and dry seasons.

Organic matter: Based on soil data from the Point Mugu estuary, pickleweed grows in soils with organic matter content ranging from 2 to 10 percent. Other California marsh studies indicate that sediments supporting pickleweed growth contain between 10 and 40 percent organic matter, with San Francisco Bay pickleweed-dominated marsh soils containing 20 to 25 percent organic matter. Sources for organic matter include the FSFA; clean pickleweed could be salvaged and incorporated into the upper 6 to 12 inches of soil. Other sources of organic matter include biochar, kelp compost, HydroPost, or peat moss.

The staging areas and access road of the FSFA will likely have areas devoid of vegetation and compacted soils from equipment traffic. These areas with compacted soils will need the soils loosened prior to seeding and planting by deep tilling or scarification to depths of 6 to 12 inches. De-compaction should be conducted when the soils are dry. Prior to seeding, weed-free compost (such as HydroPost, biochar, or kelp compost) will be spread over the area and incorporated into the upper 2 inches of soil.

Site preparation of the upland areas of the FSFA will require weed treatment prior to planting and seeding because of the dominance of non-native plant species on and around the site. Weed treatment methods are described in Section 4.1.1 and will focus on removal of invasive species. Prior to planting or seeding, weed species listed on the California Invasive Plant Council (Cal-IPC) invasive species inventory with a ranking of "high" or with "highest priority" and "high priority" rankings for control by the USFWS South San Francisco Bay Weed Management Plan will be treated with an herbicide approved by the EPA and applied by a California Department of Pesticide Regulation Certified Qualified Applicator according to product labels (Marriott et al. 2013). Restoration of native vegetation to the upland areas will require regular monitoring and treatment of weeds (addressed in Section 4.1). The FSFA upland areas that will be enclosed by the exclusion fence and not directly impacted by Removal Action activities will be regularly mowed during the sampling and excavation phases, and will follow the BO conservation requirements (BO-18 and BO-27) for vegetation removal. These upland areas are dominated by non-native vegetation and will be mowed as necessary until restoration activities take place to prevent non-native plants from setting seed.

3.2 SEEDING AND PLANTING

Restoration will employ a combination of seeding and planting. Seeding and planting will be conducted in October, prior to winter rains. Commercial seed has the advantage of costing less than mature plant material. Disadvantages include variable germination rates and times of individual species, vulnerability of seedlings to desiccation from insufficient or irregular irrigation, and vulnerability to seed herbivory and wind transport. Container plants are more expensive than seed but have the benefit of aiding seedling establishment by shielding seedlings from wind and sun. The use of container plantings may also speed restoration goals by reaching native cover targets sooner. Where feasible, NASA will revegetate restoration areas with pickleweed cuttings and seed harvested from salvage areas within the Removal Action boundary and grown and propagated in an off-site nursery. If additional pickleweed is needed for the restoration areas, it may also be collected from other areas in the SWRP and may be supplemented with additional nursery seedlings and seed, as necessary. The specific limits of the pickleweed harvest areas will be identified and staked by the restoration biologist in coordination with a USFWS-approved biologist(s) prior to initiation of harvesting activities, and boundaries will be recorded with a GPS unit for documentation. Pickleweed will be collected by crews on foot and using non-motorized hand tools. No disturbance to pickleweed-vegetated areas outside of the designated harvest areas will be permitted. Harvesting that occurs outside the Removal Action boundary will be in a dispersed manner and occur outside IR Site 25 restoration and reference areas. No more than 30 percent of pre-collection pickleweed cover will be collected from source areas.

Commercial seed is often sourced from many locations throughout coastal California. If possible, plants and seed will be sourced from the San Francisco Bay region, as close to NASA Ames and the Stevens Creek watershed as possible, to protect the genetic integrity of the surrounding habitat. Given sufficient lead time, commercial nurseries and seed suppliers are usually able to provide sufficient numbers of required species. Commercial seed will be certified weed-free. For pure live seed, a minimum of 50 pounds per acre is recommended; if pure seed is used, a minimum of 100 pounds per acre shall be applied. The goal of dense seeding is to crowd out invasive species

that may try to establish. Seed may be distributed by drilling, hand-broadcast, or hydroseed. Follow-up seeding shall be conducted by hand, if site inspections and monitoring determine supplemental planting and seeding necessary. Hand-seeded areas will be raked to incorporate seed into the top 0.5 inch of soil, and will be covered with certified weed-free rice straw mulch. It is recommended to plan for up to 2,000 pounds of straw mulch per acre. Mulch protects seeds from herbivory and moisture loss. Seed should be dispersed in the rainy season or just prior. Most seed is lost to herbivory when applied during the dry season and without mulch or supplemental irrigation. To create a mosaic pattern of vegetation on site, distribution is better controlled by spreading species individually rather than using a seed mix. An advantage of this method is minimizing the effects of allelopathy, which can inhibit successful germination of some species when multiple species are sown together.

For container plants, nurseries specializing in native plants with at least 3 years of experience in native plant propagation, especially salt marsh species, should be used. Additionally, their growing methods should include sun and salt hardening measures to reduce transplant shock for species planted at the lower elevations of the site. The use of tall pots as opposed to traditional black nursery pots is recommended to promote vertical root development. The number of container plants needed will depend on the final grading plan. If container plants or plugs are to supplement seeding, a sparse planting density could be used. For planning quantities, herbaceous plants could be spaced at 4 to 6 feet on center and shrubs at 8 feet on center, or alternatively, install groupings of natives using smaller spacing interspersed with seeded areas. The planting scheme should mimic the natural mosaic pattern of vegetation communities, with groupings of species rather than linear installations.

Fertilizers are generally not recommended or required for California native plants as they tend to promote fast-growing weeds that will outcompete native seedlings. Hydroseed mixes can be combined with organic matter and inoculated with mycorrhizal fungi to aid establishment. The soil around plantings (if container plants are installed) could also be amended with kelp compost or biochar.

If container plants are installed, certified weed-free mulch (straw or wood) will be added around plantings to minimize weeds. Weed-free straw or other mulch placed around each upland planting minimizes weed establishment and retains soil moisture. Creation of small berms around each plant also helps to retain soil moisture by acting as a catchment basin and preventing runoff. Plantings will be inspected for herbivory, and protective devices such as fencing around plantings will be installed as needed or at the time of plant installation.

The following sections detail plant palettes using a variety of species; final plant palettes for the upland and transitional habitats will likely have fewer species based on nursery availability. Upland and transitional plant palettes include a variety of species to restore these zones with diverse vegetation for refuge for the salt marsh harvest mouse. Additionally, commercially available seed or plant stock may not be available for some species, so a variety of appropriate species suited to South San Francisco Bay are listed. The wetland plant palette is restricted to species that can tolerate a range of salinity and inundation and includes species that may be impacted by project activities and provide habitat for the salt marsh harvest mouse.

Restoration and monitoring staff will comply with habitat and species protective measures outlined in Section 2.0.

3.2.1 UPLAND HABITAT

Pre-Removal Action conditions on the FSFA upland peninsula consist of a ruderal grassland community largely dominated by invasive and naturalized grasses and forbs. The area within the exclusion fencing (Figure 3) will be kept mowed throughout the Removal Action. To discourage re-colonization of invasive species at the FSFA upland restoration area, upland vegetation that is removed as part of the excavation will be transported off site to a landfill that accepts invasive and noxious weeds. The target upland vegetation community is a mix of coastal prairie and coastal sage scrub plant communities. Annuals and perennials, including low-lying shrubs, are included in Table 2. The final plant palette will depend on nursery availability but will target a seed or container mix that contains a plant community composition of 75 percent herbaceous species and 25 percent shrubs or sub-shrubs.

3.2.2 TRANSITIONAL HABITAT

Currently, the FSFA peninsula has limited transitional habitat due to steep slopes along its perimeter. The final restoration grading will include a broad swath of transitional habitat to account for varying water levels and provision of mixed vegetation for salt marsh harvest mouse refuge. The transition zone provides connectivity between high marsh and upland. Based on elevations in the SWRP, the transitional zone ranges from 3 to 5 feet above MSL. In a natural marsh, this area typically has a higher plant species diversity than the wetland due to the gradient of salinity and moisture along the slope. The recommended plant palette reflects this diversity. Final plant palette will depend on availability but will target a seed or container mix that contains a plant community composition of 75 percent herbaceous species and 25 percent shrubs or sub-shrubs.

Table 3 includes rapid-growing, native, early successional species that will serve as “nursery” plants, providing quick cover to outcompete non-natives and shade to other seedlings, and will improve soil conditions by adding organic matter. Based on the potential for variation in soil type and texture in this zone, some species may prefer soils with higher percentages of clays and silts, and others may establish in coarser-textured soils. By introducing a variety of species that are suitable for transitional habitat, the potential for seedling emergence and establishment is increased.

Table 2: Upland Habitat Plant Palette

Species	Name
Achillea millefolium	Common yarrow
Ambrosia psilostachya	Western ragweed
Amsinckia menziesii	Common fiddleneck
Artemisia californica	California sagebrush
Aster chilensis	Pacific aster
Atriplex lentiformis	Big saltbush
Bromus carinatus	California bromegrass
Bromus maritimus	Seaside brome
Calandrinia menziesii	Red maids
Camissonia ovata	Sun cup
Centromadia pungens	Common spikeweed
Danthonia californica	California oatgrass
Deschampsia cespitosa	Tufted hairgrass
Elymus triticoides	Creeping wild rye
Elymus condensatus	Giant wild rye
Epilobium brachycarpum	Annual willow herb
Eriogonum nudum	Naked stem buckwheat
Eriophyllum confertiflorum	Golden yarrow
Escholschzia californica	California poppy
Euthamia occidentalis	Western goldenrod
Festuca rubra	Red fescue
Heliotropium currasavicum	Seaside heliotrope
Hemizonia congesta	Tarplant
Heterotheca grandiflora	Telegraph weed
Hordeum brachyantherum	Meadow barley
Jaumea carnosa	Marsh jaumea
Lotus scoparius	Deerweed
Lupinus bicolor	Annual lupine
L. chamissonis	Beach lupine
L. formosus	Summer lupine
L. succulentus	Arroyo lupine
L. albifrons	Silver lupine
Malvella leprosa	Alkali mallow
Nasella pulchra	Purple needlegrass
Phacelia californica	Common phacelia
Sidalcea malviflora	Checker bloom
Trifolium fucatum	Bull clover
Vulpia microstachys	Annual fescue

Table 3: Transitional Habitat Plant Palette

Species	Name
Achillea millefolium	Common yarrow
Acmispon americanus	Spanish lotus
Ambrosia psilostachya	Western ragweed
Amsinckia menziesii	Common fiddleneck
Artemisia douglasiana	Mugwort
Aster chilensis	Pacific aster
Astragalus tener	Alkali milk vetch
Baccharis glutinosa	Salt marsh baccharis
Bromus maritimus	Seaside brome
Calamagrostis nutkaensis	Pacific reedgrass
Centromadia pungens	Common spikeweed
Distichlis spicata	Saltgrass
Elymus triticoides	Creeping wild rye
Epilobium brachycarpum	Annual willow herb
Eriophyllum confertiflorum	Golden yarrow
Euthamia occidentalis	Western goldenrod
Extriplex californica	California saltbush
Frankenia salina	Alkali heath
Grindelia stricta	Marsh gumplant
Heliotropium currasavicum	Seaside heliotrope
Heterotheca grandiflora	Telegraph weed
Hordeum depressum	Alkali barley
Lotus purshianus	Spanish clover
Madia sativa	Coast tarweed
Malvella leprosa	Alkali mallow
Phacelia californica	Common phacelia
Plantago maritima	Alkali plantain
Salicornia pacifica	Perennial pickleweed
Spergularia marina	Salt marsh sand spurrey
Symphotrichum subulatum	Annual saltmarsh aster
Symphotrichum chilense	Pacific aster

3.2.3 WETLAND HABITAT

Salt marsh vegetation has much lower diversity than transitional and uplands vegetation. The species in Table 4 will be distributed throughout the lower elevations of the site (0.5 to 3.5 feet above MSL). Seeding and planting will avoid elevations below 0.5 feet MSL that will have prolonged inundation. Based on elevations in the SWRP, 0.5 foot above MSL supports sparse cover of pickleweed; it is likely that seed spread at or below 0.5 foot above MSL will not thrive. The elevations shown in green on Figure 9 will be seeded or planted with a dominance of pickleweed (comprising 80 percent of the seed mix or plantings). Pickleweed will be planted or seeded throughout the 0.5 to 3.5 feet zone; alkali heath and saltgrass will be spread in the higher marsh areas, at elevations greater than 2 feet above MSL. All three wetland species also occur in transitional habitat and will be planted (or spread) at a lower density as part of the transitional plant palette, in the 3.5 to 5.0 feet above MSL zone, addressed in Section 3.2.2.

Table 4: Wetland Habitat Plant Palette

Species	Name
Distichlis spicata	saltgrass
Frankenia salina	alkali heath
Salicornia pacifica	perennial pickleweed

Where feasible, the species listed in Table 4 may be transplanted from Removal Action areas to available open habitat in the surrounding SWRP. Methods for transplanting pickleweed and saltgrass are detailed below. Transplants should be taken during cool, cloudy, moist weather when root surfaces will not desiccate during handling. Transplant recipient soils should be moist and have low salinity (less than 20 parts per thousand [ppt]) at the time of transplanting.

Pickleweed rhizome collection:

- Pickleweed transplants are best done during late dormancy in March and April.
- Lift plant from ground and knock off soil.
- Cut rhizome into sections, each with a node or growth point.
- Trim leaves.
- Plant immediately at appropriate depths (original relative depth or set slightly deeper, shallowly buried a few inches).
- Planting surface should be pressed firmly and slightly molded to create a small lip of soil that retains water within the planting.

Saltgrass plug collection:

- Using plug cutter (auger) or sharp spade, collect saltgrass plugs November through March.
- Plugs should be at least 3 inches in diameter and include at least one healthy root and rhizome.
- Plugs should be planted within a few hours of collecting.

4.0 MAINTENANCE AND MONITORING

The following sections present recommended methods and schedule for maintenance, monitoring, and performance criteria. Restoration maintenance and monitoring staff will comply with habitat and species protective measures outlined in Section 2.0.

4.1 MAINTENANCE

Depending on the results of monitoring, adaptive management of the site may include, but is not limited to, invasive weed removal, irrigation, installation of replacement plantings as a result of plant mortality, and supplemental site seeding. These management techniques are discussed below.

4.1.1 INVASIVE WEED REMOVAL

The restoration area will be regularly monitored for weed encroachment by a biologist skilled in identification of California native plants and Cal-IPC invasive species (the restoration biologist). Invasive control will be conducted for species listed on the Cal-IPC inventory (Cal-IPC 2017). At a minimum, during the first 90 days of plant establishment, the site will be inspected twice per month and weeds removed or treated as necessary. Weed removal events could be reduced to once monthly for the remainder of the first year. Quarterly visits would likely suffice for the remainder of the habitat maintenance and monitoring period (5 years or until vegetation performance criteria [Section 4.2.2] are met). However, more frequent inspections and weed removal may be necessary based on weed encroachment and as determined by the restoration biologist.

The upland soils of the FSFA likely harbor a large invasive seedbank based on the abundance of non-native grasses and invasive fennel on site prior to the Removal Action. Regular aggressive weed control measures for the upland restoration area will be conducted during the habitat maintenance and monitoring period to support sustainable vegetation cover by natives. Weed control measures will include the following: manual or mechanical removal (especially prior to flowering and seed production) via hand-pulling, removal using a weed wrench, or cutting of flowering parts using a weed-whacker or mower; herbicide treatment (prior to flowering and seed production); or solarization using black plastic, as approved by the USFWS-approved biologist. Weed control should be tailored to the species targeted for removal, referencing methods outlined

by Cal-IPC or the USFWS South San Francisco Bay Weed Management Plan (Cal-IPC 2017; Marriott et al. 2013).

Weed eradication efforts will be tailored to the specific infestation, with manual removal or spot treatments employed where possible. Large infestations or occurrence of aggressive invasive species may require treatment with herbicide. With all removal strategies, care must be taken to avoid impacts to native vegetation. Should chemical control be used, the State Water Resources Control Board regulates the use of herbicides in or near wetlands and Waters of the U.S. and has adopted a general permit for the discharge of pesticides to Waters of the U.S., Permit 2013-0002-DWQ. The discharge must be in compliance with this permit. An herbicide approved by the EPA for use in aquatic systems must be used and applied by a California Department of Pesticide Regulation Certified Qualified Applicator and according to product labels. Prior to herbicide application, treatment areas must be surveyed by a USFWS-approved biologist to ensure that no impacts to protected species will occur. This biologist will remain on site during treatment as deemed necessary.

4.1.2 IRRIGATION

Plants and seed will require supplemental irrigation during the first year of establishment. The success of seeding without an overhead irrigation system will largely depend on the time of application and winter precipitation. Seeding should occur just prior to winter rains, in October. Container plants will require irrigation upon installation and until establishment. Planting container plants in the rainy season (mid-October through March) is the preferred method for California natives. Planting in the rainy season will minimize the need for irrigation and allow coastal scrub plants to become somewhat established prior to their normal times of foliage dieback in the summer drought. Wetland species planted in the lower elevations (0.5 to 1.0 feet above MSL) may not require irrigation beyond initial planting or seeding, depending on site conditions. The need for regular irrigation in these areas will be determined by assessing soil moisture at the time of irrigating the upland habitat. The species selected for planting within the upland coastal scrub and transitional habitats are drought tolerant; however, they will likely require supplemental irrigation during the first year of establishment.

Irrigation to plants or seed may be in the form of a temporary irrigation system, water truck, or (for plantings only) DriWater. Temporary irrigation systems deliver overhead spray or (if only container plants are installed) drip irrigation. The irrigation line would require connection to a hydrant in the vicinity of the FSFA. Container plants can also be irrigated manually via hoses from a water truck. DriWater is a biodegradable product that breaks down into water upon contact with soil enzymes. Water is slowly released from the carton for a period of 90 days. At the end of 90 days, the carton can either be pulled out of the ground or left to decompose, which takes 6 months to 1 year (DriWater 2017).

Plantings should receive water (rainfall or irrigation) once weekly for the first 2 months, decreasing to three times per month for the following 4 months, then decreasing to twice monthly for 4 months, and once monthly for the final 2 months. The determination of irrigation need and an irrigation schedule will be made on site as a result of observation of weather patterns and plant

vigor and the timing of installation. Soil moisture will be monitored using an auger or probe and adjustments to the schedule made accordingly.

Supplemental irrigation will be discontinued as soon as possible after plants have become established, at the discretion of the restoration biologist and depending on the timing of replacement planting or seeding. The irrigation schedule can be reduced in response to winter rains, but plantings and seedlings will require irrigation through the first year at a minimum. Studies conducted on long-term irrigation in high marsh and upland transitional habitat plantings have shown an increase in the likelihood of exotic plant invasions because of the resultant lowered soil salinities and high soil moisture (Zedler 2001). Continuous supplemental irrigation of native species can also result in the luxury uptake of nutrients that cannot be sustained under natural conditions. Irrigation can promote immediate success for seedling establishment, but presents long-term problems in survivorship after the irrigation ceases (Barbour et al. 2007). During plant establishment in all habitat types across the site, soils will be allowed to dry out between moisture events, which will promote deep root growth (Zedler 2001).

4.1.3 REPLACEMENT PLANTING

Based on annual mortality during the first 3 years, replacement plantings will be installed as necessary and within the budgeted allotment for replacement caused by mortality. Typically, 30 percent mortality is projected in initial restoration calculations and budgets, with the extra amount installed as needed over the duration of the project. The final restoration plan and budget for plant material and installation should account for replacement costs of approximately 30 percent of originally installed material. In some cases, and depending on the time of year and availability of seed, manual seeding may be an option to fill in areas that are slow to revegetate. Supplemental seeding may also be required, based on site inspections and annual monitoring. Supplemental seeding will be conducted by hand and seed will be raked in and covered with mulch, as detailed in Section 3.2.

4.2 MONITORING AND PERFORMANCE CRITERIA

The following sections address monitoring methods and performance criteria.

4.2.1 MONITORING AND ADAPTIVE MANAGEMENT

Habitat restoration site monitoring supports adaptive management by identifying restoration progress and stressors that may require corrective action. It is recommended that habitat restoration monitoring include data collection from a nearby reference site. Reference site data are used to evaluate whether the restoration site is providing habitat functions at or near the level of the reference site. Concurrent monitoring of the reference site will provide data and benchmarks that can be used to measure restoration success. Reference site data also provide information related to the occurrence of regional or site-specific stressors. Stressors evident in the reference site that also occur in the restored site could indicate regional conditions either beyond the control of local management or that require NASA to undertake necessary and feasible corrective actions.

Stressors evident in the restored site but absent from the reference site would warrant adaptive management actions to alleviate the stressor within the restoration area. In this way, comparison of results determines whether restoration activities are meeting their objectives and allows for timely implementation of corrective action, if necessary. Based on the analysis of monitoring data, additional restoration needs may be identified, such as site grading, erosion control, planting, irrigation, or weed control.

Reference transect locations should be selected based on the target plant community planned for the wetland and transitional zones; comparative transects should be set across similar aspect, elevation, and topographic gradients as the restoration site, as described below. Reference sites will be selected that represent the best possible conditions within the SWRP, using native species cover as a guideline for selection. Reference site requirements for native cover and pickleweed cover are detailed in Section 4.2.2. Prior to monitoring, reference site species composition and cover data will be provided to CDFW and USFWS for review and approval.

Due to the lack of intact native upland habitat in the vicinity of the site, an upland reference site will not be established. Data from the upland restoration area will be assessed for native cover.

In accordance with the requirements of the BO, harvest impacts to the vegetative cover of the pickleweed collection areas from outside of the Removal Action boundary will be assessed. Harvest areas will be qualitatively assessed using photo-documentation (pre- and post-harvest). At the discretion of the restoration biologist, and depending on the amount of harvesting that occurs within the SWRP, permanent vegetation monitoring plots may be established in representative harvest areas and monitored concurrently with restoration site monitoring.

Monitoring will include qualitative and quantitative assessments, as detailed below.

Site Visits: The restoration biologist will conduct a site visit every 2 weeks during the first 3 months and monthly thereafter for the remainder of the first year of monitoring. At the discretion of the restoration biologist and depending on site conditions (revegetation success or weed encroachment), site visits may be reduced to quarterly for the reminder of the monitoring period. These site visits may coincide with irrigation or weed control visits. The restoration biologist will inspect the site for regeneration of native vegetation and issues that may require corrective action such as erosion and invasive species.

Photo-documentation: Prior to Removal Action activities, after restoration, and during scheduled site visits and annual monitoring, a biologist (may be a USFWS- or CDFW-approved biologist or the restoration biologist) will document site progress by taking digital photographs at designated photo-monitoring locations. A minimum of four locations will be established at each restoration area, which includes the Removal Action excavation area (conceptually shown on Figure 9), the access road of the FSFA, and staging and laydown areas. Annual monitoring will also include photo-documentation of conditions at the reference site(s). To document success over time, photographs will be taken facing the same direction each year and using compass bearings to document each direction.

Pickleweed harvest areas (outside the Removal Action boundary) will be qualitatively assessed using photo-documentation (pre- and post-harvest) at designated photo monitoring locations that will be established at the time of harvest.

Vegetation Monitoring: The final selection of reference sites and the number and layout of transects will depend on the final grading plan and size of each habitat. Vegetation assemblages vary across a gradient of elevation, moisture, and soil condition (salinity, organic matter, nutrients, etc.). For these reasons, it is recommended that vegetation monitoring employ a stratified-random sampling approach within the wetland and transitional zones, with transects set across the moisture and elevation gradient. The upland habitat transects should cross the width of the upland zone. Permanent transects are to be established during the first year of monitoring and surveyed annually in the summer by a restoration biologist.

The vegetation monitoring design may be finalized by the restoration biologist conducting annual monitoring. The following are recommendations for a monitoring program. The protocol outlined below is designed to evaluate three plant community parameters: (1) plant species diversity, (2) community physical structure, and (3) invasion of non-native species. A minimum of nine permanent 20-meter transects should be established throughout the restoration site (at least three per habitat type [wetland, transitional, upland]), with an equal number placed in the wetland and transitional reference locations (three per habitat type [wetland and transitional; no reference upland transects are required]). Transects set in the wetland and transitional zones (and the associated reference transects) should be set along a moisture and elevation gradient, from foreshore to high marsh for the wetland transects, and from high marsh to upland for the transitional transects. In this method, each 20-meter transect is considered a sample unit; during each monitoring event, ten 1-square-meter quadrats are randomly placed along the length of each permanent transect. For each monitoring event, the same transect is sampled but quadrats are randomly placed each event. Transects are surveyed for total percent vegetative cover (by plot and by species), percent bare ground, and maximum plant height of the dominant species in each quadrat. Data are analyzed for percent cover, relative non-native cover, species frequency, and canopy height. Species frequency data provide a picture of plant community composition. The height of the dominant species in each quadrat will be measured as a piece of ancillary data indicating vegetative community structure compared with reference site vegetation. Vertical structure is a measure of habitat value for other species. When collected annually, the data provide information on restoration succession and diversity.

Alternatively, the restoration biologist may wish to repeat the monitoring design used at the IR Site 25 SWRP, which established five 20-meter transects per impact area. The occurrence of native plants, non-native plants, or bare soil was recorded along each transect at exactly 0.5-meter intervals. Percent cover was estimated by dividing the total number of “hits” by the total number of points sampled (i.e., 40 points for one 20-meter transect) (Rana Creek 2011).

A schedule for monitoring and maintenance activities is summarized in Table 5.

Table 5: Restoration Monitoring and Maintenance Schedule

Activity	Frequency
Site Inspection*	• Twice per month for months 1 through 3. • Monthly for months 4 through 12. • Quarterly for remainder of monitoring and maintenance period.
Weed Removal*	• Twice per month for months 1 through 3. • Monthly for months 4 through 12. • Quarterly for remainder of monitoring and maintenance period.
Irrigation**	• Weekly for months 1 and 2. • Three times per month for months 3 through 6. • Twice per month for months 7 through 10. • Once per month for months 11 and 12.
Replacement Planting or Seeding	Inspect mortality every 6 months; conduct replacement planting or seeding as needed.
Monitoring	Annually

Notes: * Site inspections and weed removal events will be scheduled according to site conditions and restoration progress. More frequent inspections and weed removal may be necessary and will be determined by the restoration biologist.

** Irrigation schedule will depend on winter rains; sufficient winter rains will reduce the need for watering events. Soil moisture will be assessed to determine irrigation needs.

4.2.2 PERFORMANCE STANDARDS FOR DETERMINING SUCCESS

The objective of the AOI 14 restoration is to produce a self-sustaining habitat that provides structure and function similar to the target natural habitat. The standard used to deem a restoration project successful is a comparison of the restoration site to a nearby natural (reference) site that ideally would reflect an undisturbed condition. Given the nature of the SWRP, a human-made system cutoff from tidal inundation, the reference transects for the wetland and transitional zones should be located within the SWRP. However, it should be expected that spatial differences in water distribution and duration of inundation will impact vegetation, which should be reflected in both the reference site and restoration site data. Due to the variable conditions within the SWRP yearly and across years, vegetation responses within the reference sites should reflect similar responses within the restoration transects. Due to the function and design of the SWRP to accumulate stormwater runoff, pickleweed restoration should take into account pickleweed's intolerance for prolonged inundation. Restoration and reference monitoring transects should be installed along the moisture and elevational gradients and reference transect data should reflect responses to prolonged inundation; however, pickleweed that is more mature and at a greater cover would likely withstand and recover better than newly planted or seeded pickleweed. Success criteria targets are detailed in USFWS BO (Attachment H-3), conservation measure BO-24, and shown on Table 6.

Table 6: Restoration Monitoring Performance Criteria

Parameter	Target	Timing				
		Year 1	Year 2	Year 3	Year 4	Year 5
Wetland and Transitional Vegetation						
Cover of native species	≥75% of Reference	≥10% of Reference	≥20% of Reference	≥35% of Reference	≥50% of Reference	≥75% of Reference
Community composition: Marsh plain restoration pickleweed cover	≥75% of Reference	≥10% of Reference	≥20% of Reference	≥35% of Reference	≥50% of Reference	≥75% of Reference
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority."	< 5%	All years				
Upland Vegetation						
Percent average vegetative cover including non-invasive plant species.	≥60%	≥ 10%	≥ 20%	≥ 30%	≥ 40%	≥ 60%
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority."	<5%	All years				
Reference Site Requirements						
Wetland (marsh plain) transects community composition: Absolute cover of native species	≥70%	All years				
Minimum absolute cover of pickleweed	≥60%	All years				
Transitional transects: Absolute cover of native species	≥70%	All years				
Average cover of invasive plant species with Cal- IPC rating of "high" or SSFBWMP "high" or "highest priority."	< 5%	All years				

Notes:

Cal-IPC = California Invasive Plant Council

SSFBWMP = South San Francisco Bay Weed Management Plan

Performance criteria for the upland habitat in Table 6 are based on non-invasive vegetative cover. No intact native upland habitats are in the vicinity to serve as reference sites. Based on the extent of naturalized non-native vegetation in the area and currently on the FSFA, some degree of non-native cover is a likely outcome for the upland. The goals for the upland account for likely regeneration of naturalized non-natives, with a goal of less than five percent of noxious or aggressive species. Non-invasive species are those that are not listed as having "high" negative ecological impact by Cal-IPC (2017) and are also not listed as weed species with "highest priority" and "high priority" rankings for control by the USFWS South San Francisco Bay Weed Management Plan (Marriott et al. 2013).

Table 6 details performance criteria for upland, transitional, and wetland habitats. The targets and timing take into account successional processes in newly restored sites. Wetland and transitional performance criteria are relative to reference site data. Annual targets are set in order to inform on adaptive management that may be required (weed control or supplemental seeding or planting). Reference site requirements for native cover and pickleweed cover are detailed in Table 6. Prior to conducting the first year of monitoring, the restoration biologist will select appropriate reference sites that align with the requirements in Table 6. NASA will submit the selected reference locations and preliminary reference vegetation composition and cover data to CDFW and USFWS for review and approval prior to monitoring.

5.0 REFERENCES

Alderete, C. 2003. Western Pond Turtle Presence/Absence Survey of NASA Ames Research Center, Moffett Field, California, 2003. February.

Alderete, C. 2004. Ames Bird Survey 2003, NASA Ames Research Center, Moffett Field, California. March 29.

Alderete, C. 2013a. Biological Survey for NASA Ames Research Center AOI 14 Silt Fence Installation on 11/7/13. Prepared for NASA Ames Research Center.

Alderete, C. 2013b. Email correspondence between Christopher Alderete, Leidos Wildlife Biologist, and Hugo Hoffman, NASA Environmental Division, regarding AOI 14 silt fence installation western snowy plover presence/absence survey. December 18.

Alderete, C. and M. McGowan. 2003. Western Pond Turtle Presence/Absence Survey of NASA Ames Research Center, Moffett Field, California, 2002. February.

Audubon and Cornell Lab of Ornithology. 2016. eBird Range Map Database. Accessed on November 30, 2016: www.ebird.org/ebird/map.

Audubon and Cornell Lab of Ornithology. 2017. eBird Range Map Database. Accessed on February 17, 2017: www.ebird.org/ebird/map.

Barbour, Michael, Todd Keeler-Wolf, and Allan Schoenherr. 2007. *Terrestrial Vegetation of California*. University of California Press. Berkeley, California. July 17.

Bumgardner Biological Consulting. 2011a. Letter report to David Kelly, Recovery Permit Coordinator, U.S. Fish and Wildlife Service (USFWS), regarding results of California clapper rail surveys conducted in 2011 at locations associated with Installation Remediation (IR) Site 25, Naval Air Station Moffett Field, California. May 4.

Bumgardner Biological Consulting. 2011b. Letter report to Robert Lindfors, P.E. Integrated Technical Solutions, Inc., regarding results of California black rail surveys conducted in 2011 at locations associated with Installation Remediation (IR) Site 25, Naval Air Station Moffett Field, California. May 4.

Bumgardner Biological Consulting. 2012. 2012 California Clapper Rail and California Black Rail Survey Report for Installation Remediation (IR) Site 25, Naval Air Station Moffett Field, Santa Clara County, California. June 8.

Burns, E.G. and E.K. Harding-Smith. 1993. Ecology of the California Black Rail (*Laterallus jamaicensis coturniculus*) at Naval Air Station Moffett Field, 1993. October.

California Department of Fish and Wildlife (CDFW). 2016. California Natural Diversity Database, Biogeographic Data Branch. Search of listed and sensitive species occurrences in vicinity of AOI 14 Former Soil Fill Area project. October.

CDFW. 2017. California Natural Diversity Database, Biogeographic Data Branch. Search of listed and sensitive species occurrences in vicinity of AOI 14 Former Soil Fill Area project. February.

California Department of Water Resources. 2016. "California Data Exchange Center—Precipitation, Rainfall Maps from DWR/CNRFC, SF Bay Area." Accessed on November 17, 2016. http://cdec.water.ca.gov/precip_maps/.

California Invasive Plant Council (CAL-IPC). 2017. California Invasive Plant Inventory Database: http://cal-ipc.org/paf/.

California Natural Diversity Database (CNDDB). 2016. California Department of Fish and Wildlife *Rarefind 5: An Internet Application to Query the California Natural Diversity Database*, Sacramento, California. Website accessed on November 30, 2016: https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data.

Chromczak, D. 2016. NASA Ames Research Center Burrowing Owl Ecology Study, Moffett Field Breeding Season Summary Report. August.

Design, Community and Environment (DCE). 2002. NASA Ames Development Plan Final Programmatic Environmental Impact Statement. July.

DriWater. 2017. DriWater for landscaping, carton application information. Accessed on March 10, 2017. Online address: http://driwater.com/professionals/products-for-professionals/carton-ct/.

Earth Resources Technology, Inc. (ERT). 2015. Environmental Resources Document, NASA Ames Research Center, Moffett Field, California. March.

EDAW, Philip Williams and Associates, Ltd., H.T. Harvey and Associates, Brown and Caldwell, and Geomatrix. 2007. South Bay Salt Pond Restoration Project Final Environmental Impact Statement/Report. Volume 1. Submitted to U.S. Fish and Wildlife Service and California Department of Fish and Game. December.

FGL Environmental. 2015. Soil analyses results conducted for Salt Marsh Bird's-Beak Habitat Assessment, Naval Base Ventura County, Point Mugu, California. October.

Gilbane Federal. 2016. Final Vegetation Restoration Completion Report—Year 3, Installation Restoration Site 25, Former NAS Moffett Field, Moffett Field, California. June.

Goals Project. 2000. "Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish and wildlife." Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

Griffith, K. 2010. Pickleweed: Factors that control distribution and abundance in Pacific Coast estuaries and a case study of Elkhorn Slough, California. June.

ITSI Gilbane. 2012. Final Remedial Design and Remedial Action Work Plan, Remedial Action at IR Site 25, Former NAS Moffett Field, Moffett Field, California. March.

Layne, V.L. and E.K. Harding-Smith. 1995. Sensitive Species Surveys at Moffett Field, 1994. August.

Marriott, M., R. Tertes, and C. Strong. 2013. South San Francisco Bay Weed Management Plan. 1st Edition. Unpublished report of the USFWS, Fremont, California. 82 pages.

Miles, A.K., D.H. Van Vuren, D.C. Tsao, and J.L. Yee. 2015. "Experimental enhancement of pickleweed, Suisun Bay, California." California Fish and Game, Volume 101, No. 2, pages 87–100.

NASA. 2016. NASA Geographic Information Systems shapefile of pickleweed survey boundary, "Pickleweed_Extent," surveyed July.

Orton-Palmer, A. E. and J.E. Takekawa. 1992. Breeding Census for the California clapper rail (*Rallus longirostris obsoletus*) at Naval Air Station Moffett Field and Guadalupe Slough, 1992. September.

Pearl, B., K. Tokatlian, and J. Scullen. 2015. Western Snowy Plover Monitoring in the San Francisco Bay, Annual Report, 2015. Prepared for Don Edwards San Francisco Bay National Wildlife Refuge and California Department of Fish and Wildlife. December 31.

Pomeroy, D. R. 1991. Results of Preliminary Salt Marsh Harvest Mouse Surveys, 22 through 26 July, 1981 at Naval Air Station, Moffett Field, Midpeninsula Open Space District, National Aeronautics and Space Administration, Ames Research Center, Santa Clara County, California.

Rana Creek. 2011. Salt Marsh Habitat Restoration Plan, Moffett Field Naval Air Station, Installation Restoration Site 25, Mountain View, California. 13 September.

SAIC. 1999. Vegetation Surveys and Mapping at Moffett Field, California. Prepared for NASA Ames Research Center, Moffett Field, California. November.

Scott, N. J. and C. Alderete. 2001. Amphibian Survey of Moffett Field, Santa Clara County, California, with Focus on the California Red-Legged Frog (*Rana aurora draytonii*) and the California Tiger Salamander (*Ambystoma californiense*). July.

Spautz, H., N. Nur, and D. Stralberg. 2005. California Black Rail (*Laterallus jamaicensis coturniculus*) Distribution and Abundance in Relation to Habitat and Landscape Features in the San Francisco Bay Estuary. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Tetra Tech. 2016a. Final Area of Investigation 14 Action Memorandum, NASA Ames Research Center, Moffett Field, CA. 02 March.

Tetra Tech. 2016b. Final Area of Investigation 14 Geophysical Survey Report, NASA Ames Research Center, Moffett Field, CA. November.

Tetra Tech. 2016c. Email correspondence between Angela Lortie, Tetra Tech biologist, and Christopher Alderete, Leidos Wildlife Biologist, regarding management of Burrowing Owl Preserves at NASA Ames Research Center. November 18.

Tetra Tech. 2016d. Telephone conversation between Angela Lortie, Tetra Tech biologist, and Christopher Alderete, Leidos Wildlife Biologist, regarding stormwater management and hydrology of the Northern Channel, as observed during IR Site 27 remediation work that involved de-watering the North Patrol and Northern Channel ditches.

Tetra Tech. 2016e. Reconnaissance of AOI 14 Former Soils Fill Area during which plant species (including special status plant species) were noted. Site walk conducted by Angela Lortie and Katie Henry, Tetra Tech biologists, and Christopher Alderete, Leidos Wildlife Biologist (among other project team members).

Tetra Tech. 2017. Biological Assessment, Area of Investigation 14 Non-Time-Critical Removal Action. Prepared for NASA Ames Research Center, Moffett Field, California. 28 February.

Tokatlian, K., J. Scullen, and C. Burns. 2014. Western Snowy Plover Monitoring in the San Francisco Bay, Annual Report, 2014. Prepared for Don Edwards San Francisco Bay National Wildlife Refuge and California Department of Fish and Wildlife. December 31.

U.S. Army Corps of Engineers (USACE). 2009. Mapped Waters of the U.S. Subject to Section 404 of the Clean Water Act, Ames Research Wetlands Map, Moffett Field, Santa Clara County. October 8.

U.S. Fish and Wildlife Service (USFWS). 2009. Bay Checkerspot Butterfly (*Euphydryas editha bayensis*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. August.

USFWS. 2010a. *Suaeda californica* (California sea-blite). 5-Year Review: Summary and Evaluation. Ventura Fish and Wildlife Office. February.

USFWS. 2010b. San Bruno Elfin Butterfly (*Callophrys mossii bayensis*) and Mission Blue Butterfly (*Icaricia icarioides missionensis*) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. February.

USFWS. 2012. Biological Opinion on the Proposed Doherty Drive Bridge Replacement Project in the City of Larkspur, Marin County, California. April 12.

USFWS. 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Region 8, USFWS, Sacramento, California. August.

USFWS. 2016a. Formal Consultation on the San Francisquito Creek Flood Reduction, Ecosystem Restoration, and Recreation Project, from San Francisco Bay to Highway 101, in the City of East Palo Alto, San Mateo County, and the City of Palo Alto, Santa Clara County, California (U.S. Army Corps of Engineers file number 2013-00030S). January 15.

USFWS. 2016b. Official species list of threatened and endangered species that may occur at NASA Ames Research Center AOI 14 Former Soil Fill Area. Requested by NASA via USFWS Information for Planning and Conservation (IPaC) website, November 1.

USFWS. 2017. Formal Consultation on the NASA Ames Research Center Area of Investigation 14 Non-Time-Critical Removal Action, Moffett Field, Santa Clara County, California (NASA Reference #: JQ: 204-15). October 30.

Weather Underground. 2017. Precipitation summary for Mountain View, California for the period September 14, 2016 through March 14, 2017. https://www.wunderground.com/history/airport/KNUQ/2016/9/14/CustomHistory.html?dayend=14&monthend=3&yearend=2017&req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo.

Western Regional Climate Center (WRCC). 2016. Period of Record Monthly Climate Summary and Total Precipitation Summary for Palo Alto, California. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6646.

Zedler, J.B. 2001. *Handbook for Restoring Tidal Wetlands*. CRC Press. Boca Raton, Florida.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1990. California's Wildlife. Volumes I-III. California Department of Fish and Game, Sacramento, California. Website: Life history accounts for species in the California Wildlife Habitat Relationships (CWHR). Updates are noted in accounts that have been added or edited since original publication, https://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx. Accessed on November 30, 2016.

Zippin, D.B. and T.M. Engels. 1997. Directed Rare Plant Survey for California Sea-Blite (*Suaeda californica*) and Point Reyes Bird's-Beak (*Cordylanthus maritimus* ssp. *palustris*) at NASA Ames Research Center and Moffett Federal Airfield, California. October 15.

ATTACHMENT H1
USFWS SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL, SUITE 8-300
SACRAMENTO, CA 95814
PHONE: (916)930-5603 FAX: (916)930-5654
URL: kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0017 November 01, 2016
Event Code: 08FBDT00-2017-E-00019
Project Name: NASA Ames Research Center AOI 14 Former Soils Fill Area

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

Official Species List

Provided by:

San Francisco Bay-Delta Fish and Wildlife
650 CAPITOL MALL
SUITE 8-300
SACRAMENTO, CA 95814
(916) 930-5603
http://kim_squires@fws.gov

Consultation Code: 08FBDT00-2017-SLI-0017
Event Code: 08FBDT00-2017-E-00019

Project Type: Superfund Site Remediation

Project Name: NASA Ames Research Center AOI 14 Former Soils Fill Area
Project Description: NASA Ames Research Center, located at Moffett Field in Santa Clara County, California, is addressing contaminated soil within Area of Investigation (AOI) 14 Former Soils Fill Area (FSFA) by implementing a Non-Time-Critical Removal Action as lead agency under the NASA Moffett Federal Facility Agreement (FFA) with EPA Region 9 and the State of California Water Quality Control Board. Work under the FFA is conducted in accordance with CERCLA requirements and guidance. AOI 14 FSFA is approximately 8 acres and located at the northern end of NASA Ames and surrounded by a stormwater retention pond. The proposed action addresses the northern portion of the FSFA where concentrations of lead, total DDT, and total PCBs exceed the cleanup goals in samples collected from 1992 through 2014. The proposed action will consist of a Pilot Study Soil Investigation, Full-Scale Site Characterization Investigation, and Removal Action which includes site restoration, summarized below.
Site characterization sampling is required prior to development of the Removal Action Work Plan, in order to define the extent of contamination and the areas requiring soil removal. The results of soil sample analyses will inform the final site design and Removal Action Work Plan; the sampling methodology will refine the areas requiring removal and will minimize the extent and duration of removal work required at the site. Site characterization sampling consists of a Pilot Study and Full-Scale Investigation. The Pilot Study is to determine the number of incremental sampling methodology (ISM) soil sampling increments to achieve appropriate confidence levels that results will be reproducible and accurate within project objectives. The Pilot Study will occur over 10 days and is proposed to occur in January 2017. The drilling subcontractor will advance 270 direct push

borings to native bay mud, estimated to be 16 feet below ground surface (bgs). The results from the Pilot Study will determine the number of soil borings required for the Full-Scale Investigation. The Full-Scale Investigation will identify areas at AOI 14 FSFA where concentrations of lead, total DDTs, and total PCBs exceed cleanup goals in soil, fill, or sediment. The Full-Scale Investigation has an expected duration of 10 to 35 days and is proposed to occur in September 2017. The drilling subcontractor will advance from 484 to 968 direct push borings to native bay mud, estimated to be approximately 16 feet bgs, within twenty-two 100-foot by 100-foot investigation areas at the FSFA. The Removal Action will consist of excavation and off-site disposal of contaminated sediment, soil, and debris. Offsite disposal will occur at California Class I, II, or III landfills. Staging and laydown areas will be located in sites already graded for development, south of AOI 14. The Removal Action is expected to occur over approximately 9 months. Soil, fill, and sediment with COC concentrations less than the cleanup goals will be staged and stockpiled for use as fill for developing the final grade of the site. At the completion of the Removal Action, the site will be re-graded to elevations that support pickleweed, transitional, and upland habitats, and with gentle slope grades that minimize erosion; the site will be revegetated with native species and monitored by a qualified biologist for native revegetation, for up to 5 years. All activities will be conducted under the supervision of a qualified biologist. Project details including equipment to be used, methods, timing, and conservation measures will be detailed in the project Biological Assessment.

Please Note: The FWS office may have modified the Project Name and/or Project Description, so it may be different from what was submitted in your previous request. If the Consultation Code matches, the FWS considers this to be the same project. Contact the office in the 'Provided by' section of your previous Official Species list if you have any questions or concerns.

Project Location Map:

Project Coordinates: MULTIPOLYGON (((-122.06420803122457 37.42757335719065, -122.0640707029088 37.43205815512477, -122.06316089708707 37.43197636785867, -122.06242275395196 37.43091312604725, -122.06331539258825 37.429549973294044, -122.06324672777554 37.42747793346485, -122.06420803122457 37.42757335719065)))

Project Counties: Santa Clara, CA

Endangered Species Act Species List

There are a total of 12 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Amphibians	**Status**	**Has Critical Habitat**	**Condition(s)**
California red-legged frog *(Rana draytonii)* Population: Wherever found	Threatened	Final designated	
California tiger Salamander *(Ambystoma californiense)* Population: U.S.A. (Central CA DPS)	Threatened	Final designated	
Birds			
California Clapper rail *(Rallus longirostris obsoletus)* Population: Wherever found	Endangered		
California Least tern *(Sterna antillarum browni)* Population: Wherever found	Endangered		
western snowy plover *(Charadrius nivosus ssp. nivosus)* Population: Pacific Coast population DPSâU.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast)	Threatened	Final designated	
Crustaceans			

Vernal Pool tadpole shrimp *(Lepidurus packardi)* Population: Wherever found	Endangered	Final designated	
Fishes			
Delta smelt *(Hypomesus transpacificus)* Population: Wherever found	Threatened	Final designated	
steelhead *(Oncorhynchus (=salmo) mykiss)* Population: Northern California DPS	Threatened		
Flowering Plants			
California seablite *(Suaeda californica)* Population: Wherever found	Endangered		
Insects			
Bay Checkerspot butterfly *(Euphydryas editha bayensis)* Population: Wherever found	Threatened	Final designated	
San Bruno Elfin butterfly *(Callophrys mossii bayensis)* Population: Wherever found	Endangered		
Mammals			
Salt Marsh Harvest mouse *(Reithrodontomys raviventris)* Population: wherever found	Endangered		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

ATTACHMENT H2
CNDDB AND IPAC SEARCH RESULTS

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Mountain View (3712241))

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Antrozous pallidus pallid bat	G5 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	157 157	407 S:1	0	0	0	0	0	1	1	0	1	0	0
Astragalus tener var. tener alkali milk-vetch	G2T2 S2	None None	Rare Plant Rank - 1B.2	5 5	65 S:1	0	0	0	0	1	0	1	0	0	1	0
Athene cunicularia burrowing owl	G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFWS_BCC-Birds of Conservation Concern	0 10	1932 S:15	0	0	0	11	1	3	4	11	14	1	0
Bombus occidentalis western bumble bee	G2G3 S1	None None	USFS_S-Sensitive XERCES_IM-Imperiled	15 15	282 S:1	0	0	0	0	0	1	1	0	1	0	0
Centromadia parryi ssp. congdonii Congdon's tarplant	G3T2 S2	None None	Rare Plant Rank - 1B.1 BLM_S-Sensitive SB_RSABG-Rancho Santa Ana Botanic Garden	5 10	93 S:3	0	0	2	1	0	0	0	3	3	0	0
Charadrius alexandrinus nivosus western snowy plover	G3T3 S2S3	Threatened None	CDFW_SSC-Species of Special Concern NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	0 0	125 S:1	0	1	0	0	0	0	0	1	1	0	0
Chloropyron maritimum ssp. palustre Point Reyes salty bird's-beak	G4?T2 S2	None None	Rare Plant Rank - 1B.2 BLM_S-Sensitive	1 1	68 S:2	0	0	0	0	2	0	2	0	0	2	0
Circus cyaneus northern harrier	G5 S3	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern	5 10	48 S:3	0	1	0	0	0	2	2	1	3	0	0

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Corynorhinus townsendii Townsend's big-eared bat	G3G4 S2	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern USFS_S-Sensitive WBWG_H-High Priority	160 160	625 S:1	0	0	0	0	0	1	1	0	1	0	0
Egretta thula snowy egret	G5 S4	None None	IUCN_LC-Least Concern	10 10	17 S:1	0	0	0	0	0	1	0	1	1	0	0
Emys marmorata western pond turtle	G3G4 S3	None None	BLM_S-Sensitive CDFW_SSC-Species of Special Concern IUCN_VU-Vulnerable USFS_S-Sensitive	0 0	1217 S:1	0	0	0	0	0	1	0	1	1	0	0
Eryngium aristulatum var. hooveri Hoover's button-celery	G5T1 S1	None None	Rare Plant Rank - 1B.1 SB_RSABG-Rancho Santa Ana Botanic Garden	10 10	16 S:1	0	0	0	0	1	0	1	0	0	1	0
Geothlypis trichas sinuosa saltmarsh common yellowthroat	G5T3 S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	4 16	112 S:7	0	5	0	0	0	2	2	5	7	0	0
Lasiurus cinereus hoary bat	G5 S4	None None	IUCN_LC-Least Concern WBWG_M-Medium Priority		235 S:1	0	0	0	0	0	1	1	0	1	0	0
Laterallus jamaicensis coturniculus California black rail	G3G4T1 S1	None Threatened	BLM_S-Sensitive CDFW_FP-Fully Protected IUCN_NT-Near Threatened NABCI_RWL-Red Watch List USFWS_BCC-Birds of Conservation Concern	4 7	244 S:4	0	3	0	0	0	1	0	4	4	0	0
Melospiza melodia pusillula Alameda song sparrow	G5T2? S2S3	None None	CDFW_SSC-Species of Special Concern USFWS_BCC-Birds of Conservation Concern	4 18	38 S:6	0	2	0	0	0	4	4	2	6	0	0
Northern Coastal Salt Marsh Northern Coastal Salt Marsh	G3 S3.2	None None		10 15	53 S:2	0	1	0	0	0	1	2	0	2	0	0

Summary Table Report

California Department of Fish and Wildlife

California Natural Diversity Database

Name (Scientific/Common)	CNDDB Ranks	Listing Status (Fed/State)	Other Lists	Elev. Range (ft.)	Total EO's	Element Occ. Ranks						Population Status		Presence		
						A	B	C	D	X	U	Historic > 20 yr	Recent <= 20 yr	Extant	Poss. Extirp.	Extirp.
Rallus longirostris obsoletus California clapper rail	G5T1 S1	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List	0 5	98 S:10	2	3	0	0	0	5	5	5	10	0	0
Reithrodontomys raviventris salt-marsh harvest mouse	G1G2 S1S2	Endangered Endangered	CDFW_FP-Fully Protected IUCN_EN-Endangered	0 5	144 S:13	2	3	1	0	0	7	12	1	13	0	0
Rynchops niger black skimmer	G5 S2	None None	CDFW_SSC-Species of Special Concern IUCN_LC-Least Concern NABCI_YWL-Yellow Watch List USFWS_BCC-Birds of Conservation Concern	11 11	7 S:1	0	0	0	0	0	1	0	1	1	0	0
Sorex vagrans halicoetes salt-marsh wandering shrew	G5T1 S1	None None	CDFW_SSC-Species of Special Concern	1 5	12 S:3	0	0	0	0	1	2	3	0	2	0	1
Spirinchus thaleichthys longfin smelt	G5 S1	Candidate Threatened	CDFW_SSC-Species of Special Concern	0 0	45 S:1	0	0	0	0	0	1	1	0	1	0	0
Sternula antillarum browni California least tern	G4T2T3Q S2	Endangered Endangered	CDFW_FP-Fully Protected NABCI_RWL-Red Watch List		68 S:2	0	0	0	0	0	2	2	0	2	0	0
Suaeda californica California seablite	G1 S1	Endangered None	Rare Plant Rank - 1B.1	5 5	18 S:1	0	0	0	0	1	0	1	0	0	1	0
Tryonia imitator mimic tryonia (=California brackishwater snail)	G2 S2	None None	IUCN_DD-Data Deficient	0 0	39 S:1	0	0	0	0	0	1	1	0	1	0	0

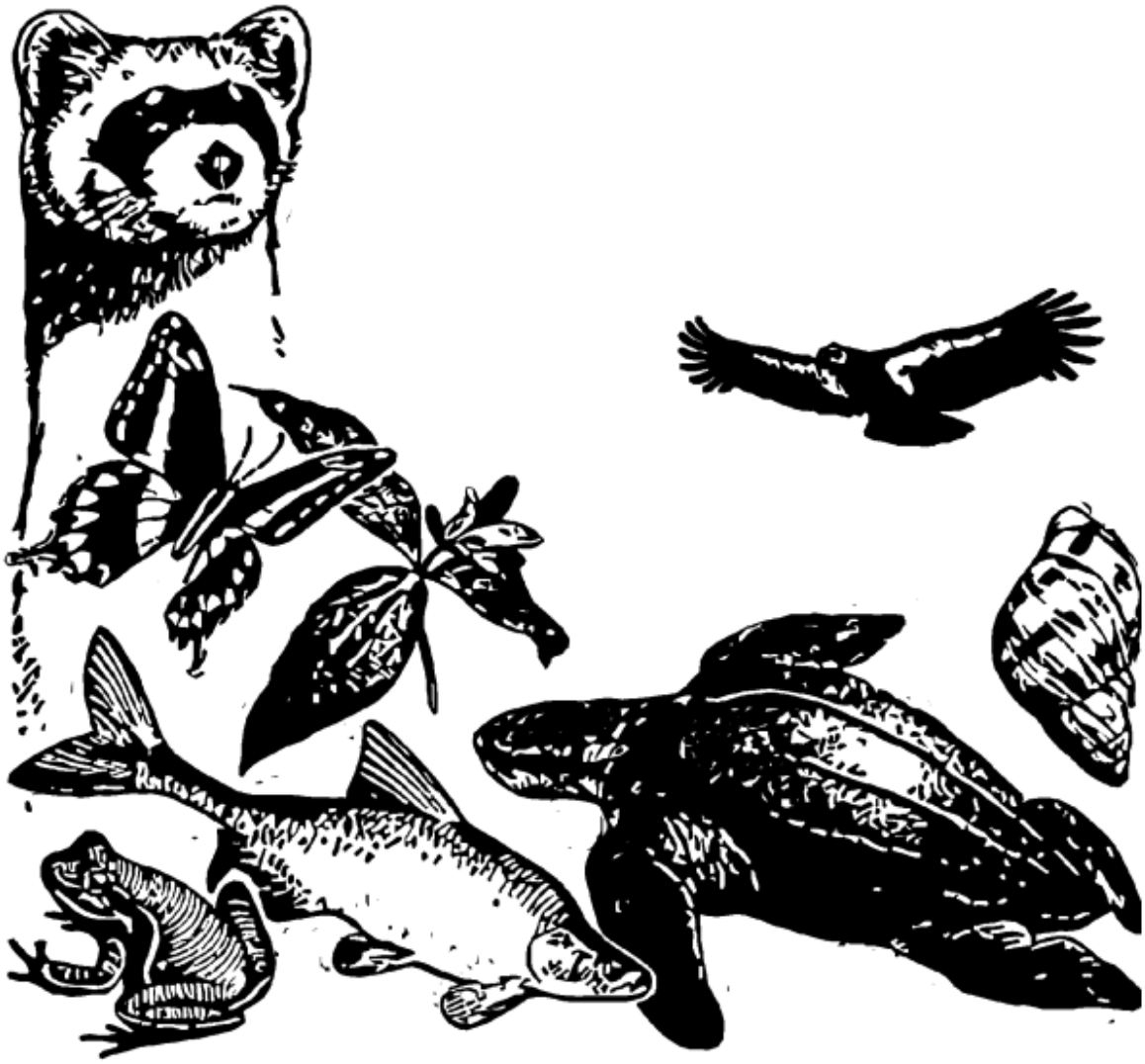
U.S. Fish & Wildlife Service

NASA Ames Research Center AOI 14

IPaC Trust Resources Report

Generated October 12, 2016 04:44 PM MDT, IPaC v3.0.9

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (https://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

Table of Contents

IPaC Trust Resources Report 1
Project Description 1
Endangered Species 2
Migratory Birds 5
Refuges & Hatcheries 9
Wetlands 10

U.S. Fish & Wildlife Service

IPaC Trust Resources Report

NAME

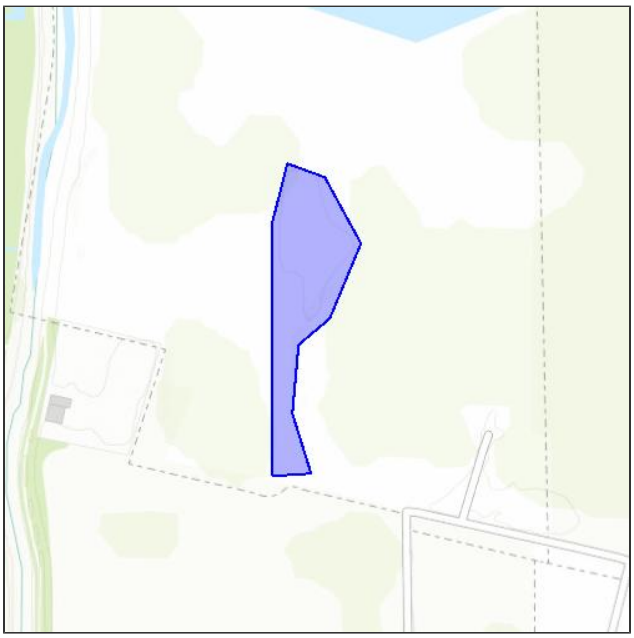
NASA Ames Research Center AOI 14

LOCATION

Santa Clara County, California

IPAC LINK

https://ecos.fws.gov/ipac/project/L7ASK-M3VUV-GMNAH-72IYE-O42UEE



U.S. Fish & Wildlife Service Contact Information

Trust resources in this location are managed by:

San Francisco Bay-delta Fish And Wildlife
650 Capitol Mall
Suite 8-300
Sacramento, CA 95814
(916) 930-5603

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list either from the Regulatory Documents section in IPaC or from the local field office directly.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Amphibians

California Red-legged Frog Rana draytonii — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D02D

California Tiger Salamander Ambystoma californiense — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=D01T

Birds

California Clapper Rail Rallus longirostris obsoletus — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B04A

California Least Tern Sterna antillarum browni — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B03X

Western Snowy Plover Charadrius alexandrinus nivosus — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07C

Crustaceans

Vernal Pool Tadpole Shrimp Lepidurus packardi — Endangered

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=K048

Fishes

Delta Smelt Hypomesus transpacificus — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=E070

Steelhead Oncorhynchus (=Salmo) mykiss — Threatened

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=E08D

Flowering Plants

California Seablite Suaeda californica — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=Q3AF

Insects

Bay Checkerspot Butterfly Euphydryas editha bayensis — Threatened

CRITICAL HABITAT

There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=I021

San Bruno Elfin Butterfly Callophrys mossii bayensis — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=I00Q

Mammals

Salt Marsh Harvest Mouse Reithrodontomys raviventris — Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A03Y

Critical Habitats

There are no critical habitats in this location

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish & Wildlife Service.[1] There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

---

1. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The following species of migratory birds could potentially be affected by activities in this location:

Allen's Hummingbird Selasphorus sasin — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0LI

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Bell's Sparrow Amphispiza belli — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HE

Black Oystercatcher Haematopus bachmani — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0KJ

Black Rail Laterallus jamaicensis — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B09A

Black Skimmer Rynchops niger — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EO

Burrowing Owl Athene cunicularia — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0NC

Common Yellowthroat Geothlypis trichas sinuosa — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B080

Costa's Hummingbird Calypte costae — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JE

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Lawrence's Goldfinch Carduelis lawrencei — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0J8

Least Bittern Ixobrychus exilis
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B092

Lesser Yellowlegs Tringa flavipes — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MD

Lewis's Woodpecker Melanerpes lewis — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HQ

Long-billed Curlew Numenius americanus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06S

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JL

Nuttall's Woodpecker Picoides nuttallii — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HT

Oak Titmouse Baeolophus inornatus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MJ

Olive-sided Flycatcher Contopus cooperi — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0AN

Peregrine Falcon Falco peregrinus — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FU

Rufous-crowned Sparrow Aimophila ruficeps — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0MX

Short-billed Dowitcher Limnodromus griseus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JK

Short-eared Owl Asio flammeus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Snowy Plover Charadrius alexandrinus — Bird of conservation concern
Season: Breeding

Song Sparrow Melospiza melodia pusillula — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B08P

Tricolored Blackbird Agelaius tricolor — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06P

Western Grebe aechmophorus occidentalis — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EA

Whimbrel Numenius phaeopus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JN

Yellow Warbler dendroica petechia ssp. brewsteri — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EN

Yellow-billed Magpie Pica nuttalli — Bird of conservation concern
Season: Year-round
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0N8

Red Knot Calidris canutus ssp. roselaari

Bird of conservation concern

Season: Wintering

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0G6

Wildlife refuges and fish hatcheries

There are no refuges or fish hatcheries in this location

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

This location overlaps all or part of the following wetlands:

Freshwater Emergent Wetland

PEM1Ch

Lake

L2UBH3h

A full description for each wetland code can be found at the National Wetlands Inventory website: http://107.20.228.18/decoders/wetlands.aspx

ATTACHMENT H3
AOI 14 USFWS BIOLOGICAL OPINION

RECEIVED
NOV 06 2017
By

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In reply refer to:
08FBDT00-2017-F-0117

Ms. Kimberly Finch, P.E.
Restoration Program Manager
Environmental Management Division
National Aeronautics and Space Administration
Ames Research Center
Moffett Field, CA 94035-1000

OCT 30 2017

Subject: Formal Consultation on the NASA Ames Research Center Area of Investigation 14 Non-Time-Critical Removal Action, Moffett Field, Santa Clara County, California (NASA Reference #: JQ: 204-15)

Dear Ms. Finch:

This letter is in response to the National Aeronautics and Space Administration's (NASA) February 28, 2017 letter requesting initiation of formal consultation with the U.S. Fish Wildlife Service (Service) for NASA Ames Research Center Area of Investigation (AOI) 14 Non-Time-Critical Removal Action, Moffett Field, Santa Clara County, California (proposed project). The NASA's letter was received by the Service on March 1, 2017. At issue are the proposed project's effects on the federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*), California clapper rail (*Rallus longirostris obsoletus*), and California least tern (*Sterna antillarum browni*) and the federally threatened western snowy plover (*Charadrius alexandrines nivosus*) and its designated critical habitat. Regarding taxonomic assignment and nomenclature for the California clapper rail, until a time when the Service officially adopts changes made by the American Ornithologists' Union (from California clapper rail [*Rallus longirostris obsoletus*] to Ridgway's Rail [*Rallus obsoletus obsoletus*]), the Service maintains the use of California clapper rail (*Rallus longirostris obsoletus*) as used in this current correspondence. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The Federal action on which we are consulting is the proposed removal action at AOI 14, in fulfillment of the NASA Moffett Federal Facility Agreement (FFA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Pursuant to 50 CFR 402.12(j), you submitted a biological assessment for our review and requested concurrence with the findings presented therein. In subsequent correspondence with the Service on July 12, 2017, you revised your findings and concluded that the proposed project

may affect and is likely to adversely affect the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern.

In evaluating your request, we based our evaluation on the following: (1) the February 28, 2017 NASA letter requesting initiation of informal consultation; (2) the *Biological Assessment: Area of Investigation 14 Non-Time-Critical Removal Action, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California* (Dated February 28, 2017); and (3) other information available to the Service.

No critical habitat for the western snowy plover occurs in the action area; therefore, none will be affected. No critical habitat has been proposed or designated for the salt marsh harvest, California clapper rail, or California least tern; therefore, none will be adversely affected. The remainder of this document provides our biological opinion on the effects of the proposed project on the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern.

Consultation History

November 9, 2016	The Service attended a biological assessment planning meeting held by NASA and its consultant, Tetra Tech.
March 1, 2017	The Service received NASA's request for formal consultation that included the *Biological Assessment: Area of Investigation 14 Non-Time-Critical Removal Action, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California* (Dated February 28, 2017).
April 24, 2017	The Service received a copy of the *Protected Species Mitigation and Habitat Restoration Plan: Area of Investigation 14, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California. Appendix H of the Area of Investigation 14 Removal Action Work Plan (2017).*
July 12, 2017	The Service received an email from the NASA revising effects determinations for the California clapper rail and California least tern *from* may affect, but not likely to adversely affect *to* may affect and likely to adversely affect.
July - October, 2017	The Service engaged in email and telephone correspondence with the NASA to clarify and confirm elements of the biological assessment.

BIOLOGICAL OPINION

Description of the Action

The proposed project is a non-time-critical contaminated material removal that consists of site sampling to further refine the proposed limits of excavation using incremental sampling methodology (ISM), excavation and off-site disposal of soil and sediment containing concentrations of contaminants exceeding cleanup goals, and restoration of the excavated areas to appropriate ecological habitat. Ecological monitoring and maintenance to ensure effectiveness of the restoration will occur following completion of excavation and restoration.

The purpose of the proposed project is to prevent erosion of and subsequent transport of contaminated material from the AOI 14 into adjacent wetlands. The AOI 14 consists of three peninsulas (the Former Soil Fill Area [FSFA], N217, and N217A) that extend into a stormwater retention pond (SWRP) that is part of the Navy Installation Restoration Site 25. An existing silt fence placed during a previous interim corrective active measure (ICAM) surrounds the majority of the FSFA and will be maintained in place during the proposed project; its placement will be modified as necessary to accommodate project activities and features.

The approximate length of time required to remove the contaminated soil and sediment will depend on results of site sampling, but the removal action is estimated to take approximately 14 months. A variance in target start dates for each phase is based on several factors including potential variance in timing of funding and contracting and review of applicable project documents by regulatory agencies. Site activities will be conducted 5 days per week, Monday through Friday, during daylight hours only, between approximately 7:00 a.m. and 6:00 p.m. depending on the time of year and amount of available daylight, or as otherwise specified by a Service-approved biologist for the protection of listed species (still during daylight hours). Weekend daytime work is not anticipated, but may occur if necessary as a result of time constraints such as those brought on by weather, unexpected contingency events, or scheduling constraints

More specifically, the proposed project consists of the following phases:

Pilot Study

Prior to pilot study sampling, the following activities will take place: (1) biological surveys; (2) vegetation clearing of the top of the FSFA; (3) exclusion fence installation around the entire FSFA, including the access road and contractor staging laydown area on the southern end of the FSFA peninsula; and (4) vegetation clearing within 4 feet outside of the exclusion fence.

The sampling will be conducted using ISM followed by analysis to determine the appropriate number of sampling increments that should be collected for the full-scale investigation at AOI 14 FSFA. The pilot study may begin during September 2017, or later, and has an expected duration of 10 days over two 5-day work weeks. The proposed

project area is divided into 100- by 100-foot investigation area grids (IAG). The IAGs include Fill IAGs (FIAG) in the FSFA and stormwater pond IAGs (SPIAG), located within the SWRP, adjacent to the FSFA. A drilling contractor will advance a total of 270 direct-push technology (DPT) borings to native bay mud, estimated to be at depths ranging from 4-8 feet below ground surface within three IAGs. The contractor will provide three drill teams that will work concurrently.

Full-Scale Investigation

Prior to full-scale investigation sampling, the following activities will take place: (1) biological surveys; (2) the exclusion fence will be adjusted as necessary to accommodate additional areas associated with the full-scale investigation; (3) vegetation clearing of the top of the FSFA, down the slopes, and into the SWRP as needed for access and to a distance of 4 feet along the outside of the exclusion fence; and (4) using ISM, identify areas at AOI 14 FSFA and two adjacent locations in Navy IR Site 25 (SPIAGs) where concentrations of lead, total dichorodiphenyltrichloroethane [DDT], and total polychlorinated biphenyls (PCBs) exceed cleanup goals in soil or sediment. This will include between 420 and 930 DPT borings (depending on results of the Pilot Study) to native bay mud (estimated between 4 and 18 feet below ground surface) within 21-23 FIAGs, with approximately 10 percent being advanced using angle-hole methods. Up to 30 borings will be advanced using a hand auger on the side slopes in FIAGs, up to 30 borings will be advanced using a hand auger or slam bar where the IAG boundary extends into the SWRP, and between 40 and 80 borings will be advanced using a hand auger or slam bar into SWRP sediment in two SPIAGs adjacent to the toe of the FSFA slope. The full-scale investigation may begin during September 2017, or later, and has an expected duration of up to 6 weeks of 5-day work weeks.

Removal

The removal may begin during October 2017, or later, and has an expected duration of approximately 12 months and will follow the evaluation of full-scale investigation sampling data and determination of final excavation design. It includes the following phases.

<u>Mobilization</u> – Mobilization will precede excavation and is expected to occur over a period of approximately one month. Mobilization will include: (1) utility clearance; (2) pre-construction photographic survey of the site, including all potential contractor staging areas and the haul route; (3) biological surveys; (4) exclusion fence realignment; and (5) vegetation removal, as necessary.

<u>Excavation and Disposal</u> – Soil and sediment with concentrations of lead, total DDTs, or total PCBs that exceed cleanup goals will be excavated and disposed of. The excavation areas, depths, and volumes will be determined based on the results of the pilot study and full-scale investigation and may include soil and construction debris at the FSFA and soil and sediment within the adjacent SWRP. The removal may require water diversion or

partial localized dewatering within the SWRP, which is yet to be determined and will be based on water levels and the areas within the SWRP that require removal. The expected duration of the excavation is approximately 10 months.

Grading – Disturbed areas will be graded during and after excavation for stormwater drainage. Final grades generally will be sloped to minimize erosion and maximize the area for optimal pickleweed growth, which currently occurs in the SWRP at elevations ranging from 0.5 to 3.5 feet above mean sea level (MSL). Clean soil, rock, and other structures not posing a worker or site visitor safety risk may be left in place. The final site grading is expected to be consistent with the surrounding SWRP, with similar bottom elevations, gentle slopes, and uplands. Erosion control devices, such as fiber rolls and sheeting to cover temporary stockpiles, will be installed during construction. Fiber rolls on the final slopes and ICAM silt fence will remain in place until vegetation is established. The estimated duration of grading and habitat restoration is incorporated into the excavation and disposal and demobilization phase duration estimates.

Habitat Restoration – After grading is finished, a hydroseeder (typically a water truck with seed, straw, and hoses) will spray pickleweed seed and other seeds of species native to the region over the surface of the regraded soils to create a vegetative cover. Restoration may include installation of nursery-grown container stock plants. Restoration areas will be revegetated with pickleweed cuttings harvested from salvage areas and adjacent undisturbed pickleweed-vegetated areas to the maximum extent practicable, with additional augmentation of nursery seedlings and seed, as necessary. The final site restoration design will be determined by the extent of the excavation and disturbed areas. It is anticipated that the final grading plan will support a mixture of wetland (vegetated salt marsh and salt panne), transitional habitat, and upland vegetation, with the final grading including elevations conducive to pickleweed growth. Pickleweed disturbed during the proposed project will be mitigated at a 3:1 ratio on site. Final acreages of impacts will be delineated after excavation activities are completed. Final grading will be implemented with the goal of creating a sustainable site that supports native species. The duration of grading and habitat restoration is included in the excavation and disposal and demobilization phase duration estimates.

Monitoring and maintenance of habitat restoration and revegetation will continue for up to 5 years to ensure the effectiveness of the restoration. Maintenance work will be conducted by hand to the maximum extent possible. Materials and supplies will be transported to the site by truck, offloaded, and moved by hand into the restoration areas. Irrigation of upland and transitional plants will include the use of a water hog or water truck and hoses. No irrigation system is planned. Maintenance will include regular invasive species control by application of manual and chemical methods. Herbicide treatment will occur by a licensed qualified applicator, according to product labels, when no rain is anticipated, and, if applying by sprayer, on days with wind velocities less than 5 miles per hour. Herbicide used in or near the SWRP will be approved by U.S. Environmental Protection Agency for use in wetlands. Annual monitoring will occur in upland, transitional, and wetland habitats to determine the success of revegetation.

Monitoring will include comparison of restoration site data with data acquired concurrently at selected reference sites.

Demobilization – During demobilization, all equipment, offices, and materials that were moved onto the FSFA, staging/laydown areas, or other work areas will be removed. After field activities are complete, the contractor will conduct final cleanup of the site and all disturbed areas and will replace or repair any existing utilities (including any roads damaged by trucks or other equipment) or landscaping that was damaged during construction activities. Demobilization is expected to occur over approximately one month.

Conservation Measures

Service-approved Biologist/Biological Monitor

1. At least 15 days prior to the onset of any construction-related activities or species/activities, NASA proposed and shall submit to the Service, for approval, the name(s) and credentials of biological monitors it requests to conduct activities specified for this project. Information included in a request for authorization must include, at a minimum: (1) relevant education; (2) relevant training on species identification, survey techniques, handling individuals of different age classes, and handling of different life stages by a permitted biologist or recognized species expert authorized for such activities by the Service; (3) a summary of field experience conducting requested activities (to include project/research information and actual experience with the species); (4) a summary of biological opinions and/or informal consultations under which they were authorized to work with the listed species and at what level (such as construction monitoring versus handling), and will include the names and qualifications of persons under which the work was supervised as well as the amount of work experience on the actual project including detail on whether the species was encountered or not; and (5) a list of 10(a)1(A) permits, if any, held or under which individuals are authorized to work with the species (to include permit number, authorized activities, and name of permit holder). No project activities shall begin until the NASA has received written Service approval for biologists to conduct specified activities.

2. A Service-approved biologist will be on site daily for the duration of the proposed project, with varying daily frequency as determined by that biologist using decision criteria including the current nature of project activities, degree of noise or disturbance they are producing, intensity of activities, presence of species, or other factors. The biologist(s) will be responsible for monitoring compliance with and implementation of conservation measures and reasonable and prudent measures. The biologist(s) will have stop-work authority in the event of non-compliance with the measures and for protection of salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern, as stipulated in the measures.

3. One or more Service-approved biologists will survey the project footprint and action area for salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern, and will have stop-work authority if any of these species are found in the monitoring area, as described in the following conservation measures. In addition to reporting requirements stipulated in the following conservation measures, a Service-approved biologist will report findings to the NASA daily.

4. One or more Service-approved biologists will conduct a training session for all project personnel and visitors prior to the beginning of any ground-disturbing and vegetation-clearing activities within the project footprint. All personnel or visitors entering the areas with any ground-disturbing and vegetation-clearing activities must attend. The training will be developed and implemented by the Service-approved biologist and a copy of the training module will be given to each person working on the project with other available copies to be kept in the project management trailer. The training module will include general provisions of the Act and penalties associated with violating those provisions, conservation measures and reasonable and prudent measures listed in the biological opinion, color photographs, a brief natural history description, and description of habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. The module will also include descriptions of pickleweed, the protection of which is important to the salt marsh harvest mouse, and the invasive pepperweed (*Lepidium latifolium*) with practices to avoid its spread.

   For work in non-sensitive habitats, environmental briefings will occur weekly or as needed. A Service-approved biologist will keep the NASA informed about significant biological resources observed on site, such as nests that require buffers. The NASA and contractors will comply with all input from a Service-approved biologist throughout the duration of the project.

5. A Service-approved biologist will monitor the site's fencing to ensure it is functioning properly and will monitor the fencing and staking to ensure they do not serve as raptor perches. In addition to the requirement specific to the perimeter fence that is articulated in Conservation Measure #20, if any fencing in the project site is found to act as perches, a Service-approved biologist will modify the fence and staking with non-lethal anti-perch devices (spike strips or other non-lethal devices) to prevent raptor predation.

General

6. All construction activity will occur within the project footprint, which includes the removal action area, approximately 4 feet beyond the removal action area exclusion fence to include vegetation/pickleweed removal areas, and staging and laydown areas. All parties entering the project footprint will be provided maps showing the project boundaries and access and staging areas and will be informed that construction activity must be confined to those corridors. Maps will include the locations of listed species and habitats and U.S. Army Corps of Engineers (Corps) jurisdictional waters.

7. Before construction begins, work areas will be clearly marked with flagging tape to avoid unintended impacts to sensitive areas and to minimize impacts to vegetation and salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern habitat. If stakes are used for flagging, they will not exceed 3 feet in height, to avoid use as perches by predatory raptors. Flagging will be removed promptly when the proposed project is complete.

8. Work will occur only during daylight hours.

9. Trash will be disposed of properly and work sites will be kept trash-free to reduce animal attraction. Trash cans must have secure lids that close tightly.

10. Staging will occur only in designated staging areas.

11. The existing ICAM silt fence will be maintained during all excavation activities to prevent migration of sediments into adjacent down-gradient habitat and according to salt marsh harvest mouse specific Conservation Measures #s 26, 27, 28, and 29.

12. Construction equipment, including workers' boots, will be cleaned of soil, seed, and plant material before entering the work site to prevent introduction of pepperweed. Workers will avoid walking through patches of pepperweed to the extent feasible.

13. Noise-reducing devices will be used during sampling and excavation activities to the extent practicable. These devices will include baffles and mufflers for construction equipment and temporary noise barrier walls around stationary noise sources such as generators. Noise-reducing practices will also be implemented where feasible, such as limiting the number of pieces of equipment running concurrently, prohibiting machinery and vehicle idling, limiting the practice of disaggregating rubble and concrete, and avoiding dropping loads into empty beds from greater height than necessary.

14. Vehicular traffic will be confined to established access and haul routes. Dump trucks waiting to get access to the site will not be allowed to idle their engines for more than 5 minutes, in accordance with California Environmental Protection Agency regulations (California Code of Regulations, Title 13, Division 3, Article 1, Chapter 10, §2485). Dump trucks waiting for access will stay on areas of gravel or paved roadways. Trucks will not be allowed to drive or park on vegetated areas along the haul routes.

15. Any period of intense haul traffic (up to 95 loads per day) will only be allowed to occur a maximum of 20 days throughout the entire proposed project duration and for no more than 5 consecutive days at a time.

16. Equipment fueling will be confined to within upland bermed areas with spill prevention kits.

17. The NASA will finalize a *Storm Water Pollution Prevention Plan (SWPPP)* of the *Area of Investigation 14 Removal Action Work Plan* that will include additional details for storm water pollution prevention. No part of the final SWPPP will replace any part of this biological opinion without reinitiation of formal consultation. The Service will review the final draft of the SWPPP and provide NASA with comments regarding any lack of consistency with elements articulated in this biological opinion.

18. Non-native vegetation removed during the proposed project (from mowing and excavation) shall be disposed of at a municipal landfill.

19. Potential perches and wildlife cover (stacks of wood, pallets, and piles of debris) will be removed from the proposed project footprint as quickly as possible and as much as is feasible. If they cannot be removed in the short term, they will be covered with tarps and/or enclosed with exclusion fencing. Minimization of these habitat elements will reduce attraction to salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern and a lack of perch opportunities will reduce potential predation on these species.

20. The NASA perimeter fence in the vicinity of salt marsh harvest mouse habitat in the storm water retention pond along North Perimeter Road will be modified with non-lethal anti-perch devices (spike strips or other non-lethal devices) to prevent raptor predation on salt marsh harvest mice, western snowy plovers, California clapper rails, and California least terns. Additional perch deterrents will be installed at structures adjacent to the SWRP, as feasible.

21. Any construction personnel who inadvertently injure or kill a salt marsh harvest mouse, western snowy plover, California clapper rail, or California least will immediately report the incident to the Service-approved biologist(s). The Service-approved biologist(s) will immediately notify the NASA, who will immediately notify the Service by telephone and email. The NASA will follow up with written notification to the Service within 5 working days of the incident by providing a hardcopy of the incident report.

Habitat Restoration

The habitat restoration proposed is predominantly for the benefit of salt marsh harvest mouse, because it has been documented in the immediate project area. The California clapper rail may also use this habitat type. As described above in the *Habitat Restoration* section of the *Project Description* and articulated in Table 1 (below), this will include grading and seeding of additional native plant species to create expanded pickelweed habitat and transitional habitat to the uplands. Because the project site is situated adjacent to a storm water retention pond, the timing, magnitude, and duration of water levels over the course of the year is not entirely predictable and consequently, the grading may afford areas that are suitable for use by the California least tern and/or the western snowy plover. Therefore, the availability of species-specific habitat will vary over and across years.

22. The NASA will compensate at a 3:1 ratio for impacts to pickleweed habitat by restoring/creating three times as much pickleweed habitat on site as is damaged or destroyed by the proposed action. It is estimated that up to 0.62 acre of pickleweed may be disturbed and will be compensated by restoring up to 1.86 acres on site. Final acreages of impacts will be delineated at the culmination of excavation activities.

23. Where feasible, restoration areas will be revegetated with pickleweed harvested from salvage areas within the removal boundary that has been grown and propagated in an off-site nursery. If additional pickleweed is needed for the restoration areas, it may also be collected from other areas in the SWRP and may be supplemented with additional nursery seedlings and seed, as necessary. The specific limits of the pickleweed harvest areas will be identified and staked by the Service-approved biologist(s) prior to the initiation of harvesting activities, and boundaries recorded with a GPS unit for documentation. Pickleweed will be collected by crews on foot and using non-motorized hand tools. No disturbance to pickleweed-vegetated areas outside of the designated harvest areas will be permitted. Pickleweed collection that occurs outside the removal boundary will be conducted in a dispersed manner by sparsely collecting pickleweed from across the entire SWRP; IR Site 25 restoration and reference areas (which will be staked prior to collection) will be avoided. Harvesting activities will take place such that existing pickleweed cover across the entire SWRP will not be reduced by more than 30 percent.

24. The restoration areas will be monitored for five years or until vegetative performance criteria articulated in Table 1 are met and suitable salt marsh harvest mouse habitat has been re-established. Harvest impacts to the vegetative cover of the pickleweed collection areas from outside of the removal boundary will be assessed over the same time period and if the deemed necessary by the Service-approved biologist, pickleweed propagules from the off-site nursery or from additional nursery seedlings and seed will be planted into these areas until the time when monitoring of the restored areas ceases.

Table 1. Vegetative performance criteria for restored areas

Parameter	Year 1	Year 2	Year 3	Year 4	Year 5
Wetland and Transitional Vegetation					
Cover of native species	≥ 10% of Reference	≥ 20% of Reference	≥ 35% of Reference	≥ 50% of Reference	≥ 75% of Reference
Community composition: Marsh plain restoration pickleweed cover	≥ 10% of Reference	≥ 20% of Reference	≥ 35% of Reference	≥ 50% of Reference	≥ 75% of Reference
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority"	< 5%	< 5%	< 5%	< 5%	< 5%
Upland Vegetation					
Percent average vegetative cover including non-invasive plant species	≥ 10%	≥ 20%	≥ 30%	≥ 40%	≥ 60%
Average cover of invasive plant species with California Invasive Plant Council (Cal-IPC) rating of "high" or South San Francisco Bay Weed Management Plan (SSFBWMP) "high" or "highest priority"	< 5%	< 5%	< 5%	< 5%	< 5%
Reference Site Requirements					

Wetland (marsh plain) transects community composition: Absolute cover of native species	≥ 70%	≥ 70%	≥ 70%	≥ 70%	≥ 70%
Minimum absolute cover of pickleweed	≥ 60%	≥ 60%	≥ 60%	≥ 60%	≥ 60%
Transitional transects: Absolute cover of native species	≥ 70%	≥ 70%	≥ 70%	≥ 70%	≥ 70%
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority"	< 5%	< 5%	< 5%	< 5%	< 5%

25. The NASA shall prepare a final *Protected Species Mitigation and Habitat Restoration Plan* (PSMHRP) with additional details of habitat restoration activities. No part of the final PSMHRP will replace any part of this biological opinion without reinitiation of formal consultation. The Service will review the draft final PSMHRP and provide the NASA with comments regarding any lack of consistency with elements articulated in this biological opinion.

Salt Marsh Harvest Mouse

26. Surveys: prior to the beginning of ground disturbance, one or more Service-approved biologists will survey the project footprint and for a distance of 10 feet beyond the project footprint for salt marsh harvest mice.
    a. Surveys will be conducted no more than 3 days prior to sampling activities and no more than 25 days (and repeated 3 days prior) to excavation activities.
    b. Surveys will be repeated daily prior to the beginning of project activities at the proposed project site; one or more Service-approved biologists will survey the proposed project site to ensure it is clear of salt marsh harvest mice.
    c. In the event that a salt marsh harvest mouse is encountered, work will be halted and a no-work zone of at least 10 feet will be maintained around the animal until the animal has moved out of the area of its own volition. If deemed necessary by the Service-approved biologist, work will be relocated to other areas as directed by the biologist, to minimize disturbance from noise, human presence, or vibration. Work will not occur in this area until it is deemed clear of mice by the Service-approved biologist. Survey reports shall be submitted to the Service quarterly and at the end of the project and should include GPS locations (latitude and longitude) and dates for observed individuals.
    d. The Service shall be notified within one day when any nest is found. Nest information reported to the Service shall include a GPS location of the nest (latitude and longitude), condition of the nest, and status of nesting activity (nest construction, feeding young, etc). Active nests shall be monitored twice weekly. Nest fate information shall be reported to the Service upon nest failure or successful weaning and information reported should include a GPS location of the nest (latitude and longitude), dates of monitoring, number of young in the nest, and fate of young upon final nest report.

27. Vegetation clearing:
    a. Once deemed clear of mice by a Service-approved biologist, the upland portion of the proposed project footprint to within 50 feet of the edge of pickleweed will be mowed to stubble no higher than 1 inch. The biologist will walk a safe distance in front of the mower to ensure no salt marsh harvest mice are present.
    b. Once deemed clear of mice by a Service-approved biologist, vegetation within 50 feet from the edge of pickleweed will be removed by hand or cut to ground level (using hand tools) in the presence of a Service-approved biologist. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving down the slope toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the mouse's tendency to stay in place and under vegetative cover, and will be instructed to work carefully through the vegetation.
    c. On slopes within the proposed project footprint, in areas deemed clear of mice and nests, pickleweed will be removed by hand or cut to ground level (using hand tools) in the presence of a Service-approved biologist. The biologist will walk a safe distance in front of vegetation removal to ensure no salt mice harvest mice are present. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the mouse's tendency to stay in place and under vegetative cover, and will be instructed to work carefully through the vegetation. Where feasible, pickleweed will be salvaged for offsite nursery propagation for use in habitat restoration on site.
    d. Vegetation will be cleared by hand or cut to ground level (using hand tools) in the presence of a Service-approved biologist to create a 4-foot buffer from the outside edge of the layout for the exclusion fence, and in a small swath (no more than 10 feet wide), to create footpaths to sampling locations in the stormwater retention pond (SWRP). The biologist will walk a safe distance in front of vegetation removal to ensure no salt mice harvest mice are present. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the mouse's tendency to stay in place and under vegetative cover, and will be instructed to work carefully through the vegetation.
    e. Vegetation will not be cleared in the vicinity of a salt marsh harvest mouse nest. The no-work zone established in Conservation Measure 26c will be adhered to, and a vegetated path from the nest and the no-work zone to another larger patch of

pickleweed within the SWRP will be left in place to allow movement of mice after weaning. After weaning, the area where the nest occurred could be cleared if necessary and with approval from a Service-approved biologist.

28. Exclusion fencing: under supervision of a Service-approved biologist, a temporary exclusion fence will be installed as close to the anticipated work areas as practicable.
    a. Before the fence is installed, Conservation Measures #s 26 and 27 will be implemented. A Service-approved biologist will inspect the fence area for salt marsh harvest mice. If a mouse is observed, it will be allowed to leave the area of its own volition. Work will not continue in this area until it is deemed clear of mice by the Service-approved biologist.
    b. The exclusion fence will be no higher than 3 feet to prevent raptor perching and will include low-density polyethylene sheeting, such as Visqueen™, to prevent mice from climbing the fence to enter the area. The sheeting will be buried at least 4 inches below the ground surface to prevent mice from burrowing under the fence. Support posts will be on the inside of the fence (work area side).
    c. The fence will extend around and enclose the entire removal action boundary and the access road and contractor staging/laydown area on the southern end, and the secondary staging area (N217A), if used. The site entrance will be closed and secured with sand bags or other material at the conclusion of each work day.
    d. Prior to excavation activities, the exclusion fence will be realigned to enclose areas requiring excavation along the perimeter of the proposed project site. In some areas (to be determined based on the extent of the excavation), it may be practicable to modify the existing silt fence with low-density polyethylene sheeting, such as Visqueen™ to function as the exclusion fence.
    e. In the event of a significant lag time between work phases, the exclusion fence will be modified to have 5-foot openings every 100 feet (or whatever distance allows movement of mice across the upland/wetland interface to large pickleweed patches within the SWRP. The fence gaps will be closed after project activity recommences and upon approval by a Service-approved biologist.

29. A Service-approved biologist will monitor the exclusion fence to ensure it remains an effective barrier to prevent entry of salt marsh harvest mice into work areas. Monitoring is required daily, prior to excavation and sampling activities. During periods of project inactivity at the site, the fencing will be monitored: (1) once weekly during clear weather and (2) within 48 hours after every storm that produces greater than 1 inch of precipitation within a 24-hour period or winds greater than 20 miles per hour (as reported by the National Weather Service Moffett Field Station); if the Service-approved biologist determines that monitoring is necessary within 48 hours after a storm that produces less than 1 inch of precipitation within a 24-hour period, the biologist will notify the NASA, who will notify the Service, with a recommended revision to this specific monitoring requirement. Maintenance of the fence will be conducted as needed throughout the work period. Any necessary repairs must be completed within 24 hours after the damage is observed. Excavation must not continue within 100 feet of the damaged fencing until the

fences are repaired and the site is surveyed by a Service-approved biologist to ensure that mice have not entered the work area.

Western Snowy Plover, California Clapper Rail, California Least Tern

30. A Service-approved biologist shall conduct breeding season daily monitoring for the western snowy plover, California clapper rail, and California least tern. Breeding season monitoring reports shall be submitted to the Service at the end of the breeding season monitoring period and at the end of the project and should include locations and dates for observed individuals.
    a. Breeding season monitoring for the western snowy plover will be conducted within the project footprint and for a distance of 600 feet from the project footprint from March 1 – September 14.
    b. Breeding season monitoring for the California clapper rail will be conducted within the project footprint and for a distance of 700 feet from the project footprint from February 1 – August 31.
    c. Breeding season monitoring for the California least tern will be conducted within the project footprint and for a distance of 300 feet from the project footprint from April 15 – August 15.
    d. The Service shall be notified within one day when any nest is found. Nest information reported to the Service shall include a GPS location of the nest (latitude and longitude), condition of the nest, and status of nesting activity (nest construction, incubating eggs, feeding young, etc). Active nests shall be monitored twice weekly until young have fledged. Nest fate information shall be reported to the Service upon nest failure or successful fledging and information reported should include GPS location (latitude and longitude) of the nest, dates of monitoring, number of young in the nest, and fate of young upon final nest report.

31. A Service-approved biologist shall conduct non-breeding season daily monitoring for the presence of individual western snowy plover, California clapper rail, and California least tern in the project footprint and for a distance of 10 feet from the project. Non-breeding season monitoring reports shall be submitted to the Service at the end of the non-breeding season monitoring period and at the end of the project and should include GPS locations (latitude and longitude) and dates for observed individuals.
    a. Non-breeding season monitoring for the western snowy plover will be conducted from September 15 – February 28.
    b. Non-breeding season monitoring for the California clapper rail will be conducted from September 1 – January 31.
    c. Non-breeding season monitoring for the California least tern will be conducted from August 16 – April 14.

32. In the event that a western snowy plover, California clapper rail, or California least tern is encountered, work will be halted by a Service-approved biologist and a no-work zone of at least 10 feet will be maintained around the animal until the animal has moved out of the area of its own volition. The NASA has determined that it cannot halt work in the

vicinity of western snowy plover, California clapper rail or California least tern nests for the length of time necessary to allow young to fledge, so stop-work in relation to nests will be until adults and any motile young have moved out of the no-work zone area of their own volition. If deemed necessary by a Service-approved biologist, work will be relocated to other areas as directed by the biologist, to minimize disturbance from noise, human presence, or vibration.

Action Area

The proposed action is located in the northern portion of NASA Ames, in Santa Clara County, approximately 10 miles northwest of San Jose. The AOI 14 consists of three peninsulas (the Former Soil Fill Area [FSFA], N217, and N217A) that extend into a SWRP that is part of the Navy Installation Restoration Site 25.

The action area is defined in 50 CFR §402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the proposed project, the action area encompasses the approximately 9.5-acre project footprint (the approximately 8-acre removal action area plus approximately 4 feet beyond the removal action area exclusion fence to include vegetation/pickleweed removal areas, the approximately 0.5-acre primary project staging and laydown area, and the approximately 1.0-acre secondary project staging and laydown area), and an additional area extending 700 feet beyond the project footprint. The 700-foot buffer is based on anticipated project-related noise and represents a breeding season disturbance avoidance buffer for these listed species.

Analytical Framework for the Jeopardy Determination

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this biological opinion considers the effects of the proposed Federal action, and any cumulative effects, on the rangewide survival and recovery of the listed species. It relies on four components: (1) the *Status of the Species*, which describes the rangewide condition of the species, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which analyzes the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

Status of the Species

Salt Marsh Harvest Mouse

The salt marsh harvest mouse was federally listed as endangered in 1970 (35 FR 16047). The listing at the species level (*Reithrodontomys raviventris*) includes two subspecies: the northern salt marsh harvest mouse (*R. r. halicoetes*), found in San Pablo and Suisun Bays, and the salt marsh harvest mouse (*R. r. raviventris*), found in the marshes of Corte Madera, Richmond, and South San Francisco Bay. Critical habitat has not been proposed or designated. A five-year review was completed in 2010 (Service 2010). A detailed account of the taxonomy, ecology, and biology of the salt marsh harvest mouse can be found in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Service 2013b).

The salt marsh harvest mouse is a Fully Protected Species under California law (California Fish and Game Code §4700).

Data are limited for estimating historical rangewide population and distribution. The salt marsh harvest mouse probably occupied most of the middle tidal, or *Sarcocornia* (pickleweed)-dominated, marsh plains and high marsh zones of San Francisco Bay, San Pablo Bay, and Suisun Marsh prior to the significant marsh reclamation of the 1840s. However, by the time of listing, it is likely that populations of the species rangewide had fallen to low levels (Service 2010).

Survey data for the species is generally sparse, with most surveys having been site-specific and relatively short term. For the northern population, the fringing salt marshes along northern San Pablo Bay (Petaluma River to Mare Island Strait), particularly the Highway 37/Mare Island Marsh and additional tidal/microtidal marshes, do support fluctuating populations of salt marsh harvest mice. Due to its large size and deep (broad) suitable salt marsh habitat, Suisun Marsh is an important site for the northern subspecies population and may contain the largest population for the species in the entire remaining range (Service 2010). Standardized annual surveys conducted there since 1997 by California Department of Fish and Wildlife (CDFW) and California Department of Water Resources (CDWR), have demonstrated fluctuations, but have shown high and increasing capture efficiencies of 10.0-11.5%, which indicates the population may be increasing (Barthman-Thompson 2010 *in* Service 2010). Surveys at other sites in the northern population's range have demonstrated similar capture efficiencies (Barthman-Thompson pers. comm. 2016). Similarly, recent research about demography and habitat use in Suisun Marsh (Sustaita *et al.* 2011) captured 1,191 individual salt marsh harvest mice in 28,104 trap nights, for an estimated density of 2.5-3.4 mice/hectare.

In general, the status of the southern population is currently considered to be more precarious than the northern population. Few major, resilient, or secure populations persist and those that do are very small and isolated compared with the historical pattern of distribution and abundance (Service 2010). Studies by Shellhammer (2005 *in* Service 2010) indicate that population size is generally correlated with the depth of the *Sarcocornia* (pickleweed) plain (i.e., the middle zone of tidal marshes). Shellhammer further noted that most of the marshes of the South San Francisco Bay are strip-like marshes and, as such, support few salt marsh harvest mice.

The salt harvest mouse is restricted to saline (salty) or brackish (somewhat salty) marsh habitats, with a *Sarcocornia* (pickleweed) dominated marsh plain middle zone, as well as and a high marsh zone being important features. Telemetry studies found mean home ranges to be approximately 0.21 hectare (0.52 acre) for the northern subspecies and approximately 0.15 hectare (0.37 acre) for the southern subspecies (Service 2010). Shellhammer (2009 *in* Service 2010) identified that generally salt marsh harvest mice do not cross large areas of open habitat (i.e. open space or unvegetated habitat). Habitat loss and fragmentation is the greatest threat to the species. Small population size and isolated populations are also a threat as these conditions increase the probability of local extirpation.

Western Snowy Plover

The Pacific coast population of the western snowy plover was federally listed as threatened in 1993 (58 FR 12864). A five-year review was completed in 2006 (Service 2006a) and a recovery plan was completed in 2007 (Service 2007). Critical habitat was designated in 1999 and revised in 2005 and 2012 (77 FR 36727). A detailed account of the taxonomy, ecology, and biology of the western snowy plover can be found in the *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover* (*Charadrius alexandrinus nivosus*) (Service 2007).

Breeding and wintering locations of the Pacific coast population of the western snowy plover are found in Washington, Oregon, and California (Service 2007). The largest number of breeding birds occurs from south San Francisco Bay to southern Baja California (Page and Stenzel 1981 *in* Service 2007; Palacios *et al.* 1994 *in* Service 2007). Four breeding areas exist in Washington (Sundstrom 2003, 2005 *in* Service 2007; Brennan and Fernandez 2004a, 2006 *in* Service 2007 Person *et al.* 2006 *in* Service 2007; Washington Department of Fish and Wildlife unpub. data *in* Service 2007), up to 14 nesting sites have been recorded in Oregon (Castelein *et al.* 2002 *in* Service 2007, Lauten *et al.* 2006a, 2006b *in* Service 2007) and over three-quarters of the California coastal breeding population is found in 8 geographic areas (Page *et al.* 1991, G. Page *in litt.* 2005a *in* Service 2007).

While western snowy plover distribution and population numbers had declined across its range prior to listing, population numbers have generally increased since the time of listing. The Pacific coast breeding range of the western snowy plover described in the species' recovery plan (Service 2007) extends from Damon Point, Washington, to Bahia Magdelena, Baja California, Mexico. The population is sparse in Washington, Oregon, and northern California. In 2006, estimated populations were 70 adults along the Washington coast (Pearson *et al.* 2006 in Service 2007), 177-179 adults along coastal Oregon (Lauten *et al.* 2006b *in* Service 2007), and 2,231 adults in coastal California and San Francisco Bay (window survey including correction factor: G. Page *in litt.* 2006, U.S. Fish and Wildlife Service 2006a *in* Service 2007).

The majority of western snowy plovers are breeding site-faithful, but some disperse within and between years. In western North America, the western snowy plover winters (here defined as late October to mid-February) mainly in coastal areas from southern Washington to Central America (Page *et al.* 1995a *in* Service 2007) and exhibit strong wintering site fidelity. The greatest threats

to the species include destruction, modification, or curtailment of habitat or range and disturbance of breeding plovers from humans and domestic animals (Service 2007).

California Clapper Rail

The California clapper rail was federally listed as endangered in 1970 (35 FR 16047). Critical habitat has not been proposed or designated. A five-year review was completed in 2013 (Service 2013a). This subspecies is one of three in California listed as endangered under the Act. The other subspecies are the light-footed clapper rail (*R. l. levipes*), which is found in tidal marshes in southern California and northwestern Baja California, and the Yuma clapper rail (*R. l. yumanensis*), which is restricted to the Colorado River Basin. A detailed account of the taxonomy, ecology, and biology of the California clapper rail can be found in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (Service 2013b).

The California clapper rail is a Fully Protected Species under California law (California Fish and Game Code §3511).

Historically, the California clapper rail was abundant in all tidal salt and brackish marshes in the San Francisco Bay vicinity, as well as in all of the larger tidal estuaries from Marin to San Luis Obispo counties. Current distribution is restricted almost entirely to the marshes of the Bay Area and where the only known breeding populations occur. California clapper rail population numbers have generally fluctuated over time and have never improved to a level warranting consideration for upgrading the status of the species since its original listing as endangered in 1970. Citing various sources, the 2013 five-year review of the California clapper rail reported a population estimated at 4,200 to 6,000 birds between 1971-1975, at only 1,500 birds between 1981-1987, and reaching an estimated all-time historical low of about 500 birds in 1991. The five-year review noted that California clapper rail numbers have rebounded slightly since the early 1990s, but that substantial increases in population may be difficult to achieve due to the current disjunct distribution of their habitat (Service 2013a).

The Invasive *Spartina* Project (ISP), a multi-partner, regional non-native *Spartina* control program, conducts annual San Francisco Bay Estuary-wide California clapper rail surveys at program-associated sites. Annual ISP California clapper rail surveys at 30 sites across the estuary from 2005-2010 showed an increase from 80 birds in 2005, to 140 birds in 2007, before declining to below 60 birds in 2010 (McBroom *et al.* 2011). The ISP has expanded the number of sites included in its rail surveys, and for 158 sites across the estuary from 2010-2015, the project reported fluctuating numbers with 577 rails in 2010, a low of 498 in 2013, and a rebound to 670 birds in 2015 (McBroom 2015). It is noted that while population levels naturally fluctuate, the significant population decreases in 2007-2008 and surrounding the years of 2010 and from 2012-2014 have been largely explained by habitat impacts from *Spartina* control activities. The severity of habitat structure impacts from *Spartina* treatments did not become demonstrated for one-two growing seasons after treatment, which resulted in a lag of several breeding seasons for impacts to California clapper rail populations to be reflected in survey results. Once the correlation was detected, *Spartina* treatment was halted at several sites, *Spartina* treatment research and related protocol modifications were instituted to minimize

impacts to clapper rails, and the program was required to increase California clapper rail habitat enhancement activities (Service 2011b, 2012c, 2013a, 2013b, 2014).

California clapper rails occur almost exclusively in tidal salt and brackish marshes with unrestricted daily tidal flows, adequate invertebrate prey food supply, well developed tidal channel networks, and suitable nesting and escape cover for refuge during extreme tides. They exhibit strong site fidelity and territorial defense and are considered sensitive to disturbance. They tend to have relatively small average home ranges of 4.7 hectares (11.6 acres) and core use areas of 0.9 hectares (2.2 acres). Threats to the species include, but are not limited to, habitat destruction and modification, low adult survivorship (ranging from 0.49 to 0.52), and predation of adults and eggs/nestlings.

California Least Tern

The California least tern was federally listed as endangered in 1970 (35 FR 16047). Critical habitat has not been proposed or designated. A five-year review was completed in 2006 (Service 2006b). A detailed account of the taxonomy, ecology, and biology is presented in the *Recovery Plan for the California Least Tern (Sterna antillarium browni)* (Service 1985).

The California least tern is a Fully Protected Species under California law (California Fish and Game Code §3511).

The species is found along the Pacific Coast of California, from San Francisco southward to Baja California. They were once abundant and well-distributed on barrier beaches along the southern California coast. While the overall extent of the range has remained essentially unchanged, the species was noted as seriously declining within that range before the 1930s (Willet 1933 *in* Service 2006b). In the early- to mid-1970s, the breeding population of California least tern was estimated at approximately 600 pairs and for the period from 1995-2005, the population was estimated as steadily increasing to approximately 7,100 pairs (Service 2006b).

The California least tern nests in colonies on relatively open beaches, which are vegetation-free due to natural scouring from tidal action. They exhibit some site fidelity, but also move among colonies. Adult terns move south along the California coast with their fledglings in the autumn, stopping to rest and feed along the migration route (Thompson *et al.* 1997 *in* Service 2006b). Little is known about the actual migration routes south of the California border, but least terns have been documented in the winter months in Baja California, on the mainland of Mexico, and on the Colima coast (Massey 1981 *in* Service 2006b), the Pacific coast of Guatemala (C. Collins, pers. comm. *in* Service 2006b), the Pacific coasts of Costa Rica (Massey 1981 *in* Service 2006b), and coastal Peru (Schulenberg *et al.* 1987 *in* Service 2006b). The greatest threats to the species include destruction, modification, or curtailment of habitat or range and disturbance of breeding terns from humans and domestic animals (Service 2006b).

Environmental Baseline

Noise

The biological assessment did not include measured background noise levels in the action area. Areas within and immediately surrounding the action area are comprised mostly of storm water retention pond, marsh, and wetland units, and contain habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. A road with limited vehicular traffic occurs in the action area and bounds the southern edge of the project site. Moffett Federal Airfield, which has light and intermittent aircraft use, is located immediately southeast of the action area. Sections of a nearby pedestrian/bicycle path (Bay Trail) run within approximately 100-500+ feet from the action area. Relative to these uses, background terrestrial noise levels in the area of the proposed project can be estimated at 67.5-75.0 dBA (dBA = decibel on an A-weighted scale - levels weighted according to sound frequency) based on a normally acceptable upper limit for noise exposure in neighborhood parks and industrial/utilities categories (U.S. Bureau of Reclamation *et al.* 2011).

Salt Marsh Harvest Mouse

Salt marsh harvest mice have been observed in the SWRP and Stevens Creek. No data were found on the population density or current distribution of salt marsh harvest mouse in the action area or NASA Ames. The Service's recovery plan shows distribution of the mouse north of the Moffett Airfield, throughout the SWRP (Service 2013b). One individual was captured at the SWRP (northeastern portion) during three nights of trapping in 1991 (Pomeroy 1991 *in* Tetra Tech 2017a), and one individual was trapped in the SWRP (Crittenden Marsh) on July 27, 1994, during 300 trap nights in July, August, and September 1994 (Layne and Harding-Smith 1995 *in* Tetra Tech 2017a). An anecdotal observation of a potential salt marsh harvest mouse in the pickleweed of the SWRP was made during a pre-construction survey for the interim action silt fence installation (Alderete 2013 *in* Tetra Tech 2017a). The California Natural Diversity Database (CNDDB 2016) has additional records of the salt marsh harvest mouse occurring 1.45 miles northeast and 2.45 miles east at Guadalupe Slough and 2.6 miles northwest at Mayfield Slough. Other populations of the southern subspecies occur throughout South San Francisco Bay, but as a whole, the southern subspecies populations are generally small and isolated compared with the probable historical pattern of distribution and abundance (Service 2013a).

A review of facility resource documents and historical survey data indicate no salt marsh harvest mouse trapping has occurred along the haul route, and no anecdotal observations of mice have been recorded in those areas. Halophytic vegetation occurs in the brackish Northern Channel and North Patrol ditches and could potentially support salt marsh harvest mice. The SWRP currently supports pickleweed and may also support salt marsh harvest mice. The 1994 survey report noted that the complete and prolonged submergence of pickleweed within the SWRP during wet years has potentially detrimental effects on the salt marsh harvest mouse (Layne and Harding-Smith 1995 *in* Tetra Tech 2017a).

Western Snowy Plover

Western snowy plovers have been observed during the winter months in the area of the SWRP as recently as 2013 (Alderete 2013 *in* Tetra Tech 2017a). Nesting birds were observed as recently

as 2014 and 2015 in Crittendon Marsh West (Pearl *et al.* 2015 *in* Tetra Tech 2017a), which abuts the western boundary of the project footprint and partially lies within the action area.

In 2014, San Francisco Bay Bird Observatory (SFBBO) documented a combined average of 12 adult plovers per week at Alviso Pond A2E (625 feet north of the action area) and Crittenden Marsh East and West (which comprise the SWRP and occupy the action area) (Tokatlian *et al.* 2014 *in* Tetra Tech 2017a). An average of 0.3 plover sightings per week were documented at A2E and Crittenden Marsh (East and West) in 2015. No nests were documented at A2E in 2014 and 2015. Alviso Pond A2E water levels are kept high to provide foraging habitat to California least terns and larger shorebirds, precluding available habitat for plover nesting. Crittenden Marsh East had 12 nests (10 hatched, two predated) in 2014 and zero in 2015; Crittenden Marsh West had two hatched nests in 2014 and one predated nest in 2015. SFBBO attributed the low nesting at Crittenden Marsh West in 2015 to high water levels and associated lack of exposed salt panne habitat throughout the nesting season, compared with available habitat (at Crittenden East) in 2014 (Pearl *et al.* 2015 *in* Tetra Tech 2017a).

Survey records from Naval Air Station Moffett Field in 1994 and 1995 indicate that western snowy plovers were observed in and near Crittenden Marsh (East and West were not distinguished), with most sightings of plovers occurring during the winter months from November 1994 to February 1995, on the levees immediately north of Moffett Field; one individual was sighted in Crittenden Marsh in July 1994 (Layne and Harding-Smith 1995 *in* Tetra Tech 2017a). More recently, a survey conducted by the NASA in December 2013 recorded two western snowy plovers in the salt flats of the SWRP (Alderete 2013 *in* Tetra Tech 2017a). A review of facility resource documents and historical survey data indicates that western snowy plovers have not been recorded along the haul route. Notably, pedestrian traffic along the Bay Trail and aircraft overflights (incoming and outgoing) from Moffett Airfield may discourage nesting in the SWRP. Studies indicate that declines in breeding occur in areas with pedestrian traffic and low aircraft overflights (U.S. Department of Transportation 2004 *in* Tetra Tech 2017a).

SFBBO notes that the most abundant potential avian predators at Crittenden Marsh are California gulls; red-tailed hawks, peregrine falcons, and common ravens have also been documented flying over A2E and Crittenden Marsh (Tokatlian *et al.* 2014 *in* Tetra Tech 2017a; Pearl *et al.* 2015 *in* Tetra Tech 2017a).

California Clapper Rail

Regionally, in Santa Clara County, California, clapper rails occur outboard of salt evaporation pond levees and along major tidal sloughs such as Alviso and Charleston sloughs; the Service's recovery plan for the rail notes that they occur in "outboard marshes of Moffett Field and Guadalupe Slough" (Service 2013b). During breeding season surveys of California clapper rails conducted by the San Francisco Estuary Invasive *Spartina* Project, rails have been detected at Alviso Slough (2.65 miles east of the project footprint), Guadalupe Slough (1.54 miles east of the project footprint), and Mountain View Slough (1.10 miles west of the project footprint), annually from 2010 – 2016. Within closer range to the project area, California clapper rails have been

detected during the breeding season at Stevens Creek to Long Point (0.25 mile west of the project footprint) in 2013 and 2016, and at Stevens Creek (0.25 mile west of the project footprint) in 2016 (McBroom 2014, 2015, 2016).

Several historical observations of California clapper rails have been documented at NASA Ames. In 1992, Orton-Palmer and Takekawa (1992 *in* Tetra Tech 2017a) observed a pair of rails and one individual in a dense pickleweed stand of Crittenden Marsh. The following year, in 1993, a single clapper rail was heard in approximately the same location during a directed California black rail survey (Burns and Harding-Smith 1993 *in* Tetra Tech 2017a). In more recent years, California clapper rails have not been detected; surveys conducted by the Navy in 2005, 2011, and 2012 had no detections of California clapper rails. The 2011 and 2012 survey reports indicate that habitat in and near the SWRP is of poor quality and nesting California clapper rails are unlikely (Alderete 2005 *in* Tetra Tech 2017a; Bumgardner Biological Consulting 2011, 2012 *in* Tetra Tech 2017a). A review of facility resource documents and historical survey data indicates that California clapper rails have not been recorded along the haul route.

California Least Tern

Regionally, nesting colonies of California least terns occur in San Francisco Bay at Alameda. California least terns also nest at Albany and at Pittsburg on Suisun Bay, and have been known to nest at the Oakland airport and Bair Island. No nesting has been documented at NASA Ames.

Several post-breeding sites in the Bay Area are located at South Bay intake salt ponds, north of the action area. Shallow tidal areas are also used, such as at the E.B. Roemer Bird Sanctuary in Alameda and at Roberts Landing in San Leandro. California least terns use the regularly flooded Service waterfowl production areas (Alviso ponds complex) that are north of the SWRP and north of the NASA Ames Moffett airfield as a post-breeding staging area. California least terns use these areas from late June through late August for foraging and roosting prior to fall migration. Adults and juveniles roost on salt pond levees and boardwalks and forage in the salt ponds and open waters of the bay (Layne and Harding-Smith 1995 *in* Tetra Tech 2017a; H.T. Harvey and Associates 2005 *in* Tetra Tech 2017a). Surveys from 1994 recorded California least terns in the flooded ponds north of the SWRP (Layne and Harding-Smith 1995 *in* Tetra Tech 2017a). A review of facility resource documents and historical survey data indicates that California least terns have not been recorded along the haul route.

Effects of the Action

General

In general, the proposed project is expected to benefit the subject species by preventing erosion and subsequent transport of contaminated material into adjacent wetlands and creating additional habitat by mitigating for disturbed pickleweed at a 3:1 ratio.

Proposed Project-Related Noise

Several pieces of equipment identified for use in the proposed project operate above the estimated background noise levels of 67.5-75.0 dBA. When multiple pieces of equipment are operating at the same time, the decibel levels may be additive: Two noises of equal level (± 1 dBA) combine to raise the noise level by 3 dBA. However, if two noises differ by more than 10 dBA, there is no combined increase in the noise level; the higher output covers any other noise (Washington Department of Transportation 2015). Equipment (and associated combined maximum noise levels at 50 feet from the source) proposed for use in the project includes, but is not limited to: tractor trailer (93 dBA), diesel generator (81 dBA), drill rig (84 dBA), hydraulic excavator (84 dBA), bulldozer (88 dBA), frontend loader (82 dBA), small dragline excavator (81 dBA), dump truck (79 dBA), grapple truck (87 dBA), scraper (84 dBA), grader (88 dBA), and roller/compactor (86 dBA). Based on this list of equipment and expected use duration and timing, the combined maximum noise output for the proposed project is expected to range from 94.1 dBA (Phase A, pilot study for two weeks) to 94.7 dBA (Phase B, full-scale investigation for six weeks) to 95.4 dBA (Phase C, removal for 12 months) at 50 feet from the source. Applying the inverse square law that noise levels decrease 6 dBA per doubling of distance from the source, wildlife within approximately 400 feet of equipment use could be exposed to noise levels of 76.0 to 77.3 dBA, and wildlife within 800 feet of equipment use could be exposed to noise levels of 70.0 to 71.3 dBA (Tontechnick-Rechner 2016 *in* Tetra Tech 2017a).

Proposed Project-Related Vibration

Vibrations from project equipment are generally expected to be short-term, of moderate frequency, and localized. Vibrations are not expected to propagate far from the source because ground vibration decreases progressively from hard rock to weak or soft soils, conditions typical of the site. Vibrations at 50 feet from the source generated from equipment during the project are estimated at approximately 15 Hertz (Hz; cycles per second) during Phase A (pilot study for two weeks), 15 Hz during Phase B (full scale investigation for six weeks), and from 40 to 46.8 Hz during Phase C (removal for twelve months).

Salt Marsh Harvest Mouse

Breeding season for the southern subspecies of salt marsh harvest mouse is from March 1 through November 30, with females having one to two litters of four mice each per year (Service 2010). The mouse lives only 8 to 12 months, so they depend on an annual reproductive success for survival (U.S. Environmental Protection Agency 2010 *in* Tetra Tech 2017a). The anticipated start date for project activities is on or after September 2017, with the project lasting approximately 14 months from the start date. This means that project activities will span at least one full breeding season for the salt marsh harvest mouse.

<u>Impacts to Individuals from Proposed Project Activities</u>

Individual salt marsh harvest mice may be crushed or otherwise killed by project-related equipment during all phases of the project. Once the exclusion fence is in place and vegetation is

cleared, the threat of crushing or otherwise killing individuals and nests will be mostly avoided. Also, while there will be a 10-foot no-work zone placed around individual mice and nests and no work will take place until the mice leave the no-work zone, all individuals encountered are expected to be harassed and possibly harmed.

Impacts to Individuals from Proposed Project-Related Noise

Hearing loss, elevated stress hormone levels, and hypertension are documented to occur for humans and animals beginning at noise exposure levels of 55 to 60 dBA (Barber *et al.* 2009 *in* Tetra Tech 2017a). No data were found on thresholds for hearing loss for mice; however, general data for mammals indicate that noise levels of 120 dBA can result in permanent hearing damage, and levels at 95 dBA can cause temporary hearing loss (NoiseQuest 2016 *in* Tetra Tech 2017a). Relative to these effects and the combined maximum noise output of 95.4 dBA at 50 feet from the source during Phase C (removal - for 12 months), it is expected that salt marsh harvest mice within 50 feet from the source during Phase C may suffer temporary loss of hearing for the duration of the project.

Masking is a significant problem for reproductive, territorial, and alarm messaging, and it affects the successful perception of motion such as that produced by predators, which in turn may have effects on mouse survival. Studies have shown that a noise increase of 3 dBA, which is just perceptible to humans, corresponds to a 50 percent loss of listening area for wildlife. Noise increases of 3 to 10 dBA correspond to 30 and 90 percent reductions in alerting distances (Barber *et al.* 2009 *in* Tetra Tech 2017a). Studies on the effects of noise on mice reproduction have shown that exposure to noise at 70 to 90 dBA for 1 hour each day during gestation decreased reproductive efficiency by decreasing live birth rates and increasing the number of stillborn pups (Rasmussen *et al.* 2009 *in* Tetra Tech 2017a). Audiogenic stressors in mice have been linked to hypertension, cardiac hypertrophy, altered electrolyte metabolism, changed immune response, altered estrus cycles, decreased fertility, and an increase of prematurely terminated pregnancies (Rasmussen *et al.* 2009 *in* Tetra Tech 2017a). Based on projected noise levels of approximately 76.0 to 77.3 dBA within 400 feet of the source and approximately 70.0 to 71.3 dBA within 800 feet of the sources, noise generated from project activities is expected to adversely affect salt marsh harvest mice in the entire action area.

Impacts to Individuals from Proposed Project-Related Vibration

Studies show that both noise and vibration induce stress in animals, and mice are more sensitive to vibration than humans (Norton *et al.* 2011 *in* Tetra Tech 2017a). In other animals, low-level whole-body vibration causes cardiovascular effects in dogs and swine, avoidance behavior in poultry, physiologic changes in rats, and behavioral changes and increases in stress-related hormones in swine. No information is available to determine the frequency ranges at which rats or mice perceive low-level vibration (Norton *et al.* 2011 *in* Tetra Tech 2017a). Although there are no comparative values of vibration thresholds in the wild, results from laboratory studies on the effects of vibration on mice indicate that vibrations in the range of 31 to 100 Hz should be avoided (Rabey *et al.* 2015 *in* Tetra Tech 2017a). Based on vibration levels from 40 to 46.8 Hz

during Phase C, salt marsh harvest mice that occur within 50 feet of the source during that phase may be adversely affected from vibration.

Impacts to Habitat

Up to 0.62 acre of pickleweed may be disturbed and will be compensated by restoring up to 1.86 acres on site. Additional area of upland and transition habitat between the salt marsh and upland areas that provides primary use habitat as well as escape cover, will be disturbed and restored. Salt marsh harvest mice may be adversely affected during the time when habitat is disturbed, but these habitat impacts will be temporary.

The removal may also require water diversion or partial localized dewatering within the SWRP, which is yet to be determined and will be based on water levels and the areas within the SWRP that require removal. If West-side Aquifers Treatment System water is diverted from entering the SWRP, the mouse would benefit from lack of inundation and increased availability of pickleweed in the surrounding SWRP. The SWRP eventually dries up by mid- to late summer, depending on winter rains. Dewatering would be localized to excavation areas. The presence of dams could temporarily alter foraging and dispersal patterns of salt marsh harvest mouse; the effects would be temporary and localized to the areas immediately around the dams and so would be minimal.

Western Snowy Plover, California Clapper Rail, and California Least Tern - Noise

The anticipated start date for project activities is on or after September 2017, with the project lasting approximately 14 months from the start date. This means that project activities will span at least one full breeding season as well as timing that includes foraging, dispersal, and migratory habitat use by the western snowy plover, California clapper rail, and California least tern. Potential effects of noise on avian species include hearing damage (permanent threshold shift) and temporary, hearing loss (temporary threshold shift), physiological and behavioral effects, masking of communication and listening.

Impacts to Individuals from Proposed Project Activities

Because there is little suitable nesting habitat in a given year within the action area for the California clapper rail, and California least tern, it is not very likely that individuals will attempt to nest within the action area during the project period. In some years there is relatively more suitable nesting habitat within the action area for the western snowy plover, so there is greater likelihood for nesting occurrence by plovers. For any of the three species, once construction activities begin, it is expected that the related human activity and noise will deter birds from attempting to nest within the action area. While a 10-foot no-work zone will be placed around individual adult and motile young western snowy plovers, California clapper rails, and California least terns until they leave the work area of their own volition, the no-work zones are not expected to fully avoid harm and harassment to these individuals. Additionally, the 10-foot no-work zone will not apply to eggs and non-motile young; therefore, harm of all eggs and non-motile young is expected. All individuals of each species may use habitat within the action area

for foraging and dispersal and it is expected that those individuals will be harassed to varying distances by project-related activities during all phases of the project.

Impacts to Individuals from Proposed Project-Related Noise

Studies indicate that birds are resistant to permanent auditory damage and hearing loss from noise exposure when exposed to high-intensity impulse noise. Birds can tolerate continuous (up to 72 hours) exposure to noises up to 110 dBA without experiencing hearing damage or permanent threshold shift. Temporary threshold shift (temporary loss of hearing that can last a few seconds to days), however, can occur from continuous noise levels between 93 and 110 dBA (Dooling and Popper 2007 *in* Tetra Tech 2017a). Relative to these effects and the combined maximum noise output range of from 94.1 dBA during Phase A (pilot study for two weeks) to 94.7 dBA during Phase B (full-scale investigation for six weeks) to 95.4 dBA during Phase C (removal for 12 months) at 50 feet from the source, it is expected that western snowy plover, California clapper rail, and California least tern within 50 feet from the source may suffer temporary loss of hearing during all phases of the project.

Studies indicate an increase in noise of 3 to 10 dBA corresponds to 30 to 90 percent reductions in alerting distances for wildlife, impairing their abilities to signal and listen, which are necessary for reproduction and survival (Service 2011a *in* Tetra Tech 2017a). Additionally, studies of noise criteria suggest that noise levels above 80 to 85 decibels are disruptive to normal behavioral patterns in birds (Transportation Noise Control Center 1997 *in* Service 2013b). Increased noise during nesting season could result in displacing birds from their nests, leaving eggs, young, and adults more susceptible to predation or environmental stress (for example, egg temperature changes, and exposure to wind and blowing sand that could result in burial of eggs. Because birds are more sensitive to disturbance during nesting and breeding season the Service has established conservative avoidance buffer distances from nests and breeding calling centers; excluding activities within 700 feet of an active nest or calling center for the California clapper rail (unless there is a substantial barrier of non-habitat, then the distance may be reduced to 200 feet), within 300 feet of an active nest for the California least tern, or within 600 feet of an active nest for the western snowy plover (Service 1999, 2008, 2012a, 2013b).

Noise from project activities can be expected to exceed estimated background levels of 67.5-75.0 dBA to a distance of approximately 800 feet (a distance which captures the nesting and calling center avoidance distances for the western snowy plover, California clapper rail, and California least tern) and to exceed 80 dBA, a level disturbing to normal bird behavior patterns, to a distance of approximately 400 feet. Considering both the species-specific breeding season avoidance buffers and noise levels disturbing to normal bird behavior, it is expected that construction noise will adversely affect California clapper rails within 700 feet from the project footprint from February 1 – August 31 (the species' breeding season) and within approximately 400 feet from the project footprint from September 1 – January 31. Construction noise is expected to adversely affect western snowy plovers within 600 feet from the project footprint from March 1 – September 14 (the species' breeding season) and within approximately 400 feet from the project footprint from September 15 – February 28. Construction noise is expected to adversely affect California least terns within 300 feet from the project footprint from April 15 –

August 15 (the species' breeding season) and within approximately 400 feet from the project footprint from August 16 – April 14.

Impacts to Habitat

Up to 0.62 acre of pickleweed may be disturbed and will be compensated by restoring up to 1.86 acres on site. The California clapper rail may also use this habitat. Additional area of upland and transition habitat between the salt marsh and upland areas that provides primary use habitat as well as escape cover, will be disturbed and restored. Because the project site is situated adjacent to a storm water retention pond, the timing, magnitude, and duration of water levels over the course of the year is not entirely predictable and consequently, habitat that is suitable for the western snowy plover, California clapper rail, and California least tern may be exposed at various times. For this reason, western snowy plover, California clapper rail, and California least tern may be adversely affected during the time when habitat is disturbed, but these habitat impacts will be temporary.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The biological assessment did not identify any future state or private activities planned in the action area. During this consultation, the Service did not identify any future non-federal actions that are reasonably certain to occur in the action area of the proposed project.

Conclusion

After reviewing the current status of the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern, the environmental baseline for the action area, the effects of the proposed NASA Ames Research Center Area of Investigation (AOI) 14 Non-Time-Critical Removal Action Project, and the cumulative effects, it is the Service's biological opinion that the NASA Ames Research Center Area of Investigation (AOI) 14 Non-Time-Critical Removal Action Project, as proposed, is not likely to jeopardize the continued existence of the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the following: (1) successful implementation of the conservation measures described in this biological opinion will minimize the adverse effects on individual salt marsh harvest mice, western snowy plover, California clapper rail, and California least tern; (2) the low likelihood that California clapper rails or California least terns will nest in the action area; (3) the small amount of habitat (approximately 0.62 acre) within the action area that will be directly disturbed; (5) the creation/restoration of approximately 1.86 acres of pickleweed-dominated salt

marsh on site; and, (6) the reduction of predation levels on salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern in the action area from minimization of predator perch opportunities.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the NASA so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The NASA has a continuing duty to regulate the activity covered by this incidental take statement. If the NASA (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the NASA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Conservation measures proposed by the NASA and described in the "Description of the Proposed Action" of the biological opinion will reduce, but do not eliminate, the potential for incidental taking of salt marsh harvest mice, western snowy plover, California clapper rail, California least tern. The Service expects that incidental take of individual salt marsh harvest mice will be difficult to detect because of the variable, unknown size of any local resident population over time and the difficulty of finding killed or injured small mammals. The Service also anticipates that incidental take of the California clapper rail will be difficult to detect or quantify because of the reclusive nature of the species. The Service considers the number of salt marsh harvest mice, western snowy plovers, California clapper rails, and California least terns subject to harassment from noise and vibrations and human activities to be impracticable to estimate. The Service,

therefore, anticipates the following levels of take as a result of implementation of the proposed project-level action.

Due to implementation of the NASA Ames Research Center Area of Investigation (AOI) 14 Non-Time-Critical Removal Action Project, incidental take for salt marsh harvest mice, western snowy plovers, California clapper rails, and California least tern and is expected in the form of:

1. harm or harassment of all salt marsh harvest mice within the approximately 9.5-acre project footprint and within 50 feet from the project footprint due to project activities and project-related noise and vibrations;

2. harm of all western snowy plovers within the approximately 9.5-acre project footprint and within 600 feet from the project footprint from March 1 – September 14 (the species' breeding season) and harassment of all western snowy plovers within approximately 400 feet from the project footprint from September 15 – February 28, due to project activities and project-related noise;

3. harm of all California clapper rails within the 9.5-acre project footprint and within 700 feet from the project footprint from February 1 – August 31 (the species' breeding season) and harassment of all California clapper rails within approximately 400 feet from the project footprint from September 1 – January 31, due to project activities and project-related noise; and

4. harm of all California least terns within the 9.5-acre project footprint and within 300 feet from the project footprint from April 15 – August 15 (the species' breeding season) and harassment of all California least terns within approximately 400 feet from the project footprint from August 16 – April 14, due to project activities and project-related noise.

5.

Reasonable and Prudent Measure

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of take on salt marsh harvest mice, western snowy plovers, California clapper rails, and California least terns:

1. The NASA will minimize the potential for harm, harassment, or mortality of salt marsh harvest mice, western snowy plovers, California clapper rails, and California least terns.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the NASA must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are non-discretionary.

1. The NASA shall minimize the potential for harm, harassment, injury, and killing of salt

marsh harvest mice, western snowy plovers, California clapper rails, and California least terns from project-related activities by implementing the Conservation Measures in this biological opinion.

2. The NASA shall comply with the reporting requirements of this biological opinion.

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the NASA shall adhere to the following reporting requirements. Should the anticipated amount or extent of incidental take be exceeded, the NASA must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within 24 hours of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Injured listed species shall be cared for by a licensed veterinarian or other qualified person, such as the Service-approved biologist for the proposed project. Notification will be made to the Assistant Field Supervisor of the Endangered Species Division at: San Francisco Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814 or by telephone at (916) 930-5603. Notification should include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the NASA shall follow the steps outlined in the *Disposition of Individuals Taken* section below.

2. The content and submittal of salt marsh harvest mouse survey reports shall be consistent with conservation measure #26, and, the content and submittal of western snowy plover, California clapper rail, and California least tern survey reports shall be consistent with Conservation Measures #s 30 and 31.

3. Sightings of any listed or sensitive animal species shall be reported to the Service and CNDDB (https://www.wildlife.ca.gov/Data/CNDDB).

4. The NASA shall submit a post-construction compliance report prepared by the on-site biologist to the San Francisco Bay-Delta Fish and Wildlife Office within sixty (60) calendar days of the date of the completion of construction activities. This report shall detail (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in meeting the conservation measures; (iii) an explanation of failure to meet such measures, if any; (iv) known project effects on the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern, if any; (v) occurrences of incidental take of these listed species, if any; (vi) documentation of employee and contractor environmental education; and (vii) other pertinent information.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Assistant Field Supervisor of the Endangered Species Division at: San Francisco Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814 or by telephone at (916) 930-5603; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement, 5622 Price Way, McClellan, California 95562, at (916) 569-8444.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the NASA Ames Research Center Area of Investigation 14 Non-Time-Critical Removal Action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(a) If the amount or extent of taking specified in the incidental take statement is exceeded;

(b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or

(d) If a new species is listed or critical habitat designated that may be affected by the identified action.

If you have any questions regarding this biological opinion, please contact Anne Mankowski, Fish and Wildlife Biologist, at Anne_Mankowski@fws.gov or (916) 930-5673 or Kim Squires, Section 7 Division Chief, at Kim_Squires@fws.gov or (916) 930-5634. Please refer to Service file number 08FBDT00-2017-F-0117 in any future correspondence regarding this biological opinion.

Sincerely,

Kaylee Allen
Field Supervisor

REFERENCES

California Natural Diversity Database (CNDDB). 2016. California Department of Fish and Wildlife.

California Department of Transportation. 2016. Technical Guidance for Assessment and Mitigation of the Effects of Highway and Road Construction Noise on Birds. June. (Contract 43A0306.) Sacramento, CA. Prepared by ICF International, Sacramento, CA, Robert Dooling, Gaithersburg, MD, and Arthur Popper, Silver Spring, MD. 87 pp.

McBroom, J. 2014. California Clapper Rail Surveys for the San Francisco Estuary Invasive Spartina Project 2014. Report prepared for the State Coastal Conservancy, San Francisco Estuary Invasive Spartina Project, Oakland, California. Olofson Environmental, Inc. Berkeley, CA. 104 pp. Accessible online at: http://spartina.org/project.htm .

_____. 2015. California Clapper Rail Surveys for the San Francisco Estuary Invasive Spartina Project 2015. Report prepared for the State Coastal Conservancy, San Francisco Estuary Invasive Spartina Project, Oakland, California. Olofson Environmental, Inc. Berkeley, CA. 111 pp. Accessible online at: http://spartina.org/project.htm .

_____. 2016. California Clapper Rail Surveys for the San Francisco Estuary Invasive Spartina Project 2016. Report prepared for the State Coastal Conservancy, San Francisco Estuary Invasive Spartina Project, Oakland, California. Olofson Environmental, Inc. Berkeley, CA. 91 pp. Accessible online at: http://spartina.org/project.htm .

McBroom, J., T. Rohmer, J. Hammond, W. Thornton, S. Chen, J. Stalker, and J. Lewis. 2011. California Clapper Rail Surveys for the San Francisco Estuary Invasive *Spartina* Project 2010. Report prepared for the State Coastal Conservancy, San Francisco Estuary Invasive Spartina Project, Oakland, California. Olofson Environmental, Inc. Berkeley, CA. 356 pp. Accessible online at: http://spartina.org/project.htm.

Rabey, K., Y. Li, N. Norton, R. Reynolds, and D. Schmitt. 2015. "Vibrating Frequency Thresholds in Mice and Rats: Implications for the Effects of Vibrations on Animal Health." *Annals of Biomedical Engineering*. Volume 43, Issue 8. August.

Rasmussen, S., G. Glickman, R. Norinsky, F. Quimby, and R. Tolwani. 2009. "Construction Noise Decreases Reproductive Efficiency in Mice." *Journal of the American Association for Laboratory Animal Science*. Volume 48(4). July.

Sustaita, D., P.F. Quickert, L. Patterson, L. Barthman-Thompson, and S. Estrella. 2011. Salt Marsh Harvest Mouse Demography and Habitat Use in Suisun Marsh, California. The Journal of Wildlife Management. 75(6):1498-1507.

Tetra Tech. 2017a. Biological Assessment: Area of Investigation 14 Non-Time-Critical Removal Action, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California. Prepared for National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California. Dated February 28, 2017. 88 pp + appendices.

U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and California Department of Fish and Game. 2011. Suisun Marsh Habitat Management, Preservation, and Restoration Plan: Final Environmental Impact Statement/Environmental Impact Report. Accessible online at: http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=781

U.S. Department of Transportation (USDOT). 2004. Synthesis of Noise Effects on Wildlife Populations. Federal Highway Administration (FHWA). Publication No. FHWA-HEP-06-016. September.

U.S. Fish and Wildlife Service (Service). 1985. Recovery Plan for the California Least Tern (*Sterna antillarium browni*). U.S. Fish and Wildlife Service, Portland, Oregon. 112 pp.

_____. 1999. Programmatic formal endangered species consultation on the proposed long-term management strategy for the placement of dredged material in the San Francisco Bay region, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 1-1-98-F-62. 41 pp.

_____. 2006a. Western snowy plover (*Charadrius alexandrinus nivosus*), 5-year review. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California. 5 pp. Accessible online at: https://ecos.fws.gov/ecp0/profile/speciesProfile;jsessionid=541F634D66C8EA8D6744A34E0EEAF2E7?spcode=B07C

_____. 2006b. California least tern (*Sternula antillarum browni*), 5-year review. U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office, Carlsbad, California. 35 pp. Accessible online at: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=8104

_____. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*). In 2 volumes. Sacramento, California. xiv + 751 pages. Accessible online at: https://ecos.fws.gov/ecp0/profile/speciesProfile;jsessionid=541F634D66C8EA8D6744A34E0EEAF2E7?spcode=B07C

_____. 2008. Formal endangered species consultation on the proposed South Bay salt pond restoration project long-term plan and the project-level phase 1 actions, Alameda, Santa Clara, and San Mateo Counties, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 81420-08-F-0621. 189 pp.

_____. 2009. Endangered species consultation for the proposed installation restoration Site 05 and the Paint Waste Area at the former Mare Island Naval Shipyard, Vallejo, Solano County, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 81420-2008-F-1844. 17 pp.

_____. 2010. Salt marsh harvest mouse (*Reithrodontomys raviventris*), 5-year review. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 61 pp. Available on the internet at: <http://www.fws.gov/sacramento/es/documents/DS%205-yr%20rev%203-31-04.pdf>.

_____. 2011b. Formal endangered species consultation for the proposed San Francisco Estuary (Estuary) Invasive *Spartina* Project: *Spartina* (ISP) Control Program and Restoration for 2011 on 95 sites; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 08ESMF00-2011-F-0686-3. 50 pp.

_____. 2012a. Biological opinion on the proposed Suisun Marsh Habitat Management Preservation, and Restoration Plan and project-level actions in Solano, County, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 08ESMF00-2012-F-0602-2. 316 pp.

_____. 2012b. Biological opinion on the proposed Doherty Drive Bridge Replacement Project in the City of Larkspur, Marin County, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 81420-2010-F-0444. 44 pp.

_____. 2012c. Formal endangered species consultation for the proposed San Francisco Estuary (Estuary) Invasive *Spartina* Project: *Spartina* (ISP) Control Program and Restoration for 2012 on 188 sites; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 08ESMF00-2012-F-0584-1. 55 pp + tables.

_____. 2013a. California clapper rail (*Rallus longirostris obsoletus*), 5-year review. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 61 pp. Accessible online at: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=4240

_____. 2013b. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. U.S. Fish and Wildlife Service, Sacramento, California. xviii + 605 pp.

_____. 2014. Reinitiation of consultation for the proposed San Francisco Estuary (Estuary) Invasive *Spartina* Project: *Spartina* (ISP) Control Program and Restoration for 2012 on 188 sites; Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara,

Solano, and Sonoma Counties, California. Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 08ESMF00-2012-F-0584-3. 2 pp.

_____. 2016. Formal consultation on the San Francisquito Creek Flood Reduction, Ecosystem Restoration, and Recreation Project, from San Francisco Bay to Highway 101, in the City of East Palo Alto, San Mateo County, and the City of Palo Alto, Santa Clara County, California (U.S. Army Corps of Engineers (Corps) file number 2013-00030S). Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service. USFWS File No: 08ESMF00-2013-F-0401. 76 pp.

Washington Department of Transportation. 2015. Biological assessment preparation advanced training manual version 10-2015. Chapter 7, Construction noise impact assessment. Washington Department of Transportation. Accessible online at: http://www.wsdot.wa.gov/NR/rdonlyres/448B609A-A84E-4670-811B-9BC68AAD3000/0/BA_ManualChapter7.pdf

PERSONAL COMMUNICATION

Barthman-Thompson, Laureen. 2016. Environmental Scientist, Wildlife, California Department of Fish and Wildlife. November 2016.

APPENDIX I
RESPONSES TO AGENCY COMMENTS

EPA/Water Board comments, dated June 13, 2017, on draft RAWP, submitted March 16, 2017

GENERAL COMMENTS

1. Consistent with ongoing discussions and comments to be provided on the Draft Sampling and Analysis Plan/Quality Assurance Project Plan (December 22, 2016), revise the RAWP [Removal Action Work Plan] to modify the ISM [incremental sampling methodology] sampling approach and statistical methodology.

Response: The RAWP will be revised to include modifications to the ISM sampling approach and statistical methodology that result from comments on the Draft Sampling and Analysis Plan/Quality Assurance Project Plan.

2. Make the figures larger, as it is difficult to read some of the information presented on the figures because the text and symbols are so small.

Response: The RAWP will be revised as described in this comment

3. Portions of the Draft RAWP refer to Tetra Tech and various contractors and their activities related to the cleanup action; however, as the lead agency, NASA is the entity responsible for all actions under CERCLA [Comprehensive Environmental Response, Compensation and Liability Act]. Revise the RAWP to describe the planned actions as those of NASA.

Response: The RAWP will be revised to minimize the discussion of specific NASA contractors as much as possible to emphasize that NASA is the lead agency and is ultimately responsible for implementing the removal action. However, the RAWP is intended to describe the work to all stakeholders, including potential removal action contractors so they can submit a complete bid to NASA. Therefore, it is necessary to identify the contractors in portions of the work plan, explain specific responsibilities of each entity, and describe how NASA and the contractors will share information internally. The division of responsibilities among NASA contractors and specific contractor names will remain in Section 1.4 (Project Personnel), Section 1.5 (Schedule), and in other sections as necessary.

SPECIFIC COMMENTS

1. **Section 1.2, Site Description and Background, page 5:** Clarify whether NASA manages the portion of the storm water retention pond that is owned by Midpeninsula Regional Open Space District. The sentence, as written, suggests that NASA manages only the central and northeastern basins.

Response: The referenced sentence will be changed to "Navy IR Site 25 includes the Eastern Diked Marsh (including the stormwater settling basin) and stormwater retention pond. The stormwater retention pond is divided into the central and northeastern basins, which are owned by NASA, and the western portion, which is owned by MROSD (Figure 4)."

2. **Section 2.1, Basis for Removal Action, page 10, 3rd paragraph:** Confirm that it is groundwater sampling results that are being relied upon for the statement that "fill contaminants have not impacted groundwater." In addition, state whether sampling from well 10A01A was conducted after 1995 and if so, what concentration(s) of tricholoroethene were detected.

Response: The referenced paragraph will be updated to indicate that groundwater sampling results indicate that fill contaminants have not affected groundwater. Information on the sampling conducted at monitoring well 10A01A will be added to Section 4.5 of the RAWP. See the response to EPA/Water Board comment #12.

3. **Section 2.2, Results of Geophysical Investigation, page 14, and Figure 6:** Explain what the red and yellow area depicted at depth on cross section A-A' indicates and why it is not included within the removal action boundary. Based on the description in the text, Figure 6 shows an area of lower resistivity (interpreted as fill) present beneath the black dashed removal action boundary and it is the fill at the site that contains the contaminants of concern.

Response: Along resistivity line RL-1 (cross-section A-A'), artificial fill appears to end at depth where the electrical resistivity changes from high to low (marked by the black dashed line between the overlying high resistivity layer and the underlying low resistivity layer). **Figure 6** in the RAWP shows the location of RL-1 (Section A-A'). The high resistivity area (red/orange area) from approximately 12 to 30 feet below ground surface (bgs) between distances 75 feet and 105 feet along cross-section A-A' appears to be associated with native geology below the artificial fill. This hypothesis is supported by (1) data indicating several similar high resistivity areas at this depth in the other electrical resistivity sections; (2) the lack of evidence of artificial fill at this depth and in this area as indicated in previous borings; and (3) a general understanding of the original deposition of the artificial fill and debris (that is, placement of the fill material on top of the native material of the former stormwater retention pond). Previous boring log 36 in the immediate vicinity of the high resistivity area (red/orange area) between distances 75 feet and 105 feet along cross-section A-A' shows interbedded peat from 10.5 to 12 feet bgs with underlying stiff, high plasticity silty clay from 12 to the bottom of the boring at 16 feet bgs that is characteristic of the native material. Boring log 36 supports the above hypothesis of why the high resistivity area (red/orange area) at depth is native and not fill. **Figure 1** below shows Boring 36 and RL-1. The results of the geophysical investigation provide an indication of the apparent depth and area of artificial fill and debris. Borings advanced as part of the site characterization will confirm the depth of the artificial fill and construction debris, and the depth of the characterization sampling will be adjusted accordingly. The text of Section 2.2 will be revised to add a sentence stating, "The dashed black line also delineates the apparent contact between artificial fill indicated by high electrical resistivity and the underlying native soil indicated by low electrical resistivity.

Figure 1 – Location of Boring 36 and RL1

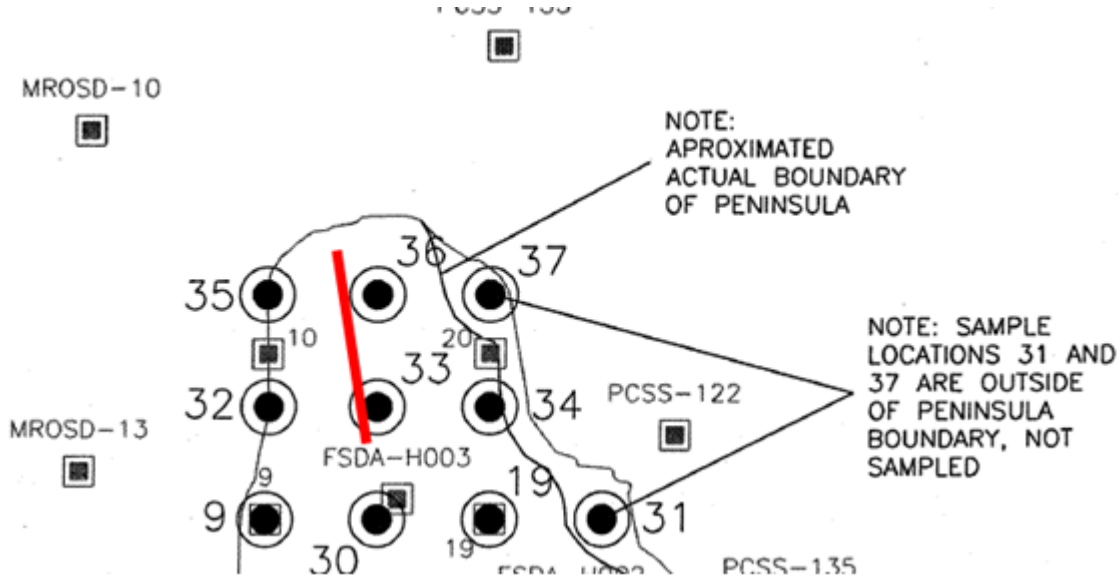
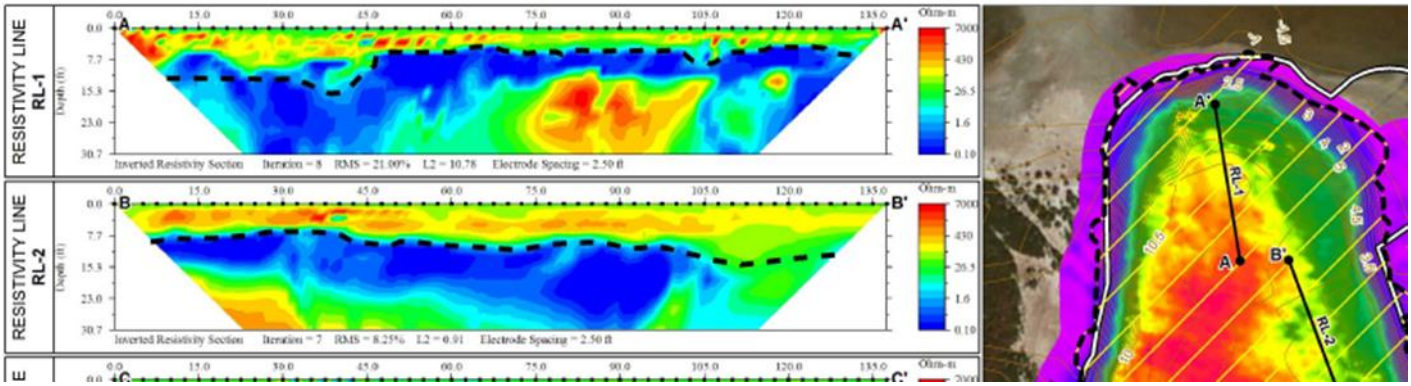


Figure 6 – Location of RL-1 (this figure is include in the RAWP as Figure 6)



The text of Section 2.2 will be revised to add a sentence indicating that "The dashed black line also delineates native soils with higher resistivity underlying the low-resistivity soils at the bottom of the artificial fill."

4. Section 2.3, Conformance with ARARs, page 17: In the second to last sentence of the section, the Draft RAWP states that "EPA has indicated that it would approve the use of 0.210 mg/kg as the PCB cleanup goal." Consistent with follow-on conversations between EPA and NASA, please revise this text and submit a written request with supporting information to EPA for authorization of the selected risk-based cleanup goals.

Response: NASA will submit a written request to EPA to provide the basis for the selected risk-based cleanup goals for PCBs. Section 2.3 of the RAWP will be updated to indicate that NASA will prepare this letter.

5. **Section 3.1, Biological Resources, page 20:** In the fourth bullet on the page, clarify that the decision criteria listed relate to whether the USFWS-approved biologist will remain on site. Also, include a reference to the appropriate section(s) of the Biological Assessment and/or Protected Species Mitigation and Habitat Restoration Plan where decision criteria are further discussed.

Response: The referenced bullet will be changed to (italics added to indicate new text): "The USFWS-approved biologist will be on site daily during surveying and sampling activities and will remain on site for the duration deemed necessary by the biologist *based on their best professional judgement on a case-by-case basis*. Decision criteria *for the biologist's presence on site* will include the current nature of project activities, degree of noise or disturbance they are producing, intensity of activities, presence of species, or other factors. *This conservation measure is also discussed in Section 2 of the BA (Appendix G) and Section 1.2 of the PSMHRP (Appendix H).*"

The BA and PSMHRP include similar language as the RAWP regarding the duration of time the USFWS-approved biologist will remain on site. The duration will be at the discretion and professional judgement of the USFWS-approved biologist, based on the decision criteria listed in the referenced bullet. Some scenarios where their presence would likely be necessary include ground disturbing activities; activities at or near noise levels indicated as thresholds in the BA; or if there are listed species present in the project work area. In these scenarios, the biologist would stay the duration to monitor activities to avoid disturbance to protected species until it has passed out of the action area.

6. **Section 3.2, Site Characterization, page 24:** The description of the borings in the SP IAGs should be clarified to state whether sampling will be conducted outside of the existing site fence and explain how access will be achieved.

Response: Section 3.2 will be modified to describe the construction of a temporary exclusion fence around the work area, vegetation removal along footpaths to sampling locations outside of the fence, and safe access to hand-sampling areas within the stormwater retention pond. The added language will be similar to the methods described in Section 1.2 of the PSMHRP and will refer to Figure 4 of the PSMHRP (Appendix H), which shows areas of pickleweed potentially disturbed by the removal action.

In addition, the description of the site characterization activities will be updated based on comments received from EPA and the Water Board on the Draft Sampling and Analysis Plan/Quality Assurance Project Plan.

7. Section 3.5, Permits and Notifications, page 28: Explain why well MW 10A01A will be abandoned and clarify if this is the only well that will be impacted by the removal action.

Response: Section 3.5, bullet 6 will be modified to reference Section 4.5 (Monitoring Well Abandonment). Section 4.5 will be modified to include the information requested in this comment. See the response to EPA/Water Board Comment #12 for more information on monitoring well 10A01A.

8. Section 3.7, Water Diversion or Damming, page 29: In the first full paragraph on the page, clarify whether wastewater from the decontamination station will be filtered and pumped into the stormwater pond or only containerized and disposed of. The sentence construction is somewhat confusing.

Response: The portion of the referenced sentence in Section 3.7 that referred to the wastewater from the decontamination station will be removed from the sentence for clarity. The sentence now states "Water that accumulates within the removal action boundary after a dam is installed or that accumulates behind the exclusion fence will be filtered and pumped into the stormwater pond (with EPA and Regional Water Board concurrence) or containerized and disposed of properly off-site."

Wastewater from the decontamination station is discussed in Section 4.9 (Decontamination of Equipment). As stated in the second paragraph of Section 4.9, waste liquids will be contained, sampled and disposed of properly or may be discharged on site with concurrence from EPA and the Water Board (depending on the results of the sampling). Also, see response to EPA/Water Board Comment #19 for discussion of wastewater disposal.

9. Section 3.7, Water Diversion or Damming, page 29: In the second paragraph, confirm that the necessary parties are notified of any diversion of WATS effluent and ensure that any necessary modification(s) to the NPDES permit are requested and approved prior to the diversion.

Response: Reuse of the treated WATS effluent is permitted under the NPDES permit for dust suppression and other uses. Section 3.7 will be modified to state that if NASA intends to divert or reuse the treated water for any purpose other than those specified in the current NPDES permit, it will consult with the Water Board before any action is taken. NASA and the Water Board caseworker will identify the necessary parties to be notified (if any).

10. Section 3.8, Construction Submittals, page 30: Clarify whether the Regrading Plan will be submitted before or after construction. Contrary to Page 30, Page 40 states "the final grading plan cannot be specified at this time."

Response: Section 4.8 (Grading and Site Restoration) will be modified to state that the final grading plan "cannot be specified *until the site characterization is complete and the final excavation areas are identified*." The grading plan will be finalized after the site

characterization is complete and before excavation begins. The final grading plan and record (as-built) drawings will be included in the removal action completion report.

11. Section 4.1.5, Contingency Plan, page 34: Revise the statement that "contaminants in on-site soil are low" as sampling has indicated that there are detections of site contaminants that are orders of magnitude greater than the cleanup goals.

Response: The referenced sentence in Section 4.1.5 will be changed to "The likelihood of unplanned releases of contaminants that could threaten human health or the environment is low because the contaminants tend to sorb strongly to soil and the release of sediment or soil from the site will be controlled through stormwater management practices, including the existing silt fence surrounding the removal action area."

12. Section 4.5, Monitoring Well Abandonment, page 37: Include sufficient information to support that monitoring well 10A01A is no longer needed for groundwater monitoring and can be destroyed and not replaced.

Response: The first paragraph in Section 4.5 will be replaced with the following paragraphs:

"Only one monitoring well (10A01A) is located at AOI 14; this well will be abandoned as part of the removal action because it is within the removal action area, will be impacted by construction activities, and is not required for ongoing monitoring. The location of monitoring well 10A01A is shown on the construction drawings (Appendix C). Monitoring well 10A01A was installed on the FSFA in 1991 to monitor potential concentrations of VOCs in groundwater as part of NASA's Center-Wide Sampling and Analysis Program.

Monitoring well 10A01A was completed to 20 feet bgs with 2-inch-diameter Schedule 40 polyvinyl chloride casing, screened from 10 to 20 feet bgs, and completed with an above-grade standpipe and bollards for protection (approximately 3 feet above ground surface). The depth to water at well 10A01A was approximately 13 feet bgs when the well was installed and the boring log for the monitoring well shows that native clay was encountered at approximately 10 feet bgs.

Samples were collected from monitoring well 10A01A semi-annually from 1991 to 1995, annually from 1996 to 2000, and once in 2004. Each sample was analyzed for VOCs. No VOCs were detected in any of the samples collected at monitoring well 10A01A except for one detection of trichloroethene (TCE) (0.61 microgram per liter [µg/L]) in the sample collected on July 6, 1995. This concentration is less than the federal and California maximum contaminant level for TCE (5 µg/L). The groundwater sample collected from monitoring well 10A01A in September 2004 was also analyzed for PCBs. No PCBs were detected in the sample.

The well is not located within or near any VOC plume or area of affected groundwater. The monitoring well has not been sampled since 2004 and no VOCs or PCBs have been detected in the well with the exception of the single TCE detection in 1995. In addition, groundwater is not a medium of concern at AOI 14 because fill material is not in contact with groundwater and because groundwater sampling results indicate that contamination is not impacting groundwater.

The contaminants detected in soil (metals, PCBs, and pesticides) generally sorb strongly to soil particles and thus, their potential for migration to groundwater is low. Therefore, monitoring well 10A01A will be abandoned and a replacement well will not be installed."

13. Section 4.7, Excavation of Contaminated Material, page 39: Confirm that the concentrations of chemicals of concern present in the fill material to be reused, if detected, will be included in the calculation of concentrations remaining on site following completion of the removal action (i.e., as part of the site-wide average).

Response: The second to last paragraph of Section 4.7 will be revised as follows:

"Analytical data from the DUs that have contaminant concentrations less than the cleanup goals (that is, not including data from DUs that will be excavated because the contamiant concentrations exceed the cleanup goals) will be used to calculate the volumetric average concentrations of lead, total DDT, and total PCBs in soil remaining at the site. These volumetric averages will be compared to the Navy IR Site 25 site-wide average remediation goals. If volumetric site-wide average concentrations of lead, total DDT, or total PCB at AOI 14 exceed the Navy IR Site 25 site-wide average remediation goals, additional evaluation or removal will be conducted at AOI 14 as part of this NTCRA. Otherwise, soil within DUs that have contaminant concentrations less than cleanup goals (clean soil) will be left in place, or if necessary, staged and stockpiled for reuse in developing final grades at the site. Based on the results of the discrete soil sampling conducted prior to 2016, it is estimated that 11,000 (bank) cubic yards of FSFA clean soil will be used for grading."

14. Section 4.8, Grading and Site Restoration, page 39: The Draft RAWP states that excavated areas within the stormwater pond will not be backfilled. Confirm the final grade of any areas excavated in the stormwater pond does not create inaccessible areas or disrupt egress paths for sensitive species, particularly the salt marsh harvest mouse.

Response: Grading for stormwater drainage and refuge for mice and other animals are two of the three general guidelines for grading listed in Section 4.8. Although the potential excavation areas within the stormwater pond will not be backfilled to avoid placing material within jurisdictional wetlands or waters of the state, Section 4.8 of the RAWP states that the "sediment will be excavated in a manner to promote drainage". Those excavation methods may include "cutting back" the sides of the excavations and or grading the sediment surrounding the excavated area to reduce or eliminate depressions within the stormwater pond. The final grading plan will include the specific volume of soil to be removed from the stormwater pond (if any) and the final grade of the disturbed area. The final grading plan will be prepared after the site characterization is completed and final excavation volumes are determined.

15. Section 4.9, Decontamination of Equipment, page 40: Confirm the use of WATS water for decontamination of equipment is allowed by the NPDES permit and/or ensure that any necessary modification(s) to the NPDES permit are requested and approved prior to its use.

Response: Please see the response to EPA/Water Board Comment #9. In addition, Section 4.9 will be modified to state "WATS water will be used if feasible *and in accordance with the NPDES permit* (see Section 3.7)."

16. Section 6.2, Sampling and Analysis Plan, page 46: Comments on the Sampling and Analysis Plan are being provided under separate cover.

Response: The RAWP will be revised to include modifications to the ISM sampling approach and statistical methodology that result from comments on the Draft Sampling and Analysis Plan/Quality Assurance Project Plan.

17. Section 6.5.2, Dust Control Plan, page 49: Confirm the use of WATS treated effluent for dust suppression is allowed by the NPDES permit and/or ensure that any necessary modification(s) to the NPDES permit are requested and approved prior to its use. If WATS effluent will be used, confirm that it will meet the necessary standards for worker inhalation safety.

Response: Please see the response to EPA/Water Board Comment #9. The current NPDES permit allows the use of water for dust control at construction sites. It lists "irrigation of landscaping or agriculture, dust control or soil compaction on construction sites, and industrial water supply" as potential reuses allowed.

Section 6.5.2 will be modified to state "As a GSR measure, treated effluent from WATS will be used for dust control, if feasible *and in accordance with the NPDES permit*."

Section 6.5.2 also will be revised to indicate that the WATS water effluent used for dust suppression will be monitored to ensure that it meets standards for worker inhalation safety at the point of discharge. The effluent will be included in the contactor's Health and Safety Plan as a potential source of VOCs and managed accordingly.

18. Section 6.6, Waste Management Plan, page 49: Confirm that the vegetative matter and construction debris, if contaminated with site chemicals of concern, will be handled and disposed of appropriately.

Response: The following sentence will be added to the end of Section 6.6.4: "*Vegetative matter will be disposed of at an appropriate off-site facility*."

In addition, Section 6.6.5 (Debris Generated During Removal Action) will be modified to include the following paragraph regarding the segregation, cleaning, and disposal of construction debris excavated during the removal action:

"Construction debris encountered during excavation will be segregated for recycling or disposal at an appropriate off-site facility, or used as backfill. NASA will determine the deposition of the construction debris based on the results of the site characterization, visual

inspection of the debris for signs of staining, and results of any wipe test or other test to detect contamination on the debris."

19. Section 6.6.6, Wastewater Disposal, page 50: Specify what standards will be used to determine whether tested water is clean.

Response: Section 6.6.6 will be changed to the following:

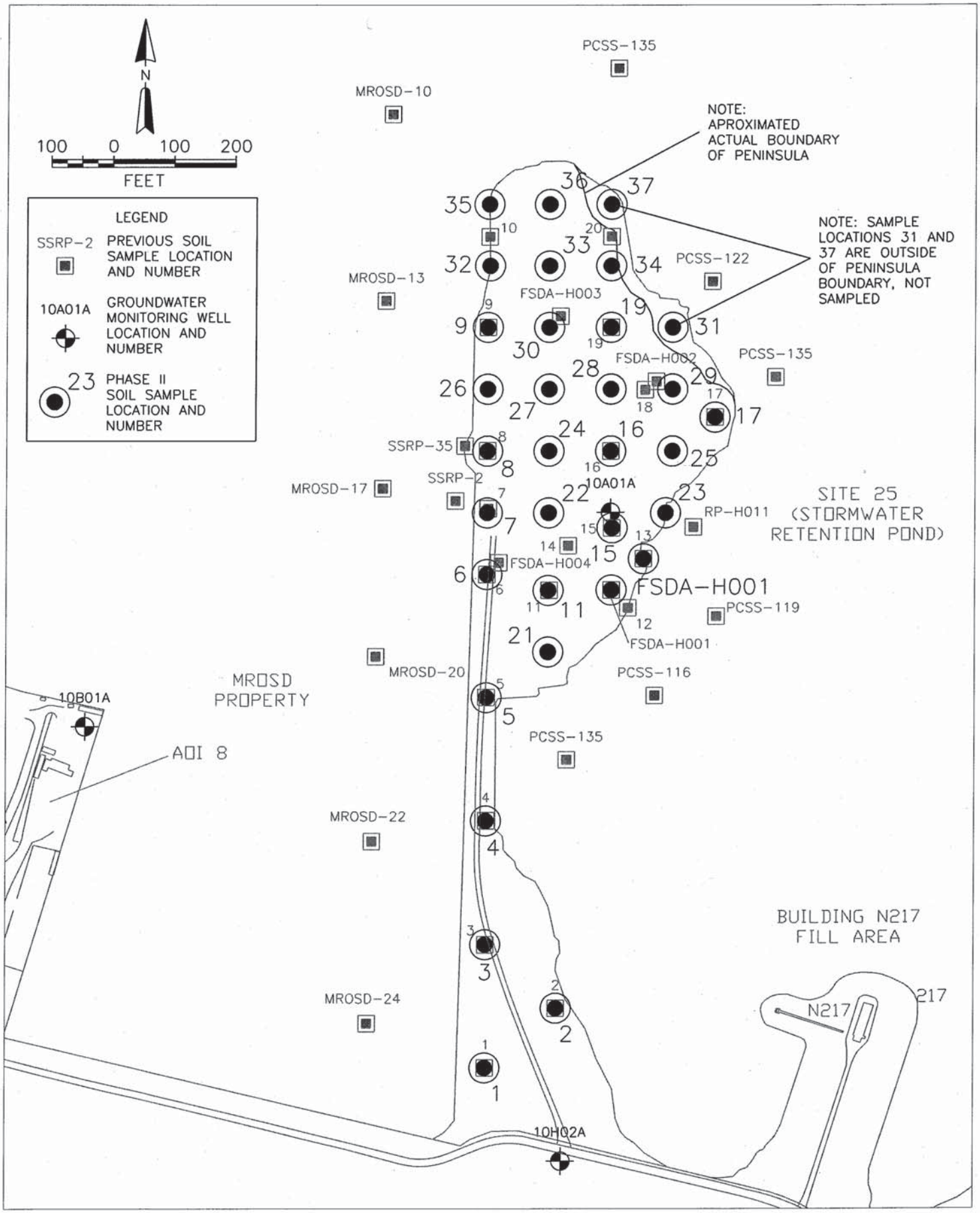
"Liquid wastes generated during the removal action will be collected and stored on site using roll-off tanks or other transportable tanks. The water will be tested for potential site contaminants including metals, pesticides, PCBs, and fuel constituents, and compared to numerical standards for Effluent Limitations and Trigger Pollutants and other water quality criteria in the NPDES permit (NPDES No. CAG91202, Order No. R2-2012-0012). If concentrations are below the numerical standards and criteria, the liquid will be discharged on site. Water not suitable for on-site discharge will be disposed of off site at a licensed disposal facility. Analytical methods and related method detection limits for the sampling of liquid waste will be consistent with those identified in the SAP for site characterization (Appendix D)."

MINOR COMMENTS

1. Section 3.1, Biological Resources, page 19: Add an "s" after "inspected for" in the first bullet.

Response: The RAWP will be revised as described in this comment.

ATTACHMENT A2
AVAILABLE SOIL BORING LOGS



Ames Research Center, Moffett Field, California 94035	TITLE: NASA AMES RESEARCH CENTER AOI 14 PHASE II ROF FSFA SAMPLE LOCATIONS	DWN: CNF CHKD: BDR DATE: 03/2007	DES.: CNF APPD: JRL REV.: 01	PROJECT NO.: AOI 14 PLATE NO.: 2

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-01

PROJECT No. A01 14 DATE 6/20/06

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet ____ of ____

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0'-2.0' grayish brown silty clay w/ angular gravel (1/2") slightly moist.

2.0'-4.0' dk brown silty clay, v. stiff, hi plast, root holes, v. moist

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-02

PROJECT No. A0114 DATE 6/20/06

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet ____ of ____

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0'-1" top soil

1.0'-3.5' angular gravel (1") in black clay matrix.

3.5'-4.0' dk brown silty clay, stiff, mod plast, v. moist

4.0'-8.0' dk gray clay, v. stiff, hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN 03

PROJECT No. A01 14 DATE
CLIENT
LOCATION
LOGGED BY BR DRILLER Gregs

BORING No.
Sheet of

Casing installation data

Drilling method
Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-2.0' med gray gravelly silt, ang gravel to 3/4"

2.0-4.0' med brown silty clay w/ gravel, gravel to 1", mottled med gray & base

4.0-6.0' mottled dk gray / dk brown silty clay, stiff, med plast, v. moist

6.0-8.0' dk gray clay, hi plast, v. stiff, v. moist

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN 04

PROJECT No. A01 14 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method Geo Probe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-5.0' lt gray mottled med gray gravelly clay, subr gravel to 1", lo plast, stiff, roots, moist

5.0-8.0' dk gray silty clay, stiff, hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN 05

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-5.0' dk gray clayey silt w/ gravel ang to sub gravel to 1/2", lo plast, med stiff, roots
moist @ 4.0'

5.0-8.0' dk gray silty clay, v. stiff, hi plast, v. moist

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN 06

PROJECT No. A01 14 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Greg

BORING No.

Sheet of

Casing installation data

Drilling method

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-3.0' med gray clayey silt w/ gravel mottled lt. brown, subA gravel to 1/2", low plast, med stiff to stiff, sand blebs

5.0-6.5' dk gray silty clay w/ tan mottling & iron staining

6.5-8.0' dk gray silty clay, v. stiff, hi plast, v. moist.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-07

PROJECT No. A0114 DATE
CLIENT
LOCATION
LOGGED BY CNF DRILLER Gregg

BORING No.
Sheet
of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-4.0' med brown sandy gravel w/ fines fine-med sand, gravel to 1", loose

4.0-8.0' silty gravelly clay, med gray, gravel to 1", med stiff, lo plast.

8.0-12.0' dk gray clay, v. stiff, hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-08

PROJECT No. A0114 DATE
CLIENT
LOCATION
LOGGED BY JRL DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method GeoProbe
Hole dia.

Water level				
Time				
Date				

Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
						0-4.0' med gray gravelly clay, dry
						4.0-8.0' med brown gravelly clay, minor silt, damp @ base
						8.0-10.0' med brown gravelly clay, damp
						10.0-12.0' dk gray silty clay, roots, black concretions, stiff, hi plast, damp

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-09

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-5.0' med gray clayey silt w/ gravel, loose-med dense, dry

5.0-5.5' gravel w/ sand

5.5-7.5' dk gray clayey silt w/ sand

7.5-8.0' sand w/ gravel

8.0-11.5' dk brown sandy clay, fine/med sand, stiff, lo plast.

11.5-12.0' sand, med

12.0-14.0' same as 8.0-11.5

14.0-16.0' dk gray/blk clay, stiff, hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-11

PROJECT No. A01 14 DATE
CLIENT
LOCATION
LOGGED BY GR DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-1.0' TOPSOIL

1.0-7.0' med brown gravelly sandy clay, fine-med sand, ang gravel to 1/2", low plast., damp

7.0-9.5' color change to med gray

9.5-12.0' dk gray silty clay, v. stiff, hi plast, moist-v. moist

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN - 13

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-1.0' Topsoil

1.0-6.0' med brown sandy clay w/ gravel
Fine-med sand, gravel to 1"

6.0-9.0' color change to med gray

9.0-12.0' dk gray silty clay, v. stiff
hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-15

PROJECT No. A01 14 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gross

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-6.0' med brown sandy gravel w/ fines, fine-med sand, gravel to 1-1/4", loose

6.0-9.0' NO RECOVERY

9.0-10.0' dk gray gravelly clay, gravel to 1", stiff, med plast, wet

10.0-12.0' dk gray silty clay, v. stiff, hi plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-16

PROJECT No. A0114 DATE
CLIENT
LOCATION
LOGGED BY JRL DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method GeoProbe
Hole dia.

Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
						0-4.0' med gray silty sandy gravel, loose, dry.
						pieces of visqueen plastic at 4.0'.
						4.0-7.0' med brown silty clay, damp at base.
						7.0-10.0' dk gray silty clay, some mottling, damp.
						10.0-15.5' dk gray/black clay, hi plast, organics, roots, damp.
						15.5-16.0' med gray gravelly silty clay, concretions, organics, v. moist-wet.

Water level				
Time				
Date				

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-21

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Greg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-1.0' Topsoil

1.0-7.5' med brown sandy silty clay w/ gravel mottled lt. brown, v. fine - fine sand, subr gravel to 1.5", dry

gravel + sand decrease downward

color change to med gray at 6.0' v. moist

7.5-12.0' dk gray silty clay, v. stiff, hi plast, wet

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-22

PROJECT No. A01 14 DATE

CLIENT:

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-3.0' sandy gravel w/ fines, med brown, fine-med sand, gravel to 1", loose

3.0-5.0' sandy gravelly clay, med brown, dry, friable.

5.0-9.0' med brown silty clay w/ gravel mottled lt. brown, med stiff, mod plast.

9.0-10.5' dk gray sandy clay, med sand, stiff, med plast, v moist.

10.5-12.5' dk gray / blk silty clay, stiff-v. stiff, hi plast.

12.5-14.0' gley clay, v stiff, hi. plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-23

PROJECT No. A01 14 DATE
CLIENT
LOCATION
LOGGED BY BR DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method GeoProbe
Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
Water level							
Time							
Date							

0-0.5' topsoil

0.5-5.0' med brown silty clay w/ gravel

5.0-6.5' med brown sandy silt w/ gravel coarse sand, loose-med dense

6.5-10.0' gravelly sandy clay, dk gray gravel increases downward

10.0-10.5' dk gray gravelly clay

10.5-12.0' dk gray silty clay, stiff, hi. plast.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-24

PROJECT No. A01 14 DATE
CLIENT:
LOCATION
LOGGED BY JRL DRILLER Gregs

BORING No.
Sheet of

Casing installation data

Drilling method Geoprobe
Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-4.0' med gray sandy gravel w/ fines, loose

4.0-4.5' dk gray silty gravel, dry, possible asphaltic material.

4.5-8.0' med brown silty clay w/ gravel damp @ 8.0'

1" coarse sand lense at 7.5', wet

8.0-12.0' dk gray/black clay, organic material + roots, stiff, hi plast., damp-moist.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-25

PROJECT No. A01 14 DATE
CLIENT
LOCATION
LOGGED BY BR DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method ~~Gr.~~ GeoProbe
Hole dia.

Water level				
Time				
Date				

Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
						0-0.5' Topsoil
						0.5-2.5' sandy gravel w/ fines, loose
						2.5-11.5' dk gray gravelly clay, gravel to 1/2", slt. moist.
						grades sandy downward
						7.0' color change to dk. brown sand decreases downward
						11.5-14.0' dk gray silty clay, stiff, h. plast.
						14.0-16.0' gley clay, stiff, h. plast. concretions.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-26

PROJECT No. A0114 DATE

CLIENT:

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-3.0' sandy gravel w/ fines, loose.

3.0-7.0' dk gray gravelly clay, gravel to 1/2". sand increases downward

7.0-11.5' dk brown gravelly clay, minor med sand.

11.5-14.0' dk gray silty clay, stiff, hi plast.

14.0-16.0' gley clay, stiff-v stiff, hi plast. concretions.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-27

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
							0-1.0' TOPSOIL
							1.0-8.0' dk brown silty clay, lo plast, dry
							grades siltier downward
							Some sub4 gravel (1/4") at 6.0-7.0'
							8.0-11.5' mottled lt gray/dk gray silty clay,
							minor gravel, v. moist @ base
							11.5-16.0' dk gray silty clay, stiff, hi plast

Water level				
Time				
Date				

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-28

PROJECT No. A01 14 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-1.0' TOPSOIL

1.0-8.0' dk brown silty clay, lo plast

Silt increases downward

4' Sandy lease 4"

8.0-11.5' mottled lt brown/dk gray silty clay mod plast, v. moist @ base

11.5-16.0' dk gray/black silty clay, stiff. hi plast

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-30

PROJECT No. A0114 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-8.0' med gray clayey silt w/ gravel loose - med dense, dry

@ 5' 4" lense of ∆ gravel to 1"

@ 7' 4" lense of sand + gravel

8.0-11.5' dk brown sandy clay, med sand, stiff, lo plast

11.5-12.0' sand layer, fine/med

12.0-14.0' SA 8-11.5

14.0-16.0' dk gray/black clay, stiff, hi plast

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-32

PROJECT No. A01-14 DATE

CLIENT

LOCATION

LOGGED BY JRL DRILLER Gregs

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-11.5' gray clayey silt

11.5-12.0' dk gray silty clay, organics, damp

12.0-12.5' peaty layer w/ roots, gravelly at base.

12.5-16.0' black clay, organics, wet.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-33

PROJECT No. A0114 DATE 6/21/06

CLIENT

LOCATION

LOGGED BY JRL DRILLER Gregg

BORING No.

Sheet ____ of ____

Casing installation data

Drilling method Geoprobe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)	DESCRIPTION
Water level							
Time							
Date							
							0-4.0' sandy silt, gray, dry, loose.
							4.0-8.0' sandy silt, gray, loose-med dense, dry
							8.0-10.0' dk gray silty clay, damp
							10.0-11.0' dk brown gravelly sand+silt, damp
							11.0-15.5' dk gray/black silty clay, organics, moist
							15.5-16.0' med gray clayey silt, moist.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-34

PROJECT No. A01 14 DATE

CLIENT

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-6.0' dK gray gravelly clay, loose to med dense

6.0-10.5' dK brown gravelly clay, med stiff-stiff, med plast

10.5-12.0' peaty interbeds w/ concrete dust.

12.0-16.0' dK gray clay, stiff, hi plast

lost sample shoe

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-35

PROJECT No. A0114 DATE

CLIENT:

LOCATION

LOGGED BY BR DRILLER Gregg

BORING No.

Sheet

of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-0.5' Topsoil

0.5-1.0' gravel

1.0-6.0' med brown silty clay w/ gravel
dk gray mottling downward

6.0-10.0' dk gray silty clay, stiff, mod plast
minor gravel.

10.0-11.5' dk gray silty clay, stiff, hi plast.

11.5-12.0' peaty area.

REMARKS:

FIELD EXPLORATORY BORING LOG

Field location of boring:

PEN-36

PROJECT No. A01 14 DATE
CLIENT
LOCATION
LOGGED BY BR DRILLER Gregg

BORING No.
Sheet of

Casing installation data

Drilling method GeoProbe

Hole dia.

	Blows/ft. or Pressure PSI	Type of Sample	Sample Number	Depth	Sample	Soil Group Symbol (U.S.C.S.)

Water level				
Time				
Date				

DESCRIPTION

0-1.5' dk gray gravelly clay, loose, dry

1.5-3.5' angular gravel to 1¼"

3.5-8.0' dk brown gravelly clay

8.0-10.5' dk gray silty clay w/ gravel stiff, lo plast

10.5-12.0' peaty interbeds.

12.0-16.0' dk gray silty clay, stiff, hi plast.

REMARKS:

EPA/Water Board comments, dated June 13, 2017, on Appendix F (DRAFT), Stormwater Pollution Prevention Plan, submitted March 16, 2017

SPECIFIC COMMENTS

20. Appendix F, Stormwater Pollution Prevention Plan (SWPPP):

a. **Section 1.6, Required Non-Compliance Reporting, page 4:** Identify the Legally-Responsible Person (LRP), or, at a minimum, the organization the LRP represents.

Response: The LRP (Garrett Turner, NASA Ames) is identified on the title page of the SWPPP and the signature page (page ix).

b. **Section 2.1.2, Project Description, page 10:** Confirm that the regulatory agencies will be provided final grading plan(s) prior to implementation.

Response: Please see the response to EPA/Water Board Comment #10. The final grading plan will incorporate the results of the site characterization and the evaluation of the volume of soil to be excavated, which will be reviewed with the regulatory agencies after site characterization is complete. The final grading plan will be part of the Removal Action Completion Report, which will be sent to the regulatory agencies.

c. **Section 2.4, Findings of the construction Site Sediment and Receiving Water Risk Determination, page 13, and Table 2.2, Summary of Receiving Water Risk, page 14:** Update the text to reflect beneficial uses and 303(d) list as identified in the 2017 Basin Plan[1].The statement regarding beneficial uses of San Francisco Bay is not accurate based on Table 2-1 of the current Basin Plan. In addition, confirm the receiving water risk using the updated information.

Response: The most recent Basin Plan amendments were adopted May 4, 2017; however, the last Basin Plan amendment affecting the receiving water body risk assessment was adopted in 2010 and was, therefore, incorporated into the risk assessment. Additionally, the only change in the 2010 amendment was SPAWN beneficial use was changed from "potential" to existing for San Francisco Bay, South.

The statement regarding beneficial uses of San Francisco Bay, South is accurate based on Table 2-1 of the current Basin Plan: San Francisco Bay, South is not listed for SPAWN *and* COLD *and* MIGRATORY (emphasis added), meaning it is not listed for all three beneficial uses. It is listed for SPAWN and MIGRATORY, but not COLD; therefore, it is not a high receiving water risk. This statement will be restated as, "Jagel Slough has no 303(d) listings or designated beneficial uses. San Francisco Bay, South is

not a 303(d)-listed waterbody impaired by sediment and does not have the designed beneficial use of "COLD", as per the San Francisco Bay Basin Plan that includes amendments adopted through May 4, 2017 (Basin Plan); therefore, the Receiving Water Risk is low." In addition, the following footnote will be added, "As per the General Permit's Risk Level Determination Worksheet (Appendix 1 of the CGP), a water body must have the beneficial uses of SPAWN, MIGRATORY, and COLD to be a "high" receiving water risk water body. San Francisco Bay, South has the beneficial uses of SPAWN and MIGRATORY, but not COLD and thus, is low receiving water risk." Table 2.2 was also modified to clarify this point in the fourth column heading: "Beneficial Uses of COLD and SPAWN and MIGRATORY".

d. **Table 2.3, Required Map Information, page 16:** Include a note that states where the figures are located. The table of contents for the SWPPP does not include a list of figures.

Response: A list of site maps included in Appendix B will be added to the table of contents for the SWPPP.

e. **Table 3.1, BMP Implementation Schedule, page 18:** Include the names of each temporary materials management BMP (WM-01, WM-07, WM-09, WM-10). While names of the other BMPs are included in the table, the specific "WM" BMPs are not identified.

Response: The name of each BMP for temporary materials management will be added to Table 3.1.

f. **Table 7.1, Summary of Visual Monitoring and Inspections, page 41:** Clarify Note 1 regarding which BMPs will be inspected more frequently than weekly. The note states the BMPs "identified below" must be inspected more frequently; however, it is not clear where in the table notes or text the BMPs being referenced are listed.

Response: Note 1 will be reworded to "Most BMPs must be inspected weekly; tracking control BMPs must be inspected more frequently than weekly."

g. **Section 7.7.1.1, Sampling Schedule, page 46:** Specify from where the "unaffected background" sample will be collected.

Response: The first sentence of the paragraph after Table 7.5, page 47, states that the unaffected background samples will be collected at sample location 6. This location is also indicated on Table 7.6.

h. **Table 7.7, Potential Non-Visible Pollutants and Water Quality Indicator Constituents, page 49:** Clarify why polychlorinated biphenyls (PCBs) are not listed as a potential water quality indicator for contaminated soil. In addition, clarify why

fuels are not listed as a potential pollutant and water quality indicator for vehicle and equipment use.

Response: PCBs will be added as a potential water quality indicator for contaminated soil. Fuels will not be listed on Table 7.7 as a non-visible pollutants as they create a visible sheen.

i. **Section 7.7.1.3, Monitoring Preparation, page 50:** Check the appropriate boxes to indicate how samples will be delivered to the laboratory. No delivery method has been selected.

Response: The text of Section 7.7.1.6 (Sample Analysis) will be modified to say: "The analytical methods and sample delivery method will be updated upon identifying a laboratory for sample analysis."

j. **Section 7.7.2, Sampling and Analysis Plan for Non-Storm Water Discharges, page 52:** Specify what the "above authorized storm water discharge" includes.

Response: "Water from dust suppression" will be added to the referenced sentence.

k. **Section 7.8.4, QA/QC3 Samples, pages 61-63:** Explain the rationale for which QA/QC samples are being collected, and include why no equipment blanks, field blanks, and travel blanks are being collected.

Response: Equipment blanks will not be collected because equipment is not being used for sample collection; all samples are grab samples. Travel and field blanks will not be collected because these are only necessary when sampling for VOCs. Section 7.8.4 will be modified to include this rationale.

l. **CSMP Attachment 2, Monitoring Records:** Include a space on the form for the inspector's employer (e.g., company name).

Response: The BMP Inspection Report form will be modified to include space for the inspector's employer/company name.

EPA/Water Board comments, dated June 30, 2017, on Appendix H (DRAFT) Protected Species Mitigation and Habitat Restoration Plan

SPECIFIC COMMENTS

1. **Section 1.2, page 8:** The second and third open bullets (○) on the page state that "upland vegetation has been mowed" and "Once deemed clear of special status species..., the upland portion of the FSFA peninsula will be mowed to stubble no higher than 1 inch," respectively. Rectify this apparent inconsistency and clarify when mowing of upland vegetation will occur.

Response: Text will be revised to clarify that mowing will occur as necessary, to maintain vegetation in the upland at 1 inch or less.

2. **Section 2.1, page 39:** The text states that the USFWS-approved biologist will ensure that contractors comply with conservation measures described in the BA; however, as lead agency, NASA is the entity ultimately responsible for ensuring work adheres to the BA. Revise the PSMHRP accordingly.

Response: Text will be revised to clarify NASA as the lead agency responsible for ensuring work adheres to requirements of the BA and BO. Also, please see the response to EPA/Water Board General Comment #3 on the RAWP.

3. **Section 4.1.1, page 56:** The first paragraph states that quarterly visits will likely suffice for the remainder of the 5-year habitat maintenance and monitoring period; however, please clarify that more frequent inspections and weed removal may be implemented if warranted by observed weed encroachment.

Response: Text will be revised to clarify that more frequent inspections and weed removal may be necessary, as determined by the professional judgement of the restoration biologist.

4. **Section 4.1.3, page 58:** The text states that a 30% morality of replacement plantings is usually projected in initial restoration calculations and budgets. Clarify if the AOI 14 RAWP and PSMHRP have allotted for the likely 30% mortality of replacement plantings.

Response: The PSMHRP does not provide specific quantities, only percentages of herbaceous and shrub/sub-shrub species. Plant quantities are not provided as the final grading plan is yet to be determined. Text will be added to clarify that the final restoration plan should account for 30 percent mortality, and the budget for plant material and installation should account for replacement costs of approximately 30 percent of originally installed plant material.

5. **Section 4.21, page 59**: Under the Photo-documentation subsection, the text states that a minimum of four locations will be established at the "restoration areas." Define the term

"restoration area" and clarify if it is the same as an "action area," another term used in the PSMHRP. Ensure that the use of these terms throughout the RAWP and PSMHRP do not confuse activities planned for "excavation areas," "IAGs," etc.

Response: Text will be revised to define "restoration area," which differs from the "Action Area," defined in Section 1.3: "as defined by 50 CFR §402.02, includes all areas of project activity that could directly or indirectly affect federally listed species".

The restoration area includes areas where Removal Action excavation occurs (conceptually shown on Figure 9), and restoration (soil decompaction and seeding) may be necessary in the staging areas and the access road of the FSFA, as stated in Section 3.1, page 50. Section 3.0 will be revised to clarify the definition of "restoration area."

6. **Section 4.21, page 59:** Under the Vegetation Monitoring subsection, the text states that a minimum of six total, or three transects for each habitat type will be established. The PSMHRP describes three habitat types: wetland, transitional, and upland. Based on this, one would expect a minimum of nine transects. Please clarify the number of transects that will be used to monitor vegetation in each habitat type.

Response: Text will be revised to state a minimum of nine transects should be established throughout the restoration site.

7. **Section 4.21, page 59:** Under the Vegetation Monitoring subsection, the text states that each 20-meter transect will include ten 1-square-meter quadrants randomly placed for each monitoring event; however, text in the first paragraph on page 60 suggests that all 10 quadrants will be sampled each monitoring event. Clarify if the random placement of the quadrants corresponds to random selection for inspection. The text is somewhat confusing.

Response: Text will be revised to clarify that permanent transects will be established and will be surveyed for each annual event, with quadrants placed randomly along the permanent transect for each event.

RESPONSES TO COMMENTS ON SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN/QUALITY ASSURANCE PROJECT PLAN)

Agency comments and NASA's responses are included in Appendix A of the Final SAP/QAPP

RESPONSES TO CDFW COMMENTS ON DRAFT PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN AND BIOLOGICAL ASSESSMENT

RESPONSES TO CDFW COMMENTS ON DRAFT PROTECTED SPECIES MITIGATION AND HABITAT RESTORATION PLAN AND BIOLOGICAL ASSESSMENT

AOI 14, NASA Ames, Moffett Field, California
November 21, 2017

Responses to California Department Fish and Wildlife comments (dated July 17, 2017, on Draft Protected Species Mitigation and Habitat Restoration Plan (PSMHRP), submitted April 24, 2017, and the Biological Assessment, submitted March 1, 2017) and per agreements made during August 10, 2017 call between NASA, NASA team (Leidos Inc., and Tetra Tech, Inc.), and CDFW

General Comments on the Draft PSMHRP

1. *Please include the following biological avoidance, minimization, and mitigation measures in the PSMHRP.*

    a. *Pre-construction biological surveys shall be conducted by a qualified biologist approved by the U.S. Fish and Wildlife Service (USFWS) and CDFW-OSPR. These surveys shall be conducted for all access routes, staging and storage areas, stockpile and dewatering areas, decontamination areas, and work areas within 14 days before the start of any project activities.*

Response: Text will be revised in the BA and Final PSMHRP to incorporate the requirements of the conservation measures as stated in the project Biological Opinion (BO) and the timing as stated above; surveys will occur within 14 days and, then again, no more than 3 days prior to activity. CDFW and NASA agreed on 8/10/2017, that the "work area" as stated above is the same as "project footprint" used in the BA and PSMHRP. The definition of "project footprint" has been further clarified with USFWS (email correspondence 10/19/2017) to include the area that could be directly physically disturbed by the Proposed Action (staging and laydown areas, the removal action boundary, and a four-foot buffer beyond the removal action boundary exclusion fence to include the pickleweed removal areas). Text will be added to the Final PSMHRP to include this text. The final project footprint will be based on the results of site characterization sampling.

    b. *The qualified biologist shall have the authority to stop work if deemed necessary for any reason to protect special status species.*

Response: Text will be revised as stated with the following additional clarifying text at the end of the statement: "consistent with the biological conservation measures of the Final PSMHRP and BO."

    c. *If remedial activities occur during the nesting season (February 1 - September 15), a focused survey for nesting birds shall be conducted by the qualified biologist for all access routes, staging and storage areas, stockpile areas, decontamination areas, and work areas 1 to 2 weeks prior to commencement of any project activities or return to work activities. The*

> *qualified biologist will survey the work area and all natural habitats occurring within 500 feet of the work area, to identify active nests. The qualified biologist shall look for new nests at least twice per week during remedial activities that occur during nesting season.*

Response: Text will be revised as stated. It was agreed on the 8/10/2017 call that the survey areas will include portions of the haul routes that are adjacent to wetlands and burrowing owl preserves (shown on Figure 6 of the PSMHRP). The construction trailer areas would be surveyed upon initial setup and as needed, as determined by the biologist. It was agreed that the haul routes that are in developed areas and not within 500 feet of habitat, would not be surveyed.

> *d. If nesting birds are observed during focused surveys, CDFW-OSPR and USFWS shall be notified and the nest locations identified on a map. No project activity shall occur within 250 feet of an identified active nest for raptors, 100 feet for other non-listed birds, or 500 feet for the rails, or until the young have fledged (as determined by the qualified biologist) or until the project proponent receives authorization from CDFW-OSPR and USFWS to proceed. If the qualified biologist and CDFW-OSPR determine the project activities are not likely to adversely affect the nest, CDFW-OSPR may authorize the project proponent to proceed. The qualified biologist shall remain on site during work activities to monitor the activity of the nesting birds. If the birds behave normally, the qualified biologist shall monitor them twice per week to ensure the status has not changed. If the birds change their behavior as a result of work activities, the qualified biologist shall continue to monitor the birds as work is moved a greater distance from the nest until the birds behave normally. The qualified biologist shall then monitor the birds twice per week to ensure the status does not changed. Through consultation with CDFW-OSPR, measures will be developed to minimize further impacts to nesting birds. Vegetation containing nests that must be removed as a result of project implementation shall be removed during the non-nesting season (September 16 — January 31).*

Response: Text of the Final PSMHRP will be revised as stated and with the following clarifications. In addition to the above-stated nest buffers, on the 8/10/2017 call, CDFW requested NASA adhere to a 500-foot buffer for white-tailed kite nests and a 600-foot buffer for burrowing owl nests. It was agreed that nest buffer distances may be modified, depending on results of nest monitoring and whether the project activity is affecting behavior. Work activities would be altered or relocated where feasible until nestlings fledge, and based on input from the project biologist. CDFW clarified that stop work would be determined by the onsite biologist. Text will be revised per the above and the Final PSMHRP will incorporate the above requested buffers.

e. *If a rare plant species is observed, CDFW-OSPR and the USFWS will be notified and the NASA ARC will coordinate appropriate avoidance, minimization, and mitigation measures with these agencies. The qualified biologist shall direct the contractor on how to proceed accordingly.*

Response: Text will be revised as stated and per the notification requirements of the BO.

f. *If any areas containing pickleweed or vegetation within 50 feet from the edge of pickleweed need to be cleared for project activities, the vegetation shall be removed only using non-motorized hand tools (i.e., trowel, hoe, rake, and shovel). No motorized equipment, including weed whackers or lawn mowers, shall be used to remove such vegetation. Vegetation shall be removed under the supervision of a qualified biologist approved by CDFW-OSPR and USFWS. If a mouse of any species is observed within the areas where vegetation is being removed, work will cease, CDFW- OSPR and USFWS shall be notified and the mouse shall be allowed to leave of its own volition. Vegetation removal may begin when no mice are observed and shall start at the edge farthest from the salt marsh and proceed towards the marsh. This method of removal provides cover for SMHM and allows SMHM to move towards the salt marsh on its own volition as vegetation is being removed.*

Response: Text will be revised to mirror vegetation removal requirements of the BO, which include hand removal in and within 50 feet of pickleweed, and mechanical clearing in the upland (to within 50 feet of pickleweed). Revised text will include direction on removing vegetation in layers, to provide an opportunity for mice to relocate, starting with the top layer first, working down the slope, and working by standing in the cleared area.

Text will be included that NASA can use electric mowing equipment for maintenance once the exclusion fence is installed and with the approval from the biologist that the fence is intact and no mice are on site.

Text that addresses environmental awareness training will be revised to include direction on vegetation removal methods, and to instruct on the mouse's behavior of staying in place and under cover. Based on direction from USFWS (in 8/22/17 consultation correspondence) that the change to "any mouse species" would be inappropriate, text will not be added to direct stop work for "a mouse of any species." This text, however, will be added to the Final PSMHRP in the context of environmental awareness training and at the introduction to the federally listed species-specific conservation measures.

g. *The final design and proposed location of the SMHM exclusion fencing shall be reviewed and approved by CDFW-OSPR and USFWS prior to placement. The qualified biologist will have the ability to make field*

adjustments to the location of the fencing depending on site-specific habitat conditions.

Response: NASA will email CDFW and USFWS a copy of the final layout of the fence location. It was agreed during the 8/10/2017 call that a site visit by CDFW will not be necessary. Text will be revised to state that the opening of the exclusion fence where trucks access the site will be closed and secured at the conclusion of each work day to prevent entry to the site by mice. Sand bags may be used to secure the fence closed in this area.

h. *Restoration areas will be revegetated with pickleweed cuttings harvested from adjacent undisturbed pickleweed-vegetated areas. The specific limits of the pickleweed harvest areas will be identified and staked by the biological monitor prior to the initiation of harvesting activities. Pickleweed cuttings will be collected by crews on foot and using non-motorized hand tools. No disturbance to pickleweed-vegetated areas outside of the designated harvest areas will be permitted. Harvesting activities will take place such that existing pickleweed cover in the harvest areas will not be reduced by more than 30 percent.*

Response: Text will be revised to state that "where feasible, NASA will revegetate restoration areas with pickleweed that is predominantly harvested from salvage areas within the removal action boundary that has been grown and propagated in an off-site nursery. If additional pickleweed is needed for the restoration areas, it may also be collected from other areas in the SWRP and may be supplemented with additional nursery seedlings and seed, as necessary. The specific limits of the pickleweed harvest areas will be identified and staked by the USFWS-approved biologist(s) prior to the initiation of harvesting activities, and boundaries recorded with a GPS unit for documentation. Pickleweed will be collected by crews on foot and using non-motorized hand tools. No disturbance to pickleweed-vegetated areas outside of the designated harvest areas will be permitted. Pickleweed collection that occurs outside the removal action boundary will be conducted in a dispersed manner by collecting pickleweed material sparsely and from across the entirety of the SWRP; IR Site 25 restoration and reference areas (which will be staked prior to collection) will be avoided. Harvesting activities will take place such that existing pickleweed cover across the entire SWRP will not be reduced by more than 30 percent."

i. *The restoration areas and pickleweed harvest areas will be monitored for five years, or until vegetative performance criteria are met and suitable SMHM habitat has been re-established. The pickleweed collection/harvest areas will be assessed immediately prior to the initiation of harvesting to determine pre-harvest vegetative cover and*

> *will be monitored after harvesting to ensure that the areas return to pre-harvest pickleweed cover within five years. For the restored areas, the vegetative performance criteria at the end of five years would be a minimum of 90 percent cover of native wetland plant species (e.g., pickleweed, saltgrass [Distichlis spicata], fat hen [Atriplex patula], alkali heath [Frankenia salina]) with a minimum of 60 percent cover of pickleweed, and less than five percent cover of non-native plant species.*

Response: Text will be revised to state that the restoration areas will be monitored for five years or until vegetative performance criteria are met in accordance with the BO. Success criteria will be revised to native species cover and marsh plain restoration pickleweed cover as shown in the following table from BO conservation measure #24:

Parameter	Target	Timing				
		Year 1	Year 2	Year 3	Year 4	Year 5
Wetland and Transitional Vegetation						
Cover of native species	≥75% of Reference	≥10%	≥20%	≥35%	≥50%	≥75%
Community composition: Marsh plain restoration pickleweed cover	≥75% of Reference	≥10%	≥20%	≥35%	≥50%	≥75%
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority."	< 5%	All years				
Upland Vegetation						
Percent average vegetative cover including non-invasive plant species.	≥60%	≥ 10%	≥ 20%	≥ 30%	≥ 40%	≥ 60%
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority."	<5%	All years				
Reference Site Requirements						
Wetland (marsh plain) transects community composition: Absolute cover of native species	≥70%	All years				
Minimum absolute cover of pickleweed	≥60%	All years				
Transitional transects: Absolute cover of native species	≥70%	All years				
Average cover of invasive plant species with Cal-IPC rating of "high" or SSFBWMP "high" or "highest priority."	< 5%	All years				

It was agreed upon during the 8/10/2017 call that harvest areas would not be quantitatively monitored, as the method of collection over a large area and in a dispersed manner will make it difficult to attempt to quantify impacts of collection. Text will be added to the Final PSMHRP to clarify that collection of pickleweed that occurs in the SWRP will be in a sparse and dispersed manner, throughout the entire SWRP, and will avoid the Site 25 restoration and reference sites. In accordance with the requirements of the BO, harvest impacts to the vegetative cover of the pickleweed collection areas from outside of the removal action boundary will be assessed. Text will be added to the Final PSMHRP that the harvest areas will be qualitatively assessed using photo-documentation (pre- and

post-harvest). At the discretion of the restoration biologist, and depending on the amount of harvesting that occurs within the SWRP, permanent vegetation monitoring plots may be established in representative harvest areas, and monitored concurrently with restoration site monitoring.

> *j. The equipment decontamination area shall be located in the designated upland staging area away from waters of the State.*

Response: The Final PSMHRP will include a measure that requires that decontamination occurs in the upland.

> *k. Upland routes covered with pavement, bare ground, or non-native vegetation shall be utilized as access routes to and from the work sites, to the maximum extent practicable.*

Response: BIO-15 already requires that vehicular traffic is confined to established routes and will stay on gravel and paved roadways. The Final PSMHRP will include text that addresses the above requirement for foot traffic.

> *l. The qualified biologist shall complete a monitoring report for each day of monitoring, which includes: the date, location, biologist's name, remedial activities occurring, special status species observed, species behavior in relation to remedial activities, and any corrective measures taken to protect such species. The biological monitoring reports should be submitted to USFWS and CDFW-OSPR on a weekly basis for the duration of the remedial activities.*

Response: Text will be revised as stated for CDFW in the PSMHRP. USFWS may have different reporting requirements; the BA and PSMHRP text will incorporate USFWS reporting requirements of the BO.

<u>*Specific Comments on the Draft PSMHRP*</u>

1. *Page 8, Section 1.2 Project Description; and page 44, Section 2.3.1 Salt Marsh Harvest Mouse-Specific Measures. The text states, "Once deemed clear of special status species by the USFWS-approved biologist, the upland portion of the FSFA peninsula will be mowed to stubble no higher than 1 inch". Uplands at A0I14 within 50 feet of the salt marsh provide habitat for special status species such as SMHM, Ridgway's Rail, and California Black Rail. As a result, the uplands within 50 feet of salt marsh habitat should not be mowed to avoid and minimize impacts to these species. Please replace this measure with the measure identified in General Comment 1f.*

Response: Text will be revised as stated and per response for General Comment item #1f above.

2. *Page 10, Section 1.2 Project Description*. The text states, *"Prior to excavation, biological surveys, exclusion fence realignment, and vegetation removal will be conducted as follows to support protection of federally listed species:"* Please revise the text to state, *"...support protection of both federal and state special status species".*

   Response: Text of the Final PSMHRP will be revised as stated.

3. *Pages 36 and 37, Section 1.3.3.7 White-Tailed Kite. The text states, "Conservation measures BIO-22 requires a biologist (may be the USFWS-approved or state species experienced biologist) to survey for bird nests within 50 feet of the Removal Action boundary and monitor for disruption of incubation activities". Due to the potential for State fully protected species, such as the White-tailed Kite, to nest within proximity to the work areas, nesting surveys should be conducted for the work area as well as all habitat within 500 feet of the work area, to identify active nests. Please replace this measure with the measures identified in General Comments 1c and 1d.*

   Response: Text of the Final PSMHRP will be revised as stated. See also, responses to General Comment 1c and 1d.

4. *Page 41, Section 2.2.1 General Conservation Measures. Measure BIO-4 states, "The USFWS-approved biologist will have stop-work authority if a federally listed and MBTA-protected species is found within the project footprint or within 10 feet of the Removal Action boundary, per guidelines set in a previous BO in the same region for the salt marsh harvest mouse (USFWS 2012)".*

   a. *Please explain the difference between the project footprint and the removal action boundary*.

   Response: The text of General Conservation Measure BIO-4 will be revised to reflect the requirements of the BO. Text will be added to the BA and Final PSMHRP to clarify the definition of "project footprint." The project footprint includes staging and laydown areas, the removal action boundary, and a maximum four-foot buffer beyond the removal action boundary exclusion fence to include the pickleweed removal areas. Figures 3 through 6 of the PSHRMP detail the removal action boundary, which is the farthest estimated extent of the excavation; pickleweed removal extends four feet beyond the removal boundary exclusion fence. Figures will be left as is, to show the different activities in different areas (since project intensity varies with the activity).

   b. *The measure indicates that the biologist will only have stop-work authority for federally listed species and MBTA-protected species. The biologist should also have stop-work authority to protect State special status species, such as the western pond turtle.*

Response: Text will be revised as stated in the Final PSMHRP, to include state special status species; the BA conservation measures will be consistent with the BO. See also response to General Comment 1d.

c. *The biologist should also have stop-work authority for the protection of State and Federal special status species that are present more than 10 feet from the Removal Action Boundary, if these species are also being adversely affected by removal activities (i.e., Western Snowy Plover, California Black Rail, Golden Eagle, Burrowing Owl, nesting birds). Please revise this measure to state, "The USFWS-approved biologist will have stop-work authority if deemed necessary for any reason to protect special status species".*

Response: Text will be revised in the Final PSMHRP as stated, with the following additional text: "consistent with the requirements of the BO and the conservation measures of the PSMHRP." See also response to General Comment 1d.

5. *Page 41, Section 2.2.1 General Conservation Measures. Measure BIO-7 states, "Exclusion material will be installed at entrances of burrows atop the peninsula to prevent burrowing owls from establishing nests". Please include as part of this measure that burrows are to be inspected for the presence of wildlife prior to installing exclusion material to ensure wildlife, including eggs and young, are not trapped within the burrows.*

Response: Text of the Final PSMHRP will be revised as stated.

6. *Page 43, Section 2.2.1 General Conservation Measures.* Measure BIO-18 states, *"Any construction personnel who inadvertently injure or kill any federally listed species will immediately report the incident to the USFWS-approved biologist".*

   a. *Please revise the measure to state, "Any construction personnel who inadvertently injure or kill any federal or state special status species..."*

Response: Text of the Final PSMHRP will be revised as stated. The BA conservation measures that address reporting will be consistent with the BO requirements.

   b. *Please add to this measure, that NASA ARC will report the incident to CDFW-OSPR within 24 hours of its occurrence*.

Response: Text of the Final PSMHRP will be revised as stated.

c. *Please explain what will happen to any special status species inadvertently injured. Will they be taken to a wildlife rehabilitation center? Please identify which licensed facility will be used.*

Response: Text of the Final PSMHRP will be revised as stated and will clarify which wildlife rehab center will be used.

7. *Page 43, Section 2.2.1 General Conservation Measures.*

a. *Measure BI0-22 states, "For birds protected under the MBTA, the USFWS-approved biologist will conduct surveys for active nests within 50 feet of the Removal Action boundary, construction trailer, and staging areas".*

Please revise this measure to state, "For birds protected under the MBTA, the USFWS-approved biologist will conduct surveys for active nests within 500 feet of the Removal Action boundary, construction trailer, staging and storage areas, decontamination areas, and access routes". Please see General Comments 1c and 1d. Project activities have the potential to impact nesting birds, not only within the work area, but also along access routes (i.e., access routes adjacent to Burrowing Owl preserves and marsh areas). In addition, some bird species, or even individual birds, may be more sensitive to work activities than others and may need a buffer distance greater than 50 feet. See Staff Report on Burrowing Owl Mitigation (Department of Fish and Game [DFG], 2012) for recommended buffer distances for Burrowing Owls.

Response: Text will be revised as stated. See also response to General Comment 1c and 1d.

b. *Measure BI0-22 states, "For active nests found within 50 feet..." Please revise this measure to state, "For active nests found within 500 feet..." Please see Specific Comment 7a.*

Response: Text will be revised as stated. See also response to General Comment 1c and 1d.

c. *Measure BI0-22 states, "Any nests found within 50 feet..." Please revise this measure to state, "Any active nests found within 500 feet..." Please see Specific Comment 7a.*

Response: Text will be revised as stated. See also response to General Comment 1c and 1d.

8. *Page 44, Section 2.3.1 Salt Marsh Harvest Mouse-Specific Measures.* Measure SHM-2 states, *"...pickleweed will be removed by hand or cut to ground level (using hand tools) in the presence of a USFWS-approved biologist'.* Please revise this measure to state, *"...pickleweed will be removed by hand or cut to ground level (using non-motorized hand tools) ..."*

Response: Text will be revised as stated.

9. *Page 47, Section 3.1 Site Preparation. Pickleweed restoration areas should be graded to match the elevation of surrounding areas where pickleweed is currently growing to avoid creating low spots where the water can pond, preventing or reducing the ability of pickleweed to become re-established. CDFW-OSPR believes the Navy's revegetation efforts at Site 25 have not met the agreed upon success criteria due to water ponding in low spots as a result of not backfilling and grading excavation areas to match the elevation of surrounding habitat, negatively impacting pickleweed growth (Nakahara, 2017).*

Response: Text will be revised to indicate grading of the restoration area will match the elevation of surrounding areas where pickleweed is currently growing, and that the transition from existing pond bottom to excavated elevation will sloped. The excavation areas that are within the stormwater pond bottom may not be included in the pickleweed restoration acreage.

10. *Page 50, Section 3.1 Site Preparation. The text states, "The FSFA upland areas that are not directly impacted by Removal Action activities will be regularly mowed during the sampling and excavation phases, per conservation measures SHM-2 and BIO-19". Please clarify whether these upland areas will be enclosed within the exclusion fence for the duration of the sampling and excavation phases. If these areas are to be enclosed within the fence throughout the work period, then after the initial hand removal of vegetation (see Specific Comment 1), the areas can be mowed under the supervision of the USFWS-approved biologist. If these areas are not enclosed within the fence for the duration of the work period, vegetation in these areas should be hand-removed on a regular basis to avoid and minimize impacts to SMHM.*

Response: Text will be revised as stated (for maintenance mowing) and to clarify these areas are within the exclusion fence. See also response to General Comment 1f.

11. *Page 50, Section 3.2 Seeding and Planting. CDFW-OSPR requests pickleweed seeds and cuttings be collected from areas adjacent to the FSFA, as was done for salt marsh restoration at Mare Island (Weston Solutions, Inc., 2007; USFWS, 2009). Please see General Comment 1h. Prior restoration efforts have shown that container stock grown*

from propagules collected on site have a higher probability of establishing successfully than those grown from non-local sources (LSA Associates, Inc., 2006). There is concern that pickleweed stock imported for planting during the Site 25 revegetation may not have been adapted to site-specific conditions (higher soil salinity) preventing Site 25 from meeting the restoration goal (Nakahara, 2015). Although the pickleweed stock came from the Palo Alto Baylands, the soil salinity levels at the source site may have differed from Site 25. As the Site 25 Salt Marsh Habitat Restoration Plan stated, "Imported stock has the potential to introduce strains that can be maladapted to the site,.." (Page 6; Rana Creek, 2011). Pickleweed growing on site has adapted to site-specific conditions and pickleweed cuttings from uncontaminated areas of the site would be preferable for revegetation of the high saline soils.

Response: Text will be revised to state that where feasible, NASA will harvest cuttings and seeds for nursery propagation, and that harvest that occurs outside the removal action boundary will occur in a dispersed manner outside IR Site 25 restoration and reference areas and will collect no more than 30 percent from harvest areas. See also response to General Comment 1h.

12. *Page 58, Section 4.2.1 Monitoring and Adaptive Management. The text states, "Concurrent monitoring of the reference site will provide data and benchmarks that can be used to measure restoration success".*

a. *CDFW-OSPR agrees that reference site data may be used as supplemental information to evaluate whether the restoration site is providing habitat functions at or near the level of the reference site and also provide information related to regional or site-specific stressors that may be affecting restoration success. However, we do not agree that success criteria for the restoration site should be based on yearly cover variability of the reference site, as was done for Site 25 (Nakahara, 2016 and 2017). For example, if cover at the reference site changes from pickleweed-dominated to weed-dominated or barrens during the monitoring period, then the restoration site should not be considered to be successfully restored if similar habitat changes occur at the restoration site. The restoration goal is to restore pickleweed habitat at a 3:1 ratio for impacts to SMHM habitat by restoring/creating three times as much pickleweed habitat on site as was damaged or destroyed by the Removal Action. Therefore, restoration success criteria should be based on quantitative goals such as 60% pickleweed cover by the end of five years, rather than qualitative goals such as whether the restoration site resembles the reference site. CDFW-OSPR requests NASA ARC implement the USFWS success criteria used at Mare Island for restoration of salt marsh habitat (USFWS, 2006 and 2009). Please see General Comment 1i.*

Response: Text will be revised to include criteria for reference site native cover and pickleweed cover. Text will also include revised success criteria, per the table in response to General Comment 1i.

b. *Please provide the criteria that will be used to select reference sites for each habitat type: wetland, transitional, and upland.*

Response: No reference sites will be used for the upland restoration sites monitoring, as described on page 61 of the Draft PSMHRP. Text will be revised to clarify that reference sites will be selected that represent the best possible condition within the stormwater pond, using native species cover as a guideline for selection, per criteria in table above (response to General Comment 1i). Wetland reference sites will satisfy the pickleweed and native cover requirements. Transitional transects will satisfy native cover requirements.

c. *CDFW-OSPR requests NASA ARC provide the species composition and percent cover information for each reference site to CDFW-OSPR and USFWS for review and approval prior to their use in the restoration monitoring and management activities. During the Site 25 restoration, the selection of reference sites containing different vegetative communities from the associated polygons to be restored was not appropriate and was not approved by the regulatory agencies. The Navy's actions resulted in the conversion of habitat from one type to another in certain polygons and did not meet the Navy's goal of restoration in-kind to pre-existing conditions (Nakahara, 2016).*

Response: Text will be revised to include direction that reference site species composition and cover data be provided to CDFW and USFWS for review and approval prior to monitoring.

13. *Page 59, Section 4.2.1 Monitoring and Adaptive Management. The text indicates that site progress will be documented by taking digital photographs at designated photo-monitoring locations. For each photo location, the photo should be taken facing the same direction each time, in order to allow for direct comparison of site photos and success criteria over time.*

Response: Text will be revised as stated.

14. *Page 60, Section 4.2.2 Performance Standards for Determining Success.*

a. *The text states, "The standard used to deem a restoration project successful is a qualitative comparison of the restoration site to a nearby natural (reference) site that ideally would reflect an undisturbed condition".*

Table 6 also provides quantitative restoration monitoring success criteria. Please explain which criteria is to be used to determine restoration success and that the goal of restoring SMHM habitat at a 3:1 ratio has been achieved. CDFW-OSPR requests NASA ARC implement the USFWS success criteria used at Mare Island for restoration of salt marsh habitat (USFWS, 2006 and 2009) for A0I14. Please see General Comment 1i and Specific Comment 12a. CDFW-OSPR does not believe that success can be met without also achieving all quantitative success criteria.

Response: Text will be revised to include the success criteria as detailed in response to Comments 1i and 12a.

b. *The text states, "Success criteria targets may need adjusting in response to drought, heavy rain events, or wetter than normal winters, to a more qualitative goal of increasing native vegetative cover throughout the monitoring period'. Please explain how quantitative success criteria targets will be adjusted to a qualitative goal. Please see Specific Comment 14a.*

Response: Text will be revised to delete reference to “qualitative."

c. *The text states, "Successful restoration should show a positive trajectory in native cover, however, storm events or drought may impede vegetative growth". CDFW-OSPR does not agree that restoration is successful based solely on a positive trajectory. As occurred for the Site 25 restoration, the Navy claimed restoration as successful for a polygon that had 66% pickleweed cover before the Remedial Action, but based this success on a "positive trajectory" from 0% pickleweed cover immediately after the excavation to 10% cover after 3 years of monitoring (Nakahara, 2016 and 2017). CDFW-OSPR does not believe that 10% pickleweed cover for a polygon that previously had 66% pickleweed cover can be considered a successful revegetation. CDFW-OSPR requests the quantitative success criteria be used to determine revegetative success rather than using a positive trajectory.*

Response: The monitoring and success criteria as stated in the PMSHRP do not solely rely on a positive trajectory. Text will be revised to clarify that the criteria include quantitative goals.

<u>Specific Comments on the BA</u>

1. *Page 15, Section 2.7.1 Pilot Study; page 21, Section 2.1.2 Full-Scale Investigation; and page 40, Section 2.5.3 Species-Specific Measures.* The text

states, *"Once deemed clear of special status species by the biologist, the top of the FSFA peninsula will be mowed to stubble no higher than 1 inch".* Please see Specific Comment 1 on the Draft PSMHRP.

Response: Text will be revised as stated in response to General Comment #1f.

2. Page *15, Section 2.1.1 Pilot Study.* The text indicates a temporary exclusion fence will be installed after the Investigation Area Grids are surveyed and marked. Pickleweed and vegetation within 50 feet of pickleweed should be hand-removed using non-motorized tools under the supervision of the USFWS-approved biologist, prior to the installation of the fence to ensure SMHM are not trapped within the fence. Please revise this measure to include this clarification.

Response: Text will be revised to clarify that vegetation removal will occur prior to fence installation.

3. *Page 37, Section 2.5.2 General Conservation Measures.* Measure BI0-4 states, *"The USFWS-approved biologist will have stop-work authority if a listed species is found within the project footprint or within 10 feet of the Removal Action boundary, per guidelines set in a previous BO in the same region for the salt marsh harvest mouse (USFWS 2012a)".* Please see Specific Comment 4 on the Draft PSMHRP.

Response: Text will be revised as detailed in response to Specific Comment #4 (a, b, c). The BA conservation measures will be consistent with the BO and per USFWS, will not include state species conservation measures.

4. *Page 37, Section 2.5.2 General Conservation Measures.* Measure BI0-7 states, *"Exclusion material will be installed at entrances of burrows atop the peninsula to prevent burrowing owls (Athene cunicularia) from establishing nests".* Please see Specific Comment 5 on the Draft PSMHRP.

Response: Text will be revised as stated in the Final PSMHRP. The BA conservation measures will be consistent with the BO and per USFWS, will not include state species conservation measures.

5. *Page 39, Section 2.5.2 General Conservation Measures.* Measure BI0-18 states, *"Any construction personnel who inadvertently injure or kill any federally listed species will immediately report the incident to the USFWS-approved biologist".* Please see Specific Comment 6 on the Draft PSMHRP.

Response: Text will be revised as stated in the Final PSMHRP. The BA conservation measures will be consistent with the BO and per USFWS, will not include state species conservation measures.

From: Nakahara, Tami@Wildlife [Tami.Nakahara@wildlife.ca.gov]
Sent: Monday, December 11, 2017 1:20 PM
To: Finch, Kimberly (ARC-JQ)
Cc: Tsao, Allen@Wildlife; Kevin Bricknell (Kevin.Bricknell@tetratech.com); ann.zoidis@tetratech.com; angela.lortie@tetratech.com; Mankowski, Anne; Wells, Elizabeth@Waterboards; YvonneW Fong (Fong.YvonneW@epa.gov)
Subject: FW: NASA Ames AOI 14 NTCRA: Responses to 11/30 CDFW Comments on Draft PSMHRP

Hi Kim,

CDFW-OSPR appreciates NASA providing the track changes version of the PSMHRP to aid in our review of NASA's response to our comments on the Draft PSMHRP. We have the following responses to NASA's responses provided in their December 5, 2017 email:

General Comments on the Draft PSMHRP

Response to General Comment 1f. In regards to CDFW-OSPR's request to include the biological avoidance measure in the PSMHRP to stop work if a mouse of any species is observed within areas where vegetation is being removed, until the mouse leaves of its own volition, CDFW-OSPR would like to offer the following clarifying points. Work will only need to be stopped by the qualified biologist within the area where the mouse is observed in order to allow the mouse to leave the area. Vegetation removal can continue in other areas while waiting for the mouse to leave. This should be less time consuming than the alternative measures proposed by NASA which would require the qualified biologist to positively identify the mouse. Again, as CDFW-OSPR has previously explained, this would require the mouse to be in hand in order for the qualified biologist to adequately view its distinguishing features. Traps would need to be set in order to capture the mouse, since it is unlikely the mouse can be captured by hand. With very limited exception not applicable here, state law prohibits take of fully protected species including actions taken as part of specific project mitigation measures. As such, CDFW cannot authorize trapping or take of a State fully protected species for removal activities. There is also concern for the safety and well-being of the salt marsh harvest mouse, as well as the biologist, during any attempts to capture the mouse for identification, due to stress inflicted on the mouse and the potential for injuries to both entities. However, without capturing the mouse, it is unclear how the qualified biologist will positively identify the mouse to species level.

If take occurs for a State fully protected species during removal activities, CDFW-OSPR will require NASA to consult with CDFW-OSPR and USFWS on how to revise the avoidance measures to prevent further take from occurring.

In regards to Conservation Measure BIO-4/BO-4 (Environmental Awareness Training), text in the revised PSMHRP reads:
"…. *The training module will include general provisions of the Endangered Species Act and penalties associated with violating those provisions, conservation measures and reasonable and prudent measures listed in the BO, color photographs, a brief natural history description, and description of habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern*." The training module should also include information on compliance with State regulations (i.e., State Endangered Species Act, State fully protected species statutes) and measures in the PSMHRP to protect State special status species (e.g., California Black Rail, White-tailed Kite, Burrowing Owl, nesting birds, rare plants).

Please let us know if you have any questions or would like to discuss this further.

Thank you,
Tami

Tami LaBonty (formerly Nakahara)
Senior Environmental Scientist (Specialist)
California Department of Fish and Wildlife (CDFW)
Office of Spill Prevention and Response (OSPR)
Base Realignment and Closure (BRAC)
1700 K Street, Suite 250
Sacramento, CA 95811
Phone (916) 324-8452
Tami.Nakahara@wildlife.ca.gov

From: Finch, Kimberly (ARC-JQ) [mailto:kimberly.s.finch@nasa.gov]
Sent: Tuesday, December 5, 2017 10:30 AM
To: tami.nakahara@wildlife.ca.gov; allen.tsao@wildlife.ca.gov
Cc: Bricknell, Kevin <Kevin.Bricknell@tetratech.com>; Zoidis, Ann <Ann.Zoidis@tetratech.com>; Lortie, Angela <angela.lortie@tetratech.com>; anne_mankowski@fws.gov
Subject: NASA Ames AOI 14 NTCRA: Responses to 11/30 CDFW Comments on Draft PSMHRP

Hi Tami,

Please see below responses (blue text) that address comments provided in your 11/30/17 email. Also attached is a track changes version of what will be the Final Protected Species Mitigation and Habitat Restoration Plan (PSMHRP - Appendix H to the Removal Action Work Plan). The below responses are mostly text from the document that you did not have in hand when you provided the comments. Hopefully, this will help answer your remaining questions and provide overall context to the responses. We are on track to issue the Final RAWP, with all Appendices documents, by 12/14/17.

Please let me know if you have any questions or if you would like to discuss any of these responses.

Regards,
Kim

Kimberly Finch, P.E.
Restoration Program Manager
Environmental Management Division
NASA Ames Research Center, MS 204-15
Moffett Field, CA 94035-0001
650.604.1294

From: "Nakahara, Tami@Wildlife" <Tami.Nakahara@wildlife.ca.gov>
Date: Thursday, November 30, 2017 at 1:13 PM
To: "Finch, Kimberly (ARC-JQ)" <kimberly.s.finch@nasa.gov>
Cc: "Tsao, Allen@Wildlife" <Allen.Tsao@wildlife.ca.gov>, Elizabeth Wells <Elizabeth.Wells@waterboards.ca.gov>, Yvonne Fong <Fong.YvonneW@epa.gov>, "Kevin Bricknell (Kevin.Bricknell@tetratech.com)" <Kevin.Bricknell@tetratech.com>, "Mankowski, Anne" <anne_mankowski@fws.gov>
Subject: FW: NASA Ames AOI 14: Responses to CDFW Comments

Hi Kim,

CDFW-OSPR has reviewed NASA's response to our comments on the Draft Protected Species Mitigation and Habitat Restoration Plan (PSMHRP), and Biological Assessment for AOI 14, received on November 21, 2017. We have the following responses:

General Response to NASA's Response to Comments.

1. Several of NASA's responses indicate revisions will be made to the document, but NASA did not provide the revised document or the exact language that will be used for these responses. CDFW-OSPR cannot determine whether these revisions are acceptable without reviewing them.

General Comments on the Draft PSMHRP

Response to General Comment 1f. NASA responded, "*Text will be revised to mirror vegetation removal requirements of the BO, which include hand removal in and within 50 feet of pickleweed, and mechanical clearing in the upland (to within 50 feet of pickleweed)*". CDFW-OSPR is concerned that the statement regarding mechanical clearing "*to within 50 feet of pickleweed*" may be interpreted as mechanical clearing is allowed within 50 feet of pickleweed. We recommend revising this measure to state "*...mechanical clearing in the upland (up to 50 feet from pickleweed)*", for clarification.

NASA Response: In 2.4.1 BIO-27/BO-27, clarification is made that mechanical clearing is from 50 feet of edge of pickleweed. This was made clear in Section 1.2 project description, and is added to the measures as well.

Text in PSMHRP (Section 1.2 Project Description) reads:

- Once deemed clear of mice by a USFWS-approved biologist, vegetation within 50 feet of the edge of pickleweed will be removed by hand or cut to ground level (using non-motorized hand tools) in the presence of a USFWS-approved biologist and per the requirements in Section 2.4.1.

- Once deemed clear of special status species by a USFWS-approved biologist, the upland portion of the FSFA peninsula (starting from the edge of the hand-cleared areas addressed above and from a distance of 50 feet from the uppermost pickleweed edge) will be mowed to stubble no higher than 1 inch. The USFWS-approved biologist will walk a safe distance in front of the mower to ensure that no salt marsh harvest mice are present. With the approval of the USFWS-approved biologist and once deemed clear of mice, mowing will be conducted as necessary for the duration of the Removal Action to maintain upland vegetation at a height of 1 inch or less.

Text of BIO-27/BO-27 measure has been revised to read:

- Once deemed clear of mice by a USFWS-approved biologist, the upland portion of the proposed project footprint (up to 50 feet from the upper edge of pickleweed) will be mowed to stubble no higher than 1 inch. The biologist will walk a safe distance in front of the mower to ensure that no salt marsh harvest mice are present.

- Once deemed clear of mice by a USFWS-approved biologist, vegetation within 50 feet of the edge of pickleweed will be removed by hand or cut to ground level (using non-motorized hand tools) in the presence of a USFWS-approved biologist. Vegetation removal shall start farthest away from the salt marsh and move in a direction toward the

salt marsh to direct mice toward the salt marsh and allow cover for mice as they leave the work area. Hand vegetation removal will occur with field staff standing and working from cleared areas, moving down the slope toward the SWRP. Vegetation cutting and removal will start with the upper strata and work down through the canopy. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

CDFW-OSPR also requested NASA to include the following biological avoidance and minimization measure in the PSMHRP: "*If a mouse of any species is observed within the areas where vegetation is being removed, work will cease, CDFW-OSPR and USFWS shall be notified and the mouse shall be allowed to leave of its own volition*". NASA responded, "*Based on direction from USFWS (in 8/22/17 consultation correspondence) that the change to 'any mouse species' would be inappropriate, text will not be added to direct stop work for 'a mouse of any species'. This text, however, will be added to the Final PSMHRP in the context of environmental awareness training and at the introduction to the federally listed species-specific conservation measures.*"

CDFW-OSPR again requests this avoidance measure be added to the PSMHRP to direct stop work for the protection of the salt marsh harvest mouse, which is not only federally-listed as endangered, but also State-listed as endangered and a State fully protected species. No take is allowed for State fully protected species, including incidental take. Salt marsh harvest mice are difficult to identify in the field because they look very similar to western harvest mice (USFWS, 2013). Key field characteristics that distinguish the salt marsh harvest mouse and western harvest mouse include the hair color on the belly and the tail characteristics (tail thickness in mm, tail hair color, and shape of the tip of the tail). These characteristics require the mouse to be in hand in order to adequately view these features. Even then, positive identification of a salt marsh harvest mouse may be difficult. Trying to view these features on a small rodent running through the vegetation is difficult if nearly impossible. CDFW-OSPR cannot authorize NASA to pursue, catch, or capture a State fully protected species (which is defined as "take" under the State definition) in order to positively identify it for avoidance during a removal action. If a salt marsh harvest mouse is killed during removal activities due to misidentification, it is still considered to be "take" and would not be in compliance with CDFW Applicable or Relevant and Appropriate Requirements. Therefore, we highly recommend a conservative approach to protecting this species by ceasing work if <u>a mouse of any species</u> is observed within the areas where vegetation is being removed, and allowing the mouse to leave of its own volition.

NASA Response: Text in the revised PSMHRP reads:
Conservation Measure BIO-4/BO-4 (Environmental Awareness Training):
.... The training module will include general provisions of the Endangered Species Act and penalties associated with violating those provisions, conservation measures and reasonable and prudent measures listed in the BO, color photographs, a brief natural history description, and description of habitat for the salt marsh harvest mouse, western snowy plover, California clapper rail, and California least tern. Due to the difficulty of field identification to species level, any mouse sighted will trigger the conservation measures for the salt marsh harvest mouse, and those measures will remain in place until a biologist with specific salt marsh harvest mouse permitted handling and identification experience can be brought on site and make an evaluation.

The module will also include descriptions of pickleweed, the protection of which is important to the salt marsh harvest mouse, and the invasive pepperweed (*Lepidium latifolium*) with practices to

avoid its spread. Vegetation removal methods will also be addressed and will detail requirements of BIO-27/BO-27 for the protection of the salt marsh harvest mouse. Field staff will be instructed on the salt marsh harvest mouse's tendency to stay in place and under vegetative cover and will be instructed to work carefully through the vegetation.

Also in the introductory text for Federally Listed Species Measures (a section added to the PSMHRP, because conservation measures were reorganized to match the BO and to add CDFW's additional measures) this text is included:

"Conservation measures specific to federally listed species are detailed below. As stated in BIO-4 in Section 2.1, due to the difficulty of field identification of the salt marsh harvest mouse to species level, any mouse sighted will trigger the conservation measures for the salt marsh harvest mouse until a biologist with species-specific permitted handling and identification experience can be brought on site."

Specific Comments on the Draft PSMHRP.

Response to Specific Comment 14a. NASA responded, "*Text will be revised to include the success criteria as detailed in response to Comments 1i and 12a*". It is still unclear what success criteria NASA will be using for the restoration areas. Please clarify if the success criteria will be based on meeting the quantitative criteria listed in the table from BO conservation measure #24 (see NASA's response to CDFW-OSPR's General Comment 1i), or will it be a combination of meeting the quantitative criteria, as well as qualitative criteria such as a comparison of the restoration site to the reference site, and a positive trajectory. If it is a combination of both quantitative and qualitative criteria, please explain how success will be determined if the restoration only meets part of the criteria. For example, will the restoration be considered successful if it does not meet the quantitative criteria, but the restoration site qualitatively resembles the reference site and there is a positive trajectory? CDFW-OSPR maintains our position that we do not believe success can be met without also achieving all quantitative success criteria.

NASA Response: The PSMHRP performance criteria are as stated in the RTC table, which matches the BO requirements for criteria and is quantitative only.

Response to Specific Comment 14b. CDFW-OSPR previously requested NASA explain how quantitative success criteria targets will be adjusted to a qualitative goal in the event of drought, heavy rains, or wetter than normal winters. NASA responded, "*Text will be revised to delete reference to "qualitative*". It is still unclear how NASA will adjust success criteria targets in response to drought, heavy rains, or wetter than normal winters. Please explain. CDFW-OSPR understands that weather can affect the success of the restoration, however, NASA should discuss any proposed changes to the success criteria with the regulatory agencies, including CDFW-OSPR and USFWS, and obtain their approval prior to its use. Adaptive management (e.g., supplemental watering during droughts, supplemental seeding and plantings, weeding, etc.) should also be considered to address any shortcomings of the restoration areas in order to restore appropriate habitat that will benefit the survival of the salt marsh harvest mouse, as well as other special status species.

NASA Response: It is anticipated that in the event success criteria cannot be met due to conditions beyond the control of NASA, NASA would initiate discussion with the agencies to discuss the site conditions, challenges, and potential revised targets.

The text of the PSMHRP Revised text reads:

"Success criteria targets may need reevaluation in response to prolonged drought, heavy rain events, or wetter than normal winters. Successful restoration should show a positive trajectory in native cover and meet the cover targets detailed in Table 6; however, storm events or drought may impede vegetative growth and limit the practical achievement of timing targets for cover specified in Table 6, necessitating adaptive management actions such as supplemental watering, reseeding, or weed removal, and a longer monitoring period and/or reevaluation of performance criteria targets."

The text in Section 4.2.1 reads (no revisions from original text):

"Based on the analysis of monitoring data, additional restoration needs may be identified, such as site grading, erosion control, planting, irrigation, or weed control."

Also in performance standards section (4.2.2):

"Annual targets are set in order to inform on adaptive management that may be required (weed control or supplemental seeding or planting). Reference site requirements for native cover and pickleweed cover are detailed in Table 6. Prior to conducting the first year of monitoring, the restoration biologist will select appropriate reference sites that align with the requirements in Table 6. NASA will submit the selected reference locations and preliminary reference vegetation composition and cover data to CDFW and USFWS for review and approval prior to monitoring."

Response to Specific Comment 14c. NASA responded, "*The monitoring and success criteria as stated in the PSMHRP do not solely rely on a positive trajectory. Text will be revised to clarify that the criteria include quantitative goals*". Please see CDFW-OSPR's response to Specific Comment 14a on the Draft PSMHRP.

NASA Response: See above responses.

Please let us know if you have any questions or would like to discuss this further. CDFW-OSPR is available for a conference call to discuss these comments prior to finalization of the document.

References

USFWS. 2013. U.S. Fish & Wildlife Service, Bay Delta Fish & Wildlife Office, Species Account, Salt Marsh Harvest Mouse, *Reithrodontomys raviventris*. Available online at: https://www.fws.gov/sfbaydelta/EndangeredSpecies/.../salt_marsh_harvest_mouse.rtf. Last updated March 19, 2013.

Thank you,
Tami

Tami LaBonty (formerly Nakahara)
Senior Environmental Scientist (Specialist)
California Department of Fish and Wildlife (CDFW)
Office of Spill Prevention and Response (OSPR)
Base Realignment and Closure (BRAC)
1700 K Street, Suite 250
Sacramento, CA 95811
Phone (916) 324-8452
Tami.Nakahara@wildlife.ca.gov

From: Finch, Kimberly (ARC-JQ) [mailto:kimberly.s.finch@nasa.gov]
Sent: Tuesday, November 21, 2017 11:10 AM
To: Nakahara, Tami@Wildlife <Tami.Nakahara@wildlife.ca.gov>; Tsao, Allen@Wildlife <Allen.Tsao@wildlife.ca.gov>
Cc: Yvonne Fong <Fong.YvonneW@epa.gov>; Wells, Elizabeth@Waterboards <Elizabeth.Wells@waterboards.ca.gov>; Bricknell, Kevin <Kevin.Bricknell@tetratech.com>; Mankowski, Anne <anne_mankowski@fws.gov>
Subject: NASA Ames AOI 14: Responses to CDFW Comments

Tami,

Please see the attached for NASA's responses to CDFW's comments on the draft work plans for the AOI 14 removal action. We are preparing the Final plans, which will incorporate the RTCs, final comments from EPA and the Regional Water Board, and the provisions of the Biological Opinion from USFWS.

Regards,
Kim

Kimberly Finch, P.E.
Restoration Program Manager
Environmental Management Division
NASA Ames Research Center, MS 204-15
Moffett Field, CA 94035-0001
650.604.1294

From: "Finch, Kimberly (ARC-JQ)" <kimberly.s.finch@nasa.gov>
Date: Thursday, July 13, 2017 at 12:07 PM
To: Yvonne Fong <Fong.YvonneW@epa.gov>, Elizabeth Wells <Elizabeth.Wells@waterboards.ca.gov>
Subject: Re: NASA Ames AOI 14 Geophysical Report Comments

Yvonne and Elizabeth,

I apologize for the delay in getting back to you about these comments. Please see the information below that addresses comments 2, 3, 7, 9, and 10. We are not addressing the remaining comments since they are editorial in nature and the Geophysical Report will not be revised. As relevant, the responses are reflected in the Removal Action Work Plan and will be reflected in the Removal Action Completion Report.

Thanks,
Kim

Kimberly Finch, P.E.
Restoration Program Manager
Environmental Management Division
NASA Ames Research Center, MS 204-15
Moffett Field, CA 94035-0001
650.604.1294

From: Yvonne Fong <Fong.YvonneW@epa.gov>
Date: Tuesday, March 7, 2017 at 2:35 PM
To: "Finch, Kimberly (ARC-JQ)" <kimberly.s.finch@nasa.gov>
Cc: "Chuck, Donald M. (ARC-JQ)" <donald.m.chuck@nasa.gov>, "kevin.bricknell@tetratech.com" <kevin.bricknell@tetratech.com>, "Elizabeth.Wells@waterboards.ca.gov" <Elizabeth.Wells@waterboards.ca.gov>
Subject: RE: NASA Ames AOI 14 Geophysical Investigation Report

Hello Kim,

EPA and Water Board staff reviewed the *Area of Investigation 14 Former Soil Fill Area Geophysical Investigation Report* (Report) dated December 2016. As stated in the Report, the objectives of the investigation were to 1) detect and delineate the apparent lateral (horizontal) extent of artificial fill and debris fill and help estimate the apparent vertical extent of the artificial fill at the AOI 14 FSFA and 2) provide information to constrain approximate volume estimates of detectable apparent artificial fill and debris fill at the AOI 14 FSFA to support the NTCRA remedial action work plan design.

The regulatory agencies were not provided an opportunity to review a work plan prior to conduct of the geophysical investigation work and the report was submitted to the agencies as a final

document. The regulatory agencies are not requesting that NASA revise the report; however, we do have the following comments:

1) Page ES-1: The second bullet should refer to the upcoming removal action work plan, not remedial action work plan.

2) Page ES-2: For the magnetometer and EM31 data, an explanation of how the 0.5-second interval and 5 foot transect spacing were determined would be useful. Similarly, for the electrical resistivity data, an explanation of how the 2.5 foot electrode spacing was determined would also be useful.

   Response: For magnetometer and EM31 data collection, the 0.5-second interval sampling rate and 5-foot transect spacing were used to provide adequate resolution of the lateral extent of apparent artificial fill assuming some areas may have less ferrous metal debris and construction debris (for example, concrete, asphalt, wood, and rebar) than others. Typical magnetometer and EM31 surveys to delineate the lateral extent of landfills use a 0.5- or 1-second interval sampling rate and 5 or 10-foot transect spacing depending on the type and amount of expected landfill material and size of the site. For example, if a landfill has mostly concrete with very little rebar and metal debris, then a higher sampling rate (such as 0.5 second) and tighter line spacing (such as 5 feet) is used to ensure better detection of the metal co-located with the concrete, and resolution of the lateral extent of the landfill material. However, if there is an abundance of metal in the landfill material then a lower sampling rate (such as 1 second) and wider line spacing (such as 10 feet) is often used to provide adequate detection and increase field data collection productivity. The 2.5-foot electrode spacing between 56 electrodes was used for the electrical resistivity surveys to optimize detection and resolution of artificial fill material at the anticipated depth given the depth of artificial fill was expected to extend no deeper than 20 feet bgs. As stated in the last sentence of Section 3.0 (Page 3), the maximum depth of detection is typically 1/3 to 1/5 the length of the resistivity line.

3) Page ES-2: The survey appears to have been conducted over accessible areas; however, the text does not state how much area was inaccessible for surveying, show the areas on a figure, or present the reasons why, other than that portions were inundated with water as stated on page 3 and shown on Figure 2.

   Response: The inaccessible area covered with water, which was the area inaccessible for surveying, is shown on Figures 2 through 4 at the northeast corner of the site.

4) Section 1.0, last paragraph: While the geophysical investigation work plan may have been approved by NASA, it was not submitted to or approved by the regulatory agencies.
5) Section 2.0, fifth paragraph: The text mentions the MOU between the Navy and NASA; however, the two Federal Facilities Agreements that established additional roles and responsibilities for environmental restoration and compliance between the regulatory agencies and both the Navy and NASA are not mentioned.
6) Section 2.0, sixth paragraph: The text notes the silt fence present around AOI 14 but does not mention that it was installed in response to a Unilateral Administrative Order.

7) Section 3.2, second paragraph: The RMS errors ranged up to 22.60 percent which seems relatively high; however, there is no discussion of the significance of this result.

Response: Every effort was made during field data collection and modeling (inversion) to reduce RMS errors. The magnitude of RMS errors were found to be an inherent limitation of site conditions and are common at sites where noisy data points attributed to site conditions are unavoidable. RMS error up to 22.60% did not have a significant impact on the resistivity data interpretation given the interpreted vertical limits of apparent artificial fill correlated well with previous boring logs. The second sentence of the second paragraph in Section 3.2 (Page 5) states, "Noisy data points were removed and a strong gradient array was used for the inversions to further reduce the root mean square (RMS) error", which describes the primary methods used to reduce RMS errors. In addition, RMS errors, measured apparent resistivity pseudosections, and calculated apparent resistivity pseudosections were carefully considered during interpretation of the vertical limits of apparent artificial fill.

8) Section 4.0, first paragraph: There is duplicate text in this paragraph regarding the apparent extent of fill and ferrous metal debris.

9) Figure 2: The "assumed removal action boundary" is shown as a white line with black boundaries that does not encompass the full extent of the apparent fill as determined by the geophysical survey and shown with a red line in the figure. It is not clear why the assumed removal action would exclude fill areas outside the white line with black boundaries or to what extent alternative sampling methods for the FSFA side slopes described in the AOI 14 Sampling and Analysis Plan (draft dated December 2016) will assess the potential for contamination in these excluded areas.

   Response: The assumed removal action boundary shown in the geophysical report figures has been revised in the RAWP to consist of the apparent artificial fill limits inferred from the geophysical survey results plus the semi-circular northeast corner of the site boundary shown in Figures 2 through 4.

10) Figure 4: A high resistivity area is present below 20 ft bgs along resistivity line RL-1; however, there is no discussion of how or why it was determined that this does not represent artificial fill.

   Response: The high resistivity area below 20 feet bgs along resistivity line RL-1 (between distances 75 feet and 105 feet) appears to be associated with high resistivity related to the site-specific geology below the artificial fill. This hypothesis is supported by (1) data indicating several similar high resistivity areas at this depth in the other electrical resistivity sections and (2) there is no history of artificial fill below 20 feet bgs based on previous borings and the conceptual site model.

While the revisions to the Report itself are not being requested, the regulatory agencies assume information on the geophysical survey will be discussed in the removal action completion report (RACR). Therefore, these comments should be taken into consideration when preparing the RACR.

Thank you,
Yvonne
<image001.gif>

From: Finch, Kimberly (ARC-JQ) [mailto:kimberly.s.finch@nasa.gov]
Sent: Friday, December 02, 2016 12:39 PM
To: Fong, YvonneW <Fong.YvonneW@epa.gov>; Elizabeth.Wells@waterboards.ca.gov
Cc: Mezquita, Marlon <Mezquita.Marlon@epa.gov>; Chuck, Donald M. (ARC-JQ) <donald.m.chuck@nasa.gov>; tami.nakahara@wildlife.ca.gov; allen.tsao@wildlife.ca.gov; kevin.bricknell@tetratech.com
Subject: NASA Ames AOI 14 Geophysical Investigation Report

All,

Attached for your information is the report of the recent geophysical surveys completed at AOI 14. This information is being used to support the removal action design and will be reflected in the removal action work plan.

Regards,
Kim