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**CENTER-WIDE SAMPLING AND  
ANALYSIS PROGRAM**

**PROGRAM OVERVIEW**

**NASA Ames Research Center  
Moffett Field, California**

(EKI 920008.05)

*Prepared For:*

**Facilities Engineering Branch  
NASA Ames Research Center  
Moffett Field, California**

**25 March 1994**

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Kalinowski, Inc.**

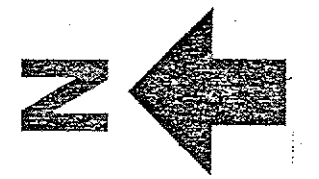
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**A29**

**EDC1182**

So. /  
Removal  
Project



0 400 800  
(Approximate Scale in Feet)

LEGEND

- Monitoring Well Location and Groundwater Elevation (feet MSL)
- Approximate groundwater elevation contour (ft MSL)
- Estimated Gradient Magnitude and Direction



Notes:

1. All locations are approximate.
2. Contours are approximate.
3. Base from AutoCAD basemap supplied by NASA Ames.
4. Data is from August 1993 quarterly sampling event.

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Estimated Potentiometric  
Surface, A Aquifer Zone  
NASA-Ames Research Center  
Moffett Field, CA  
March 1994  
EKI 920008.05  
Figure 3





0 400 800  
(Approximate Scale in Feet)

LEGEND

- 6214012A Existing Monitoring Well  
150 Location and Concentration of TCE in ug/L
- ▲ CPT-17  
3.3 Existing CPT Location and Concentration  
of TCE in ug/L
- 50 Approximate isoconcentration contour,  
dashed where inferred

Notes:

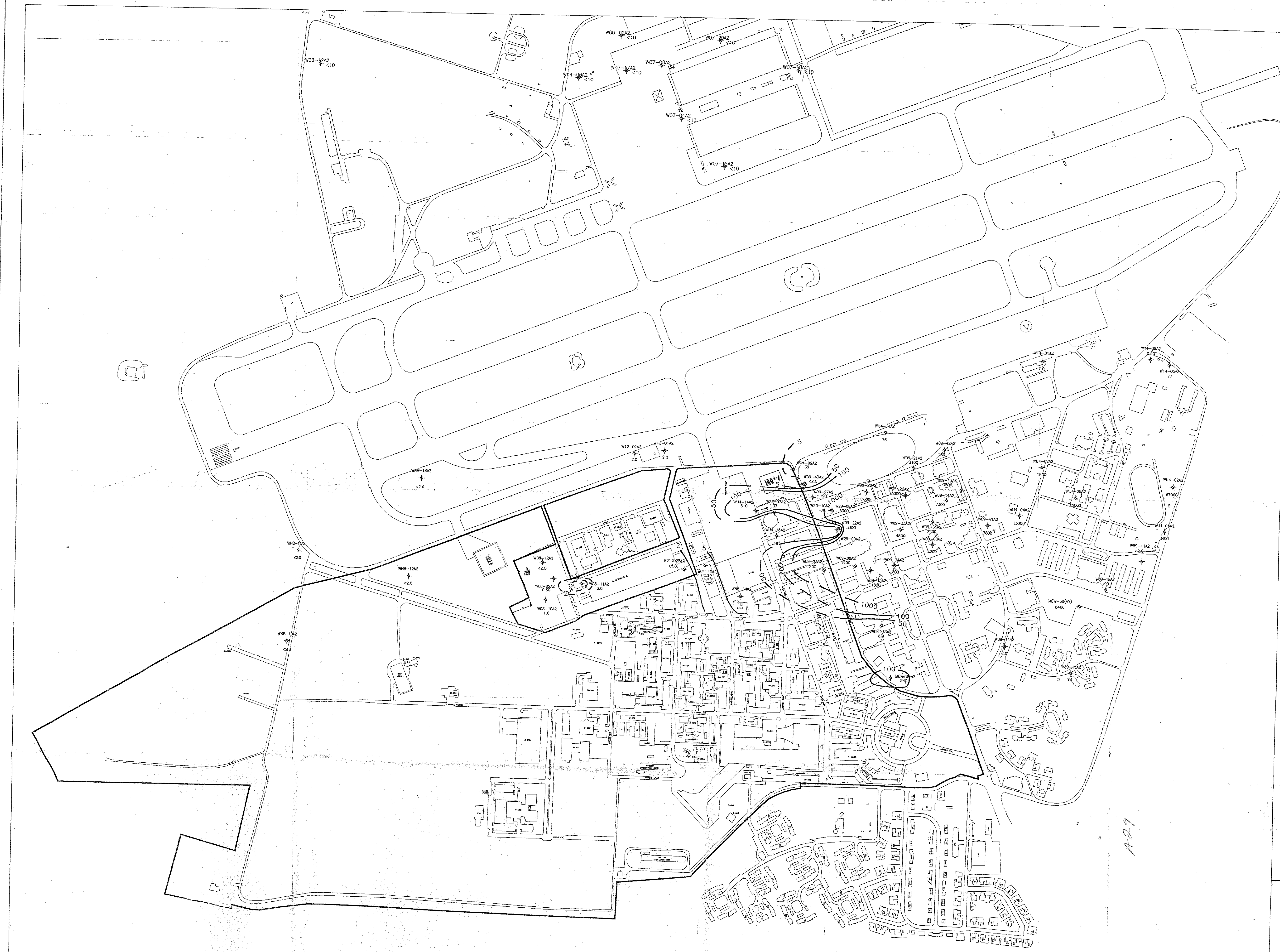
1. Data posted are most recent data for each location. Most data are from 1992 or 1993; some data are from 1991.
2. All NASA well designations begin with "62". All Navy well designations begin with "W". New wells have four character designations.
3. Data for Navy and MEW wells are from Navy database given to NASA and copied to EKI. EKI makes no claim as to completeness or accuracy of these data.
4. Data presented are data available to EKI by December 1993. Additional data may exist.
5. Isoconcentration contours may change as new or additional data become available.
6. Basemap is from AutoCAD basemap supplied by NASA-Ames.
7. All locations are approximate.

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TCE in Groundwater  
A/A1 Aquifer Zone  
NASA-Ames Research Center  
Moffett Field, CA  
March 1994  
EKI 920008.05  
Figure 4







0 400 800  
(Approximate Scale in Feet)

# LEGEND

- 6214012A Existing Monitoring Well  
150 Location and Concentration of TCE in ug/L
- ▲ CPT-17 Existing CPT Location and Concentration  
3.3 of TCE in ug/L
- 50 Approximate isoconcentration contour,  
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TCE in Groundwater  
A2 Aquifer Zone  
NASA-Ames Research Center  
Moffett Field, CA  
March 1994  
EKI 920008.05  
Figure 5

**Program Overview  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center**

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## **1. INTRODUCTION**

The NASA Ames Research Center ("NASA Ames") is devoted to research and development in aeronautics, space science and exploration, space research and technology, space transportation, and earth system science. NASA Ames was established in 1939 as a National Advisory Committee for Aeronautics (NACA) research and aircraft testing facility. In 1958, the name of the facility was changed to NASA Ames Research Center. Since that time, a variety of support functions and other research and development laboratories have been built on the property.

NASA Ames is a federal facility located on 421 acres at Moffett Field, California (Figure 1). The property is secured by a series of locked gates, fences, and guarded entrances. Approximately 50 buildings and related research facilities are located at the south half of the property. The north part of NASA Ames is undeveloped, consisting of non-tidal marshlands and uncultivated fields previously leased for agricultural use. Marshlands and grasslands on the NASA Ames property within a diked, non-tidal ponding area at the north end of the facility ("the storm water retention pond"), and the area south of Perimeter Road ("the marsh") have been defined as wetlands. Man-made levees north of the retention pond separate NASA Ames from salt evaporators, the San Francisco Bay National Wildlife Refuge, and San Francisco Bay. According to the Ames Master Plan, no future development is planned for the wetland areas of NASA Ames (CDM, 1991).

### **1.1 PROGRAM OBJECTIVES**

The Center-Wide Sampling and Analysis Program ("CWSAP" or "the Program") has been conceived and implemented by NASA Ames as a systematic, formal program to conduct an overall site evaluation of potential soil and groundwater issues at NASA Ames. The Program, as currently planned, consists of the following tasks:

- Collect and review pre-existing data,
- Define areas of NASA where further investigation is warranted ("Areas of Investigation" or "AOIs"),
- Prepare work plans for the proposed investigations at each AOI ("AOI Work Plans"), if further investigations are warranted,
- Complete the sampling and analyses proposed in AOI Work Plans,



- Evaluate the new data in conjunction with the old data, and
- Produce a final environmental evaluation report that presents and interprets all available soil and groundwater data for NASA Ames. The conclusions of this report will be used to identify areas within NASA Ames that may require remediation of soil, groundwater, or both.

## **1.2 PROGRAM OVERVIEW**

As stated above, NASA Ames Research Center includes numerous buildings situated on over 400 acres of land. Due to the size of the facility, the number of buildings, and the variety of activities that have occurred at the facility, specific Areas of Investigation were identified at NASA Ames (Figure 2). The delineation of AOIs was based upon physical layout, historical activities, and/or known or suspected environmental issues. The division of NASA Ames into AOIs will allow for a more focused investigation of each selected area.

The following topics are discussed in this Program Overview report:

- Site geology and hydrogeology,
- Chemicals detected in soil and groundwater at NASA Ames,
- Offsite sources of chemicals that have migrated onto NASA Ames, and
- Objectives of the investigation proposed for each AOI.

Detailed work plans for each AOI ("AOI Work Plans") are submitted as separate volumes.

With the completion of this Program Summary and the associated AOI Work Plans, the first three of the tasks described in Section 1.1 above have been completed for ten AOIs within NASA Ames.

## 2. SITE SETTING

NASA Ames is located along the south end of San Francisco Bay, approximately 35 miles southeast of San Francisco and immediately north of Mountain View, California (Figure 1). NASA Ames lies south and east of the Mid-Peninsula Open Space District and south of salt evaporators (ponds) formerly maintained by the Leslie Salt Company and recently purchased by the Cargill Corporation ("the Leslie Salt Ponds"). Moffett Field Naval Air Station ("Moffett Field") is adjacent to the east of NASA Ames. Stevens Creek marks the west boundary of the NASA Ames property. The San Francisco Bay National Wildlife Refuge, a state protected marshland, lies to the north of the Leslie Salt ponds.

### 2.1 OVERVIEW OF SITE HISTORY

Operations at NASA Ames have used various hazardous materials including: metals, solvents, fuels, oils, PCB oils, acids, bases, and radioactive materials (Harrison, 1992). Previous investigations and reports on the site indicate that some of these materials may have been released into soil and/or groundwater at NASA Ames. Additionally, chemical plumes in groundwater (and perhaps soil) that originate at the Middlefield-Ellis-Whisman Superfund Study Area ("MEW Study Area") and Moffett Field Naval Air Station ("Moffett Field") extend from their offsite sources to beneath areas of NASA Ames property (e.g. RFA, 1991; PRC, 1991; IT, 1993).

Numerous environmental investigations have been conducted at NASA Ames over the years (Appendix 1). For the most part, investigations have been related to a particular building, incident, or chemical release. As the first step towards developing a strategy for a site-wide environmental assessment, NASA contracted Erler & Kalinowski, Inc. ("EKI") to review a number of NASA Ames documents and summarize the information they contained (EKI, 1992). As part of the Center-Wide Sampling and Analysis Program, EKI reviewed additional documents pertaining to NASA Ames, Moffett Field, and the MEW Study Area. Results of this additional review are presented below and in the individual AOI Work Plans.

Approximately 60 underground storage tanks ("USTs") are known to have existed at NASA Ames. At least 29 of these tanks have been removed over the past several years; some have been removed and replaced by new tanks. Chemical releases to soil and/or groundwater have been noted at many of the former or

present tank locations and are addressed in the individual AOI Work Plans.

Records of spills and releases that occurred in 1988 and after appear relatively complete. Pre-1988 areas of concern were identified through the review of historical aerial photographs and other documents. Locations of documented spills and other areas of concern are discussed in the individual AOI Work Plans.

### 3. SITE HYDROGEOLOGY

#### 3.1 REGIONAL GEOLOGY

NASA Ames is located near San Francisco Bay, in the northwest part of the Santa Clara Valley. The site lies on the gently sloping alluvial plain that extends from the base of the Santa Cruz Mountain foothills northeast to San Francisco Bay. San Francisco Bay lies approximately 1.5 miles north of NASA Ames, beyond the salt evaporators that bound the facility to the north (Figure 1). The foothills of the Santa Cruz Mountains lie approximately five miles southwest of the facility. Stevens Creek runs along the west boundary of NASA Ames. Geologic studies were conducted in the surrounding area by Dibblee (1966), Pampeyan (1970), Helley and Brabb (1971), Rogers and Williams (1974), and Helley and LaJoie (1979).

The structural geology of the bedrock in the area, like that of the California Coast Ranges in general, is complex owing to the area's long geologic history within the boundary between the Earth's Pacific and North American Plates. Over geologic time, the nature of this boundary has changed from one of plate collision and subduction that resulted in the formation of the Franciscan Formation to the present-day right-lateral strike-slip boundary, as expressed in the San Andreas Fault (Atwater, 1970). These intense plate interactions have produced the overall northwest-trending structural grain of the coast ranges that includes most faults, fold axes, and strikes of rock units.

The San Andreas Fault lies approximately 5.5 miles southwest of the study area; additional faults are mapped or inferred between the San Andreas Fault and the study area (Dibblee, 1966). The San Jose Fault likely lies under NASA Ames (CDM, 1992).

Bedrock in the vicinity of the study area is exposed in the foothills to the west. The oldest exposed rocks belong to the Cretaceous (144 to 65 million years ago ("mya")) Franciscan Formation. The Franciscan Formation is composed of a variety of rock types, including chert, sandstone, serpentine, basalt, and greenstone (Dibblee, 1966). Rock units younger than the Franciscan Formation, ranging in age from Eocene to Pliocene (55 to 5 mya), also are exposed in the foothills. These units are composed primarily of sedimentary rocks such as sandstone, siltstone, and shale, but also include some volcanic basalt and diabase (Dibblee,



1966). The limited available evidence suggests that rocks of the Franciscan Formation comprise the bedrock beneath NASA Ames (Dames and Moore, 1990).

During the Pliocene (5 to 2 mya), the basin now occupied by San Francisco Bay began to subside (Calif. D.W.R., 1975). As the basin subsided, sediments from the Santa Cruz Mountains and foothills washed down from the highlands into the basin, forming numerous coalescing alluvial fans. The oldest group of these alluvial fan deposits is known as the Santa Clara Formation, and ranges in age from Pliocene to Early Pleistocene (5 mya to 70,000 years ago). The Santa Clara Formation is exposed at the base of the foothills west of NASA Ames (Dibblee, 1966).

Dibblee (1966) and Helley and LaJoie (1979) recognize two alluvial units younger than the Santa Clara Formation, an older alluvium of Late Pleistocene age (70,000 to 10,000 years ago) and an overlying younger alluvium of Holocene (less than 10,000 years ago) age. Geologic mapping by Helley and LaJoie (1979) indicates that younger alluvium comprises the surficial geologic unit at NASA Ames; older alluvium is not found at the surface at NASA Ames. Alluvial deposits underlying NASA Ames are approximately 1,400 feet thick (Dames & Moore, 1990). The age of sediments beneath NASA Ames have not been confirmed.

Sedimentation at NASA Ames and vicinity has been influenced by three independent regional processes: the continued subsidence of the San Francisco Bay basin, the long-term climate-induced fluctuations in sea level, and the seasonal variation in rainfall. In former periods of lower sea level, sedimentation in the area of NASA Ames was likely dominated by fluvial (stream- or river-related) processes depositing relatively coarse-grained sediments in a gently sloping alluvial fan or alluvial plain-type environment. This style of deposition is evidence by the occurrence of layers of sand and gravel as apparently channelized deposits, as indicated by logs of drill cores and cone penetrometer testing ("CPT") completed at NASA Ames.

At other times in the geologic past, sea level has been higher and the bay shoreline has been west of its current location, possibly extending to the base of the foothills (Helley and LaJoie, 1979). During such times, it is likely that sedimentation in the area was dominated by a low-energy tidal marsh environment that resulted in the deposition of clayey "bay mud." Bay mud is recognized in drill cores from the site by its blue-grey to green-grey color and the

occasional presence of shell fragments. Pulses of coarser sediments, produced by storm-related streamflow, may have interrupted mud deposition in the tidal marsh from time to time.

Such variations in depositional environment are reflected in the subsurface geology of the site, where both fluvial deposits (sand and gravel) and tidal marsh deposits (bay mud) have been encountered in the subsurface during drilling.

In conditions such as those at present, with a relatively close San Francisco Bay shoreline, different parts of NASA Ames are subject to different types of sedimentation. Sedimentation on the south part of the property and along Stevens Creek is dominated by fluvial processes, whereas sedimentation in the north part of the property occurs primarily as deposition of fine-grained sediments in seasonal freshwater marshes. Under current climatic conditions, deposition in both areas occurs primarily in winter months during periods of increased rainfall and resulting increased streamflow and increased runoff into marsh areas.

### **3.2 GEOLOGY OF NASA AMES**

The geology of NASA Ames was reviewed using the available onsite data collected by NASA from soil borings and CPT soundings. The CPT soundings generally extended to depths of 30 to 60 feet below ground surface (ft bgs); most soil borings did not extend beyond 30 ft bgs. The discussion of site geology is therefore limited to the upper 30 feet of sediments underlying the site. Additional subsurface data has been collected from NASA Ames by the Navy and by the MEW Companies. Review of this data was not included in the current scope of work. Additional Navy and MEW data will be incorporated into the report completed at the end of the CWSAP.

Overall, the soil underlying the site can be characterized as being composed primarily of clay or clayey silt that contains numerous, relatively thin, discontinuous, coarser-grained layers or lenses of silt, sand, and/or gravel. The coarsest of the beds are likely to represent fluvial deposits such as stream-channel, levee, sheet wash, and/or debris flow deposits. Finer-grained beds may represent floodplain, overbank, and/or low-streamflow stream channel deposits. Thick layers of clay or clayey silt likely represent tidal and/or freshwater marsh deposits, whereas thin clay layers may represent either marsh deposits or low-energy fluvial deposits. Additionally, the contacts between apparently

horizontally contiguous lenses of sand and silt may be gradational. Contiguous lenses may represent facies changes within a single depositional unit.

### 3.3 HYDROGEOLOGY OF NASA AMES

Various consultants working for the Navy and for the MEW Companies have evaluated the hydrogeology of the area (Appendix 1). Deposits of coarse-grained sediments within the stratigraphic column have been divided generally into three aquifer zones, the "A", the "B", and the "C" aquifer zones. Relatively few borings on NASA property extend below the A aquifer zone. Additionally, releases of chemicals at NASA Ames are unlikely to have affected aquifer zones deeper than the A zone. Therefore, a detailed correlation of aquifer zones between the MEW site, Moffett Field, and NASA Ames was not made as part of the preparation of AOI Work Plans.

In general, the A-aquifer zone extends from ground surface to approximately 45 feet below ground surface ("ft bgs"). The B-aquifer zone extends from approximately 50 to 75 ft bgs and the C-aquifer zone extends from approximately 120 to at least 160 ft bgs. The C aquifer zone is the shallowest aquifer generally considered to be potentially suitable for drinking water. The main aquifers used to supply drinking water generally occur at depths greater than 240 ft bgs (CAN, 1993).

The groundwater flow direction across NASA and Moffett Field is generally to the north toward San Francisco Bay at a relatively gentle gradient, ranging from approximately 0.008 ft/ft to 0.002 ft/ft (Figure 3). The potentiometric surface of the shallow A-aquifer, ranges from approximately 18 feet above mean sea level at the south boundary to near sea level in the wetlands at the north boundary of the site. Groundwater elevations may be tidally influenced. Additionally, at the north end of NASA Ames, groundwater elevations and gradients are apparently influenced by ongoing dewatering occurring at the north end of Moffett Field, at the Navy Building 191 lift station.

#### 4. CHEMICALS DETECTED IN SOIL AND GROUNDWATER AT NASA AMES

A number of chemicals have been detected in soil and/or groundwater at NASA Ames. These chemicals include:

- Petroleum hydrocarbons, i.e. fuels such as gasoline, diesel fuel, and jet fuel,
- Chlorinated volatile organic compounds ("VOCs") commonly used as solvents,
- Polychlorinated biphenyls ("PCBs"), formerly used in transformers and other electrical equipment, and
- Various metals.

Sources for all of these chemicals may exist at NASA Ames. However, the bulk of the chlorinated VOCs in groundwater at NASA Ames is likely to have migrated to NASA Ames from upgradient sources at Moffett Field Naval Air Station ("Moffett Field") and/or the Middlefield-Ellis-Whisman Study Area ("MEW Study Area"). As an example, trichloroethene ("TCE") is the most widely distributed chlorinated solvent at NASA Ames; however its distribution suggests that it originates primarily from offsite sources (Figures 4 and 5). Offsite sources are discussed further in the following section.

The distribution of chemicals in soil and groundwater at NASA Ames within each AOI is discussed in the corresponding AOI Work Plan.



## **5. OFFSITE SOURCES OF CHEMICALS**

### **5.1 MEW STUDY AREA**

Known soil and groundwater affected by VOCs located upgradient (south) of NASA Ames and Moffett Field has been investigated under the guidance of the EPA for several years (EPA 1989; EPA, 1991). The offsite source area is bounded by Middlefield, Ellis, and Whisman Roads and is referred to as the Middlefield-Ellis-Whisman Study Area or MEW Study Area (Figure 1). The MEW Study Area is comprised of facilities owned or operated by approximately 20 companies, including Fairchild Semiconductor Corporation, Intel Corporation, and Raytheon Company (EPA, 1989).

Various investigations have indicated that VOCs originating at the MEW Study Area are migrating downgradient in the shallow groundwater beneath Moffett Field and NASA Ames (e.g. EPA, 1991; HLA, 1987; IT, 1993). The primary VOCs detected in the shallow groundwater beneath the MEW Study Area and downgradient areas are:

trichloroethene	("TCE")
1,1,1-trichloroethane	("TCA")
cis- and trans-1,2-dichloroethene	("1,2-DCE")
1,1-dichloroethene	("1,1-DCE")
trichloroethene	("TCE")
1,1-dichloroethane	("1,1-DCA")
tetrachloroethene	("PCE")
cis-1,2-dichlorobenzene	("1,2-DCB")
trichlorotrifluoromethane	("Freon 113")
chloroform	
vinyl chloride.	

The extent of these chemicals in groundwater migrating onto Moffett Field and NASA Ames can be inferred from EPA (1991), from Figure 4 and Figure 5 herein, and from figures prepared by IT (1993) and attached herein as Appendix 2.

### **5.2. MOFFETT FIELD SOURCE AREAS OF CONCERN TO NASA**

A number of confirmed sources of chemicals released to soil or groundwater are known to exist within Moffett Field. Several of these source areas are located upgradient of NASA Ames. Chemicals from these sources are likely to have migrated onto NASA property via transport in groundwater. In some instances, chemicals leaked or spilled at Moffett Field near the Navy/NASA property line may have directly affected

soil at NASA Ames. The principal known Moffett Field source areas that may have affected NASA Ames are summarized in Table 2.

The primary chemicals originating at Moffett Field that affect NASA Ames are:

- the chlorinated organic solvents TCE, 1,2-DCE, PCE, TCA, 1,1-DCE, and 1,1-DCA,
- petroleum hydrocarbons, quantified as total petroleum hydrocarbons ("TPH"), and
- benzene, toluene, ethylbenzene, and xylenes ("BTEX").

The sources and distribution on the west side of Moffett Field of these chemicals and others is presented by IT (1993). Figures prepared by IT (1993) showing the interpreted distribution of chemicals in groundwater are attached as Appendix 2. The data presented in these figures are subject to more than one interpretation and EKI makes no claim as to the accuracy or completeness of IT's (1993) figures. However they do illustrate the general distribution of chemicals in groundwater and imply some source areas at Moffett Field. In viewing IT's (1993) figures, it is important to note that contours have been drawn only for relatively high chemical concentrations; isoconcentration contours drawn for Maximum Contaminant Levels ("MCLs") or other potentially applicable cleanup standards would encompass a larger area. As an example, compare IT (1993) Figure 4.2-4A and Figure 4 herein.

Chemicals sources on the west side of Moffett Field are of primary concern to NASA Ames. Due to the general north to north northeast groundwater gradient in the area, sources of chemicals on the east side of Moffett Field are unlikely to have affected NASA Ames.

## **6. AREAS OF INVESTIGATION**

Ten areas within NASA Ames have been designated as Areas of Investigation. Individual AOI Work Plans have been prepared as separate volumes for each of the areas. A brief description of each AOI and the objectives of the investigation at the AOI is presented below. For detailed descriptions of the areas and the recommended investigations refer to the individual AOI Work Plans.

Procedures to be used during the investigations are presented in Appendix 3 and are in accordance with the Unified Quality Assurance Project Plan, Middlefield-Ellis-Whisman Study Area, Mountain View and Moffett Field, California ("Unified QAPP") (Canonie, 1991), included as Appendix 4.

### **6.1 AOI 1**

AOI 1, also known as "the fuel farm", is located in the southeast corner of NASA Ames. Four 20,000-gallon underground storage tanks ("USTs") are located within AOI 1. The USTs are used to store jet fuel and comprise the primary jet fuel storage facility at NASA Ames. There are no buildings located within AOI 1.

The primary objective of the work planned within AOI 1 is to further investigate the extent of migration of jet fuel that was released on 9 May 1992. An evaluation of the upgradient Navy Site 9 is also recommended in order to provide additional information on the impacts of releases at Navy Site 9 on NASA Ames. This work will be coordinated with the planned excavation and removal of the USTs at the fuel farm, planned by NASA for 1994.

### **6.2 AOI 2**

AOI 2 is located at the south end of the NASA Ames property. The area includes laboratories that specialize in flight and guidance simulation, flight systems research, and life science research (buildings N-239, N-239A, N-210, N-243, and N-243A). USTs have existed at four locations within AOI 2 (Tank 19, 21, 22, and 24). Analyses of soil and groundwater samples from within AOI 2 indicate the presence of petroleum hydrocarbons, BTEX compounds, and VOCs.

The objectives of the work proposed for AOI 2 are:

- to evaluate soil and groundwater quality at the locations of current or former USTs,
- to assess whether a local source of chlorinated VOCs exists, and
- to further assess the magnitude of chemicals migrating in groundwater onto AOI 2 from upgradient sources at Moffett Field and the MEW Study Area.

### **6.3 AOI 3**

AOI 3 is located on the north side of the aircraft ramp and includes the areas between and around buildings N-248A, N-248B, and N-259. In the past, two groups of USTs were located within AOI 3. The tanks were known to have leaked and were removed. NASA has planned an excavation of soil impacted by tank leakage for 1994.

Analyses of soil and groundwater samples from within AOI 3 have detected petroleum hydrocarbons and VOCs. Free-phase petroleum hydrocarbons are likely to be present on the groundwater surface.

The objective of the work proposed for AOI 3 is to further evaluate the extent of petroleum hydrocarbons in the soil. The extent of petroleum hydrocarbons and VOCs in groundwater will be addressed in the work proposed for AOI 9.

### **6.4 AOI 4**

AOI 4 is located on the west side of the NASA Ames property. AOI 4 includes the National Full-Scale Aerodynamics Complex ("NFAC") and the surrounding area. Twelve USTs have existed within AOI 4. Several of the USTs have reportedly leaked and some are scheduled for removal. Analyses of soil and groundwater samples from within AOI 4 have detected petroleum hydrocarbons and VOCs.

The objectives of the work proposed for AOI 4 are:

- to evaluate the extent of any groundwater impacted by releases from USTs at AOI 4,
- to evaluate the groundwater quality at the upgradient boundary of AOI 4 in order to assess the possibility of upgradient sources of VOCs in groundwater,



- to assess whether chemicals were released to surface soil in storage areas visible on aerial photographs, and
- to assess whether mercury was released to soil from a storm drain vault where the occurrence of mercury was documented in 1990.

#### **6.5 AOI 5**

AOI 5 is located in the west part of the NASA Ames property. AOI 5 includes six buildings used as bioscience laboratories (N-261), and two electrical substations (N-225 and N-225A). One UST was previously located within AOI 5 (Tank 18). The tank was removed in 1990. Analyses of soil and groundwater samples from within AOI 5 have detected petroleum hydrocarbons, metals, PCBs, and VOCs.

The objectives of the work proposed for AOI 5 are:

- to investigate whether Tank 18 may have released chemicals to soil and/or groundwater,
- to investigate whether a source of chlorinated solvents exists in the area, and
- to evaluate the possibility of historical releases of chemicals to the soil through previous site activities.

#### **6.6 AOI 6**

AOI 6 is located in the north part of NASA Ames. AOI 6 includes the open storm drain, the diversion structure at the north end of the drain, and the adjacent exposed soil that parallels Lindbergh Avenue. The open storm drain is no longer in use and was replaced with a buried concrete pipe storm drain system in mid-1993.

NASA intends to decommission the open storm drain in 1994 and remove the concrete drain and its contents. Samples will be collected in order to assess disposal options for the storm drain, its contents, and the exposed soil on both sides of the storm drain.

#### **6.7 AOI 7**

AOI 7 is located on the east side of the NASA Ames property. The area includes a vertical takeoff and landing area ("the VTOL pad") and is bordered to the south by a storage yard

that is part of Moffett Field ("Navy Site 8"). Analysis of soil and groundwater samples from within AOI 7 have detected VOCs.

Two objectives will be addressed by the work proposed for AOI 7. These objectives are:

- to further evaluate the extent of the chemicals known to exist in the soil and groundwater at the south end of AOI 7, adjacent to the Navy Storage Yard, and
- to evaluate the areas along the north and east perimeters of the Navy Storage Yard for the presence of chemicals in soil and groundwater.

#### **6.8 AOI 8**

AOI 8, also known as "Navarro Farms", is located at the northwest corner of NASA Ames property. The area includes one building (N-267) and a bioremediation pad. One UST was previously located within AOI 8 (Tank U13). The tank was removed in 1989. Analyses of soil and groundwater samples from within AOI 8 have detected petroleum hydrocarbons, oil and grease, pesticides, methylene chloride, and metals.

The primary objective of the work planned for AOI 8 is to determine whether the groundwater quality has been affected by activities that have occurred within AOI 8. Sampling of groundwater at locations both upgradient and downgradient of the area will be done to accomplish this objective. Limited soil sampling will also be done in order to evaluate the soil chemistry in areas that have not been sampled previously.

#### **6.9 AOI 9**

AOI 9 is located on the east side of the NASA Ames property. The area includes space science research and flight data acquisition facilities, a recreation area, and a child care center. No USTs are currently known to exist within AOI 9; however the Navy is investigating the possibility that a UST associated with the former blimp mooring circle may exist in the area. Analyses of soil and groundwater samples from within AOI 9 have detected petroleum hydrocarbons and solvents.

The objectives of the work proposed for AOI 9 are:

- to evaluate the likelihood of sources of chemicals within AOI 9,

- to evaluate the impacts on AOI 9 of petroleum hydrocarbons apparently originating within AOI 3.

A general evaluation of the impacts on AOI 9 of Navy activities at the adjacent Moffett Field is made in the Work Plan for AOI 9.

#### **6.10 AOI 10**

Six electrical substations exist at NASA Ames. Four of the substations are addressed in this Work Plan; the other two substations are discussed in the Work Plan for AOI 5. No documented soil or groundwater samples have been collected in any of the substations within AOI 10.

Transformer oil containing PCBs was used historically in many of the transformers at NASA Ames. The primary objectives of the work proposed for AOI 10 is to investigate the soil within the electrical substations for the presence of PCBs.

#### **6.11 ADDITIONAL AOIs**

During the course of reviewing data and preparing work plans for AOI 1 through AOI 10, two additional AOIs were identified. Work plans for the investigation of these two additional AOIs are currently under preparation and will be submitted separately at a later date. The two additional AOIs are described below.

##### **AOI 11 - Additional Underground Storage Tank Sites**

Additional USTs are known to exist at NASA Ames in 13 areas outside the original ten AOIs. AOI 11 will encompass 10 of these 13 UST locations. Twelve USTs are located at the ten sites to be included in AOI 11. The remaining three UST sites will be addressed in the future Work Plan for AOI 12.

##### **AOI 12 - Building N-211 Area**

The area defined as AOI 12 is comprised of the triangular area of NASA Ames bounded by McCord Avenue, Severyns Avenue, and King Road (Figure 1). The area includes buildings N-211, N-212, and N-213. This area was defined as an Area of Investigation because:

- 1) N-211 is one of the older buildings in existence at NASA Ames and it has been used for aircraft maintenance throughout its life,
- 2) the area includes three present or former locations of USTs, designated Tanks 12, 13, and 14, and
- 3) the area overlies the regional groundwater plume that originates at the MEW Study Area and Moffett Field. It is not currently known if a dissolved solvent plume in the AOI 3/AOI 12 area is an extension of the regional plume or due to a more local source.



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**Table 1**

**AOI 1: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Groundwater sampling planned to investigate the extent of migration of jet fuel from the spill documented in Section 2.1 of the AOI 1 Work Plan

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	-
Total Soil Samples	-
Total Groundwater (well) Samples	8
Groundwater (Hydropunch) Samples	-

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	8
TPHd	-	8
TPHjp5	-	-
TPH/Fuel Fingerprint	-	-
Other TPH	-	-
EPA 8010	-	-
EPA 8240	-	-
EPA 8270	-	-
EPA 8080	-	-
EPA Priority Metals	-	-

**NOTES:**

TPHg - Total Petroleum Hydrocarbons as Gasoline  
 TPHd - Total Petroleum Hydrocarbons as Diesel  
 TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline  
 TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel  
 BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 2: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil and groundwater sampling is planned to investigate the possibility that the four underground storage tanks released chemicals to the soil and/or groundwater.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	14
Total Proposed Monitoring Wells	1
Total Proposed CPT Locations	9
Total Soil Samples	28
Total Groundwater (well) Samples	1
Groundwater (Hydropunch) Samples	9

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	28*	10*
Other TPH	-	-
EPA 8010	-	-
EPA 8240	28	10
EPA 8270	28	10
EPA 8080	-	-
EPA Priority Metals	-	-

**NOTES:**

\* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 3: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil sampling is planned to investigate the lateral extent of the hydrocarbons present in the soil.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	10
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	-
Total Soil Samples	20
Total Groundwater (well) Samples	-
Groundwater (Hydropunch) Samples	-

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	20*	-
Other TPH	-	-
EPA 8010	20	-
EPA 8240	-	-
EPA 8270	-	-
EPA 8080	-	-
EPA Priority Metals	-	-

**NOTES:**

\* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 4: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil and groundwater sampling is planned to investigate the possibility that former and existing underground storage tanks released chemicals of concern. Soil sampling is also planned in areas that appear to have stained soil as documented in aerial photographs.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	11
Total Proposed Monitoring Wells	1 <sup>(a)</sup>
Total Proposed CPT Locations	22
Total Soil Samples	21
Total Groundwater (well) Samples	12
Groundwater (Hydropunch) Samples	22

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	20 <sup>(b)</sup>	20 <sup>(b)</sup>
Other TPH	-	-
EPA 8010	-	-
EPA 8240	20	21
EPA 8270	-	-
EPA 8080	20	-
Mercury	1	4

**NOTES:**

(a) Completion of well dependent upon results of other sampling and analysis proposed in the work plan for AOI 4.

(b) EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 5: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil and groundwater sampling is planned to investigate the possibility that chemicals of concern were released into the soil and/or groundwater from Tank 18. Sampling is also planned to investigate whether soil and/or groundwater were affected by chemicals of concern that potentially originated from either (1) a documented oil spill, (2) an equipment storage area, and/or (3) an electrical substation.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	127
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	8
Total Soil Samples	131 to 274
Total Groundwater (well) Samples	1
Groundwater (Hydropunch) Samples	8

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	131 to 254*	3*
Other TPH	-	-
EPA 8010	-	-
EPA 8240	80 to 152	8
EPA 8270	-	10
EPA 8080	123 to 246	-
EPA Priority Metals	72 to 144	-

**NOTES:**

\* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes



**Table 1**

**AOI 6: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil from beneath the concrete of the storm drain will be sampled every 20 feet along the length of the storm drain in order to characterize the soil and evaluate whether further excavation may be necessary.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	100
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	-
Total Soil Samples	100
Total Groundwater (well) Samples	-
Groundwater (Hydropunch) Samples	-

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHp5	-	-
TPH/Fuel Fingerprint	100*	-
Other TPH	-	-
EPA 8010	-	-
EPA 8240	-	-
EPA 8270	30	-
EPA 8080	100	-
EPA Priority Metals	10	-
ICP Metals (non-EPA method)	100	-

**NOTES:**

- \* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected
- TPHg - Total Petroleum Hydrocarbons as Gasoline
- TPHd - Total Petroleum Hydrocarbons as Diesel
- TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline
- TPHp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel
- BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 7: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil and groundwater sampling is planned in order to further assess the distribution of chemicals present along the boundary between NASA Ames and the Navy Storage Yard.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	10
Total Soil Samples	10
Total Groundwater (well) Samples	3
Groundwater (Hydropunch) Samples	20

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	10*	13*
Other TPH	-	-
EPA 8010	-	-
EPA 8240	10	23
EPA 8270	-	-
EPA 8080	10	-
EPA Priority Metals	-	-

**NOTES:**

\* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 8: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Groundwater sampling is planned to investigate whether groundwater has been affected by activities that have historically occurred in AOI 8. Soil sampling will be done to evaluate soil in areas that have not previously been sampled.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	4
Total Proposed CPT Locations	-
Total Soil Samples	4
Total Groundwater (well) Samples	5
Groundwater (Hydropunch) Samples	-

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	4	5
Other TPH	-	-
EPA 8010	-	-
EPA 8240	4	5
EPA 8270	-	-
EPA 8080	4	-
EPA Priority Metals	-	-

**NOTES:**

\* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 9: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil and groundwater sampling is planned to evaluate (1) the impacts of Navy/Moffett Field activities on AOI 9, and (2) the lateral extent in groundwater of petroleum hydrocarbons that apparently originate from AOI 3. Sampling will also evaluate the likelihood of chemical sources within AOI 9.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	-
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	7
Total Soil Samples	4
Total Groundwater (well) Samples	4
Groundwater (Hydropunch) Samples	7

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	4*	11*
Other TPH	-	-
EPA 8010	-	-
EPA 8240	4	11
EPA 8270	-	-
EPA 8080	4	-
EPA Priority Metals	-	-

**NOTES:**

- \* EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected
- TPHg - Total Petroleum Hydrocarbons as Gasoline
- TPHd - Total Petroleum Hydrocarbons as Diesel
- TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline
- TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel
- BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 1**

**AOI 10: Summary of Proposed Work and Sample Analyses**  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center

**Objectives of Proposed Work**

Soil sampling is planned to evaluate whether PCBs occur in the soil within the electrical substations.

**Summary of Proposed Work**

Total Proposed Surface Soil Sampling Locations	160 to 240 <sup>(a)</sup>
Total Proposed Soil Borings	-
Total Proposed Monitoring Wells	-
Total Proposed CPT Locations	-
Total Soil Samples	40 to 60 <sup>(a)</sup>
Total Groundwater (well) Samples	-
Groundwater (Hydropunch) Samples	-

**Summary of Sample Analyses**

Laboratory Analysis	Total Proposed Soil Samples	Total Proposed Groundwater Samples
TPHg + BTEX	-	-
TPHd	-	-
TPHjp5	-	-
TPH/Fuel Fingerprint	40 to 60 <sup>(a,b)</sup>	-
Other TPH	-	-
EPA 8010	-	-
EPA 8240	-	-
EPA 8270	-	-
EPA 8080	40 to 60 <sup>(a)</sup>	-
EPA Priority Metals	-	-

**NOTES:**

(a) The number of samples and analyses will depend upon the number of concrete pads having multiple transformers.

(b) EPA Method 8020 analyses (for BTEX) will be performed if TPHg or TPHav is detected

TPHg - Total Petroleum Hydrocarbons as Gasoline

TPHd - Total Petroleum Hydrocarbons as Diesel

TPHav - Total Petroleum Hydrocarbons as Aviation Gasoline

TPHjp5 - Total Petroleum Hydrocarbons as JP5 Jet Fuel

BTEX - Benzene, Toluene, Ethylbenzene, and total Xylenes

**Table 2**

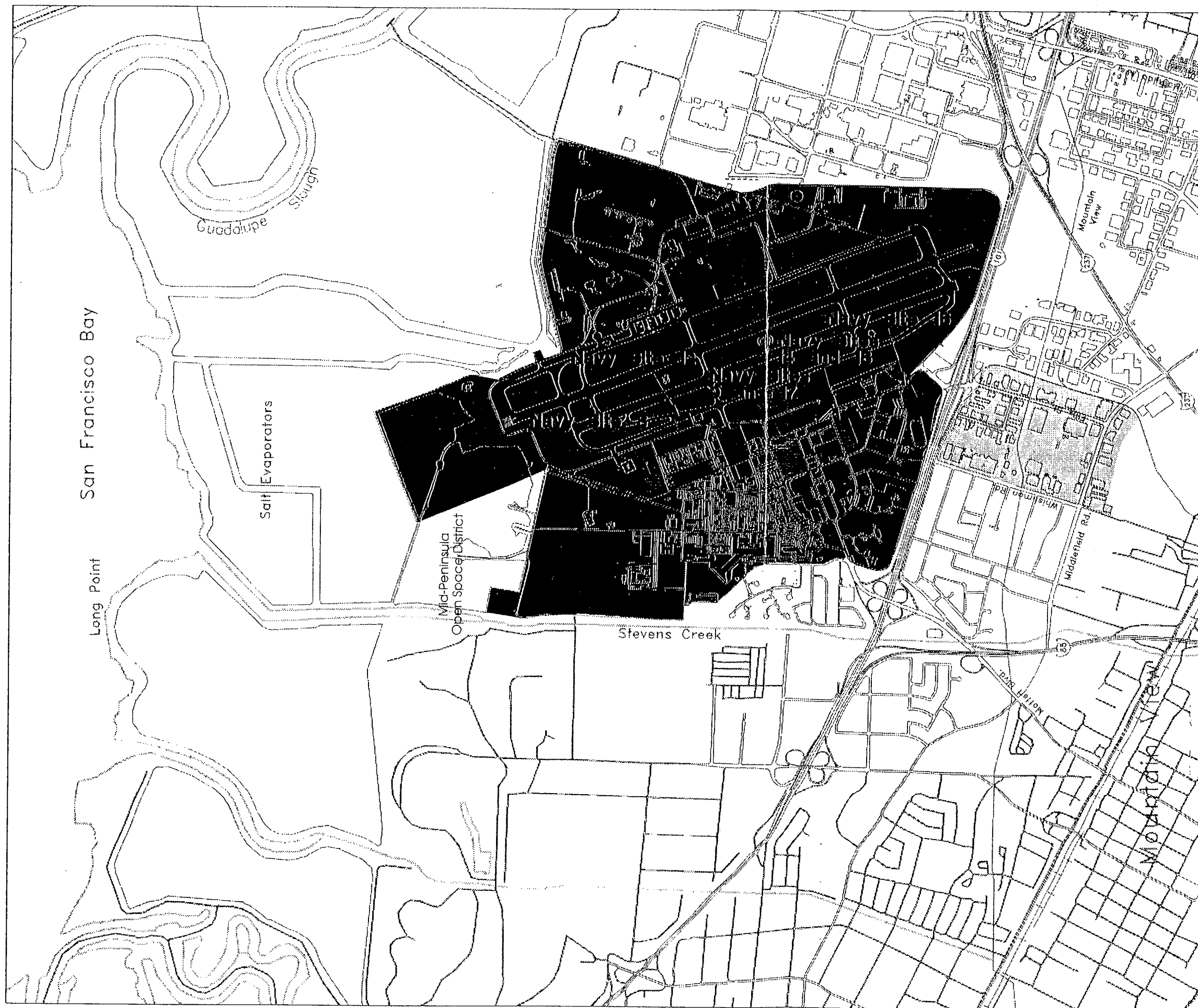
**Summary of Navy Source Areas that May Have Affected NASA Ames  
Center-Wide Sampling and Analysis Program  
NASA Ames Research Center  
EKI 920008.05**

<b>Navy Site Designation<sup>1</sup></b>	<b>Site Description</b>	<b>Chemicals Potentially Released<sup>2</sup></b>
Site 8	Navy Storage Yard	Waste oil Transformer oil Paint and paint thinner Solvents Unknown drum contents?
Site 9	Old Fuel Farm and Old NEX Gas Station	Aviation gasoline Waste oil Solvents
	Other Site 9 Sources	Gasoline Diesel fuel Waste oil
Site 12	Fire-Fighting Training Area	Jet fuel Diesel fuel Solvents
Site 14	Abandoned Tanks	Diesel fuel Kerosene Solvents
Site 16	Public Works Steam Cleaning Rack	Petroleum products? Solvents?
Site 17	Public Works Paint Shop	Paint and paint thinners Turpentine Toluene Solvents? Petroleum products?
Site 18	Dry Cleaners'	Solvents, primarily PCE

**Notes**

<sup>1</sup> See Figure 1 for locations.

<sup>2</sup> Chemicals listed are from IT (1993). Chemicals followed by "?" are EKI additions to list, based on inferred site usage.



0 2000 4000  
(Approximate Scale in Feet)

-  NASA-Ames Research Center
-  Moffett Field Naval Air Station
-  Middlefield-Ellis-Whisman Source Areas

**Notes:**

1. All locations and property boundaries are approximate.
2. Basemap from electronic basemap provided by NASA-Ames.

**Erler &  
Kalinowski, Inc.**

Location Map

NASA-Ames Research Center  
Moffett Field, CA  
March 1994  
EKI 920008.05  
Figure 1





**APPENDIX 1**  
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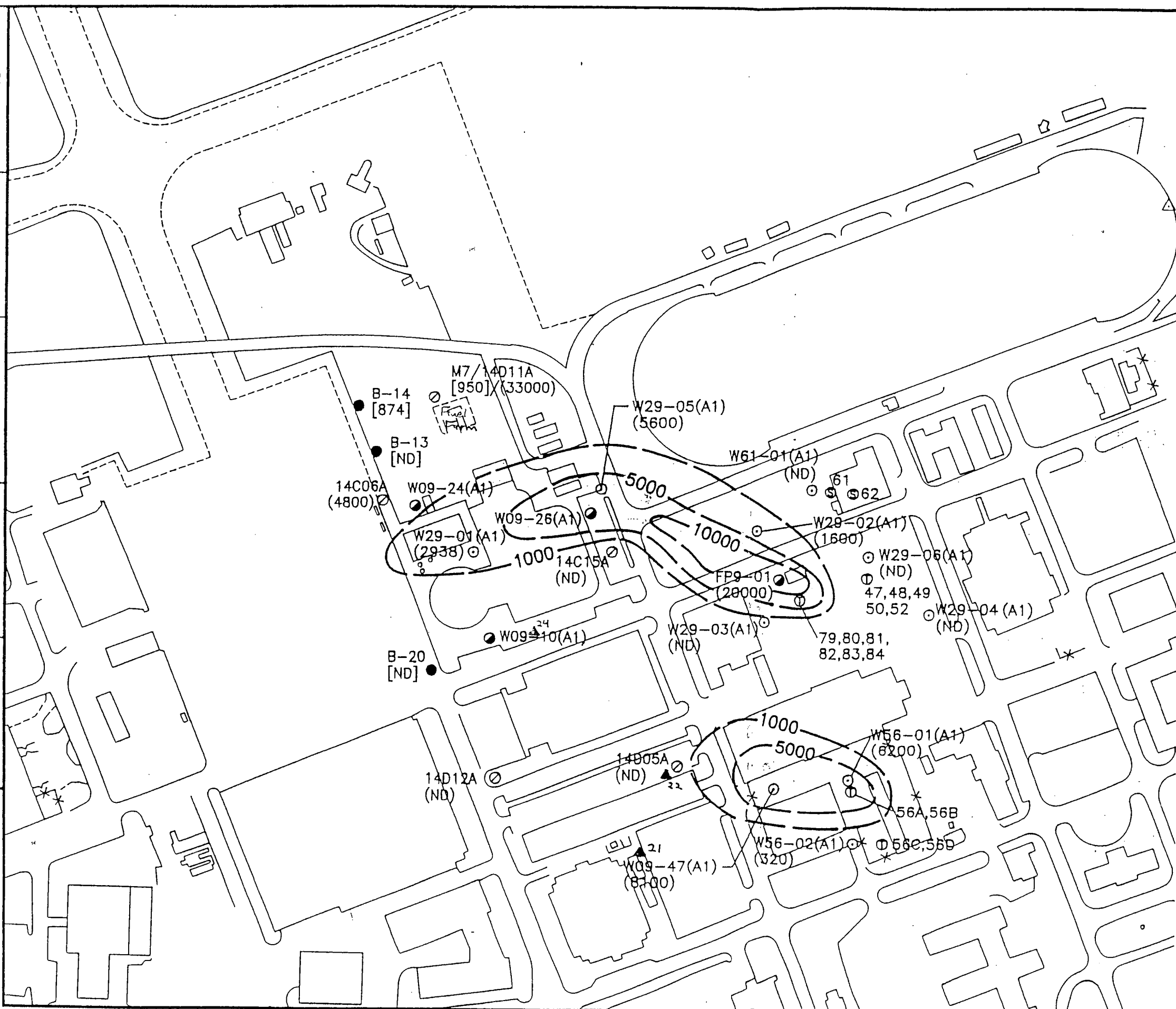
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**APPENDIX 2**

Groundwater Maps Prepared by IT (1993)

OU 4 RI  
4097290F 01/13/93 10:41am JWH



LEGEND:

- IT MONITORING WELL
  - NASA-AMES SOIL BORING/  
MONITORING WELL
  - NASA-AMES SOIL BORING
  - ⊙ CLEAN MONITORING WELL
  - ⊖ TANKS
  - Ⓢ SUMPS
- (150) TPH GROUNDWATER CONCENTRATION  
IN ug/l (ppb)
- 1000 — CONTAMINENT CONCENTRATION  
CONTOUR, (ppb)
- [950] TPH SOIL CONCENTRATION IN mg/kg  
(ppm) (BETWEEN 10 TO 11.5ft bls).
- (ND) NOT DETECTED

NOTES:

1. W09-10(A1), W09-24(A1), AND W09-26(A1) WERE ANALYZED FOR JP-5 FUEL ONLY AND WERE REPORTED AS NONDETECTS.
2. NASA-AMES WELLS 14D11A AND 14C06A ARE NOT CONSISTENT WITH UPGRADIENT DATA TRENDS AND HAVE NOT BEEN CONTOURED.

SCALE:

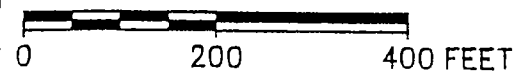
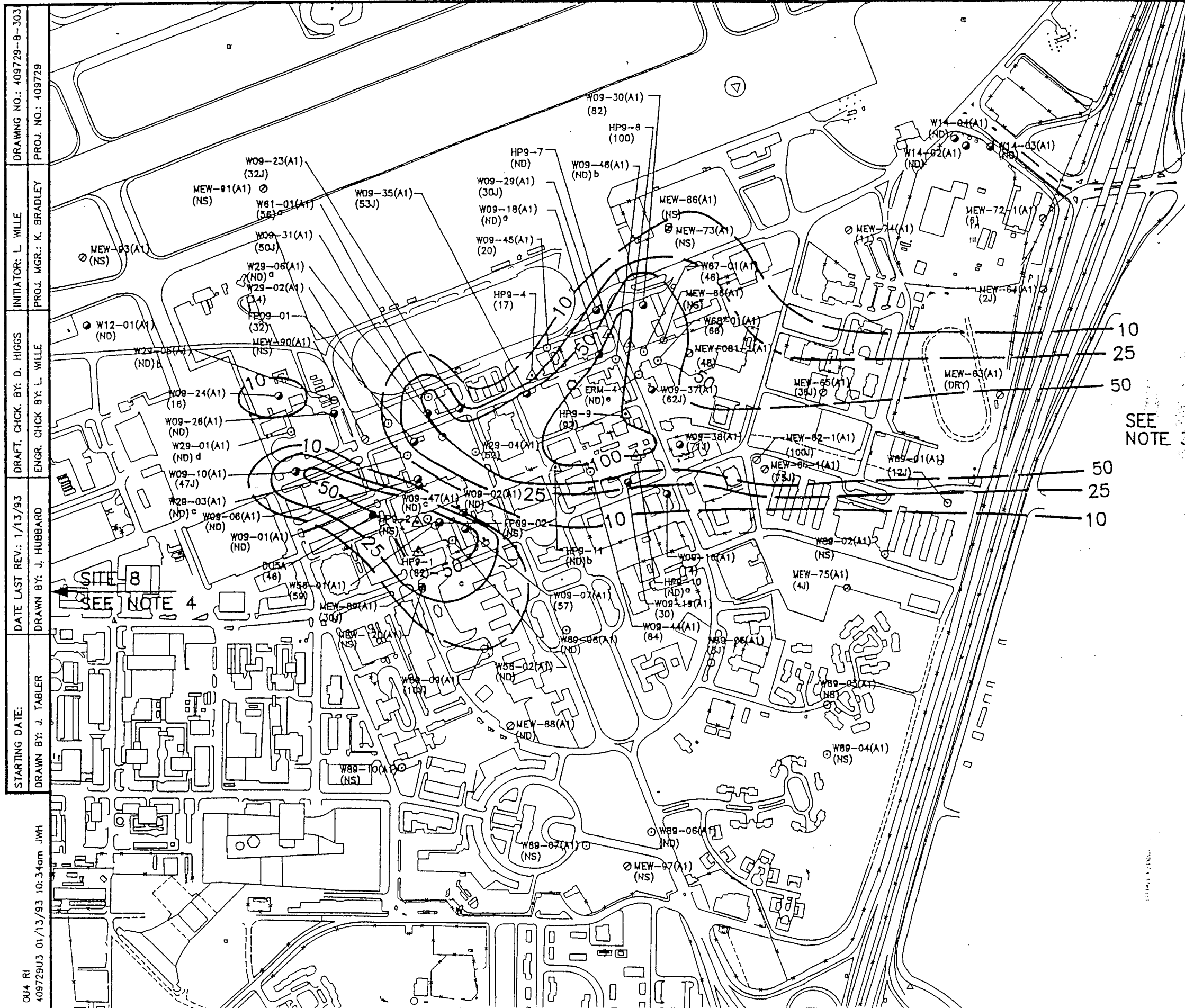


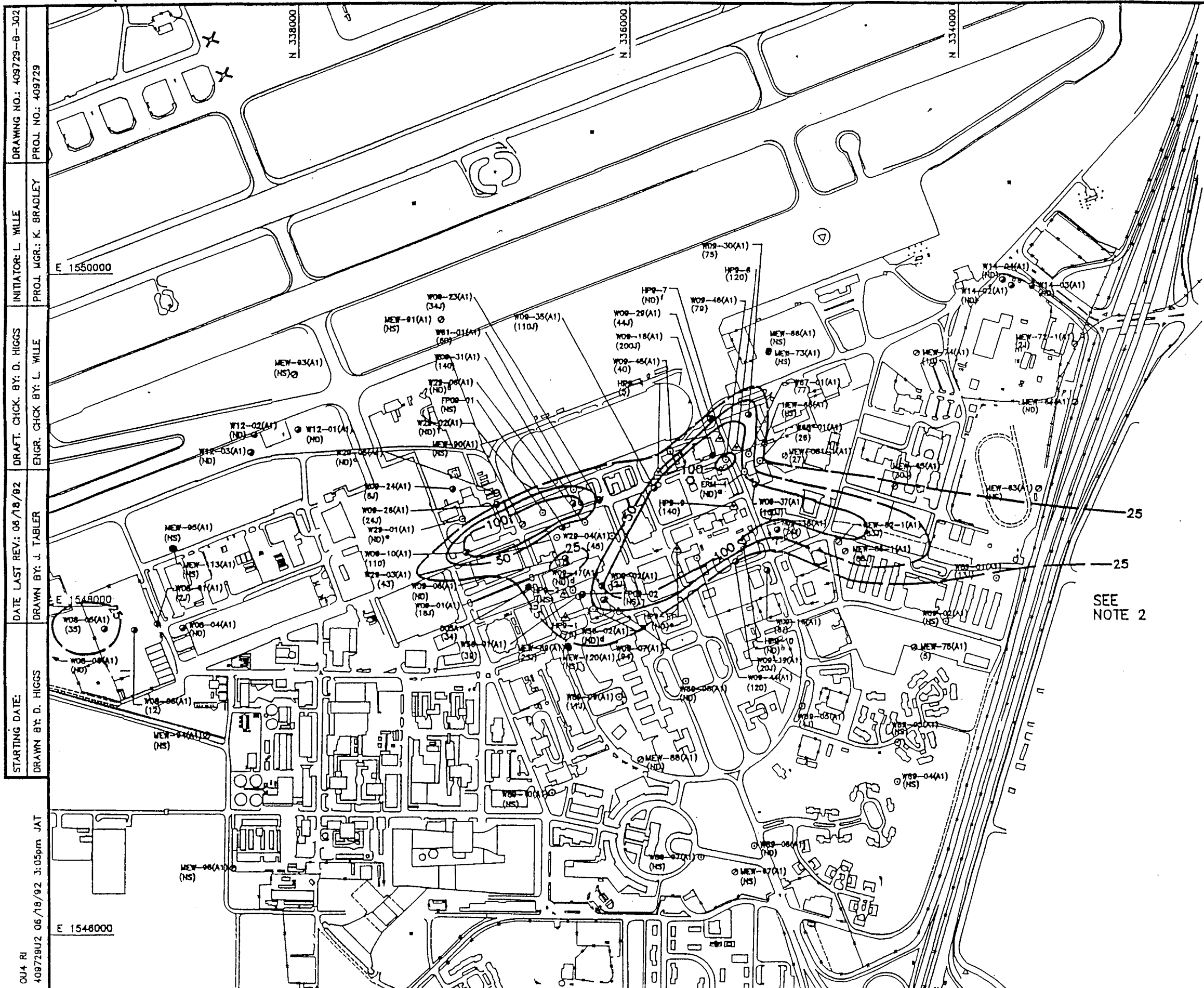
FIGURE 4.2-8B  
SITE 9-TPH GROUNDWATER  
CONCENTRATION CONTOUR MAP  
A1 AQUIFER ZONE, JULY 1991

NAVAL AIR STATION  
MOFFETT FIELD, CALIFORNIA





DRAWING NO.: 409729-8-303  
 PROJ. NO.: 409729  
 INITIATOR: L WILLE  
 PROJ. MGR.: K. BRADLEY  
 DRAFT. CHK. BY: D. HIGGS  
 ENGR. CHK. BY: L WILLE  
 DATE LAST REV.: 1/13/93  
 DRAWN BY: J. HUBBARD  
 STARTING DATE:  
 DRAWN BY: J. TABLER  
 004 RI  
 409729U3 01/13/93 10:34am JWH



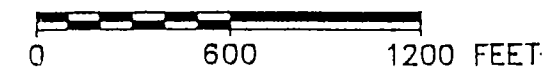
**LEGEND:**

- 100 - CONTAMINANT CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- IT MONITORING WELL
- MEW MONITORING WELL
- CLEAN MONITORING WELL
- (180) CONCENTRATION IN µg/l(ppb)
- (30J) ESTIMATED CONCENTRATION IN µg/l (ppb)
- (ND) NOT DETECTED
- (NS) NOT SAMPLED
- a DETECTION LIMIT OF 1000 µg/l (ppb)
- b DETECTION LIMIT OF 500 µg/l (ppb)
- c DETECTION LIMIT OF 250 µg/l (ppb)
- d DETECTION LIMIT OF 100 µg/l (ppb)
- e DETECTION LIMIT OF 50 µg/l (ppb)
- f DETECTION LIMIT OF 10 µg/l (ppb)

**NOTES:**

1. DATA VALIDATION CRITERIA FOR GROUNDWATER SAMPLES NOT ANALYZED BY IT CORPORATION IS PRESENTED IN SECTION 4.1.1.
2. A 1,1-DCE GROUNDWATER CONCENTRATION CONTOUR MAP FOR THE MEW AREA WAS NOT PRESENTED IN THE RI/FS REPORT (HLA, 1987b).

**SCALE:**



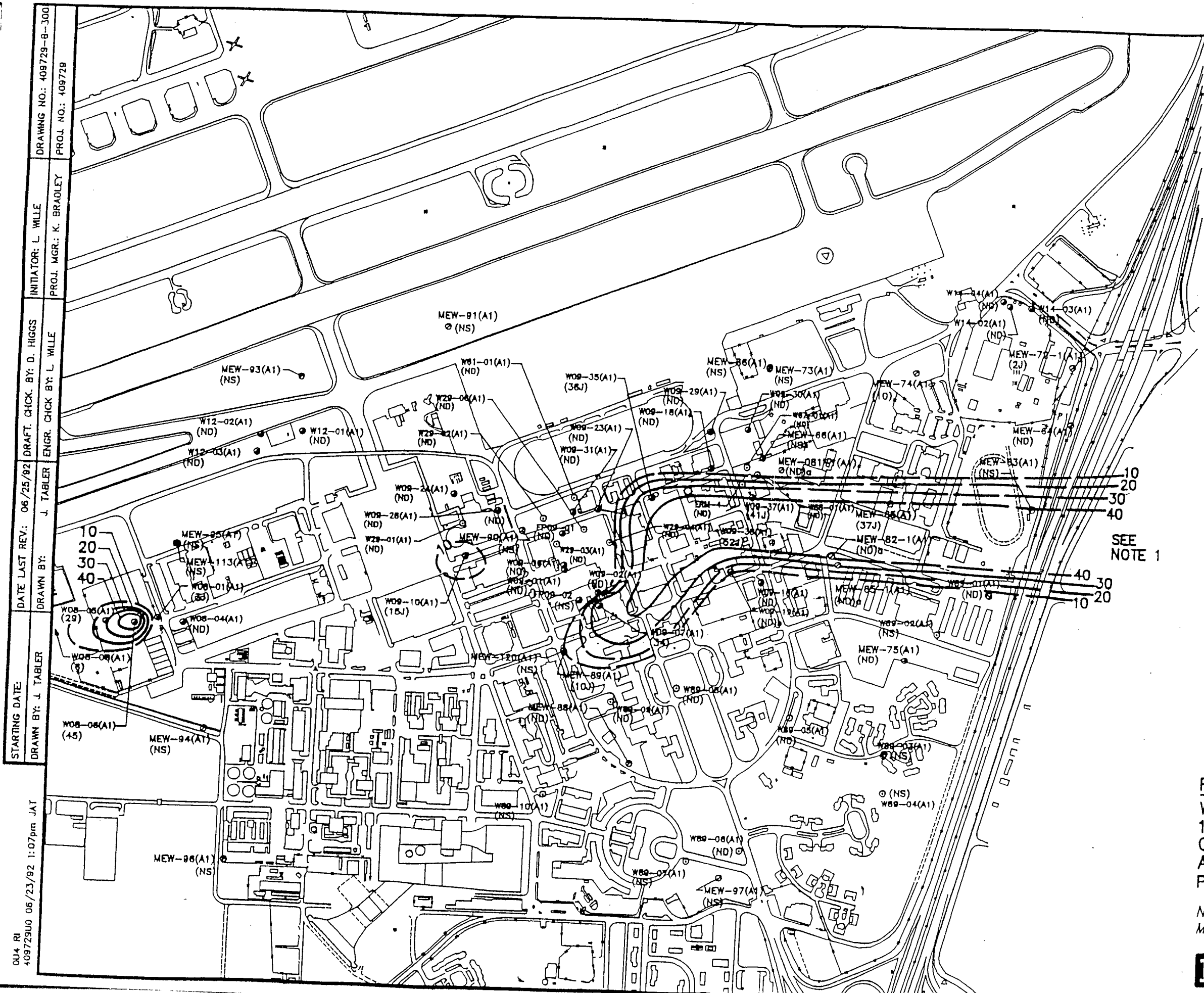
**FIGURE 4.2-6**  
WEST SIDE AQUIFER  
1,1-DCE GROUNDWATER  
CONCENTRATION CONTOUR MAP  
A1 AQUIFER ZONE  
PHASE II, 2nd QUARTER 1991

NAVAL AIR STATION  
MOFFETT FIELD, CALIFORNIA



DRAWING NO.: 409729-8-302  
INITIATOR: L. WILLE  
PROJ. MGR.: K. BRADLEY  
DRAFT: CHCK. BY: D. HIGGS  
ENGR. CHCK BY: L. WILLE  
DATE LAST REV: 06/18/92  
DRAWN BY: J. TABLER  
STARTING DATE: DRAWN BY: D. HIGGS  
044 RI  
409729U2 06/18/92 3:05pm JAT





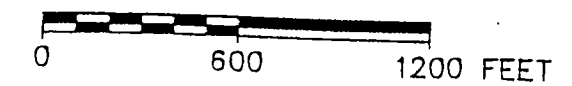
**LEGEND:**

- 20— CONTAMINANT CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- IT MONITORING WELL
- MEW MONITORING WELL
- CLEAN MONITORING WELL
- (34) CONCENTRATION IN  $\mu\text{g/l(ppb)}$
- (ND) NOT DETECTED
- (NS) NOT SAMPLED
- a DETECTION LIMIT OF 250  $\mu\text{g/l (ppb)}$
- b DETECTION LIMIT OF 25  $\mu\text{g/l (ppb)}$

**NOTES:**

1. SEE FIGURES 4.2-7B AND 4.2-7C FOR MEW AREA 1,1,1-TCA GROUNDWATER DISTRIBUTION (OCTOBER 1986-JUNE 1987)
2. VALIDATION CRITERIA FOR GROUNDWATER SAMPLES NOT ANALYZED BY IT CORPORATION ARE PRESENTED IN SECTION 4.1.1.

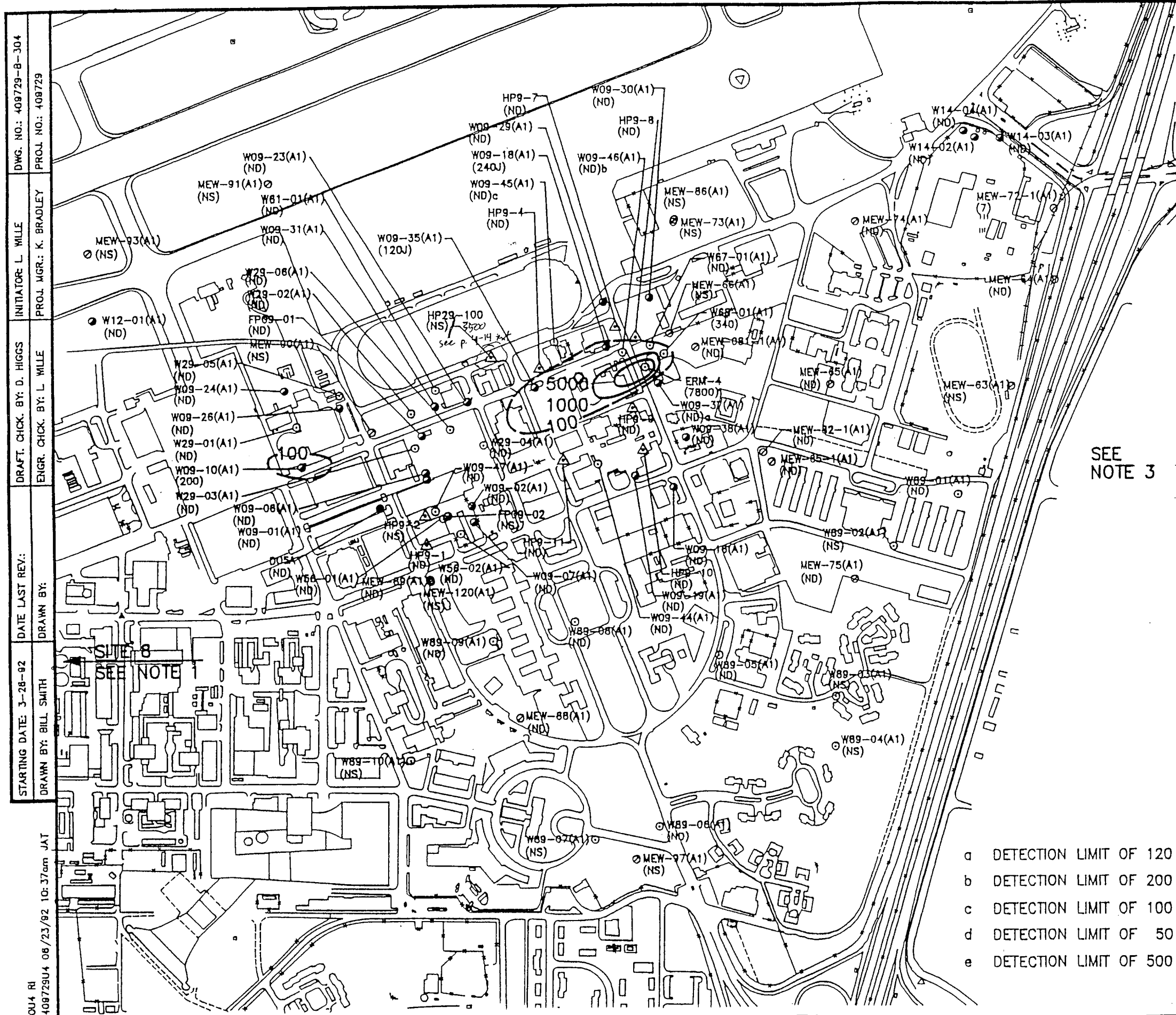
**SCALE:**



**FIGURE NO. 4.2-7A**  
**WEST SIDE AQUIFER**  
**1,1,1-TCA GROUNDWATER**  
**CONCENTRATION CONTOUR MAP**  
**A1 AQUIFER ZONE**  
**PHASE II, 2nd QUARTER 1991**

NAVAL AIR STATION  
MOFFETT FIELD, CALIFORNIA





# LEGEND:

- 1000 - CONTAMINANT CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- IT MONITORING WELL
- MEW MONITORING WELL
- CLEAN MONITORING WELL
- △ CLEAN HYDROPUNCH LOCATIONS
- NASA MONITORING WELL
- (180) CONCENTRATION IN µg/l(ppb)
- (ND) NOT DETECTED
- (NS) NOT SAMPLED

## NOTES:

1. TETRACHLOROETHENE (PCE) WAS NOT DETECTED IN SITE 8 MONITORING WELLS.
2. DATA VALIDATION CRITERIA FOR GROUNDWATER SAMPLES NOT ANALYZED BY IT CORPORATION IS PRESENTED IN SECTION 4.1.1.
3. A PCE GROUNDWATER CONCENTRATION CONTOUR MAP FOR THE MEW AREA WAS NOT PRESENTED IN THE RI/FS REPORT (HLA, 1987b).

## SCALE:

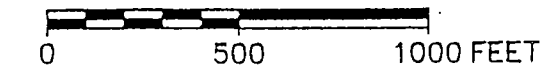


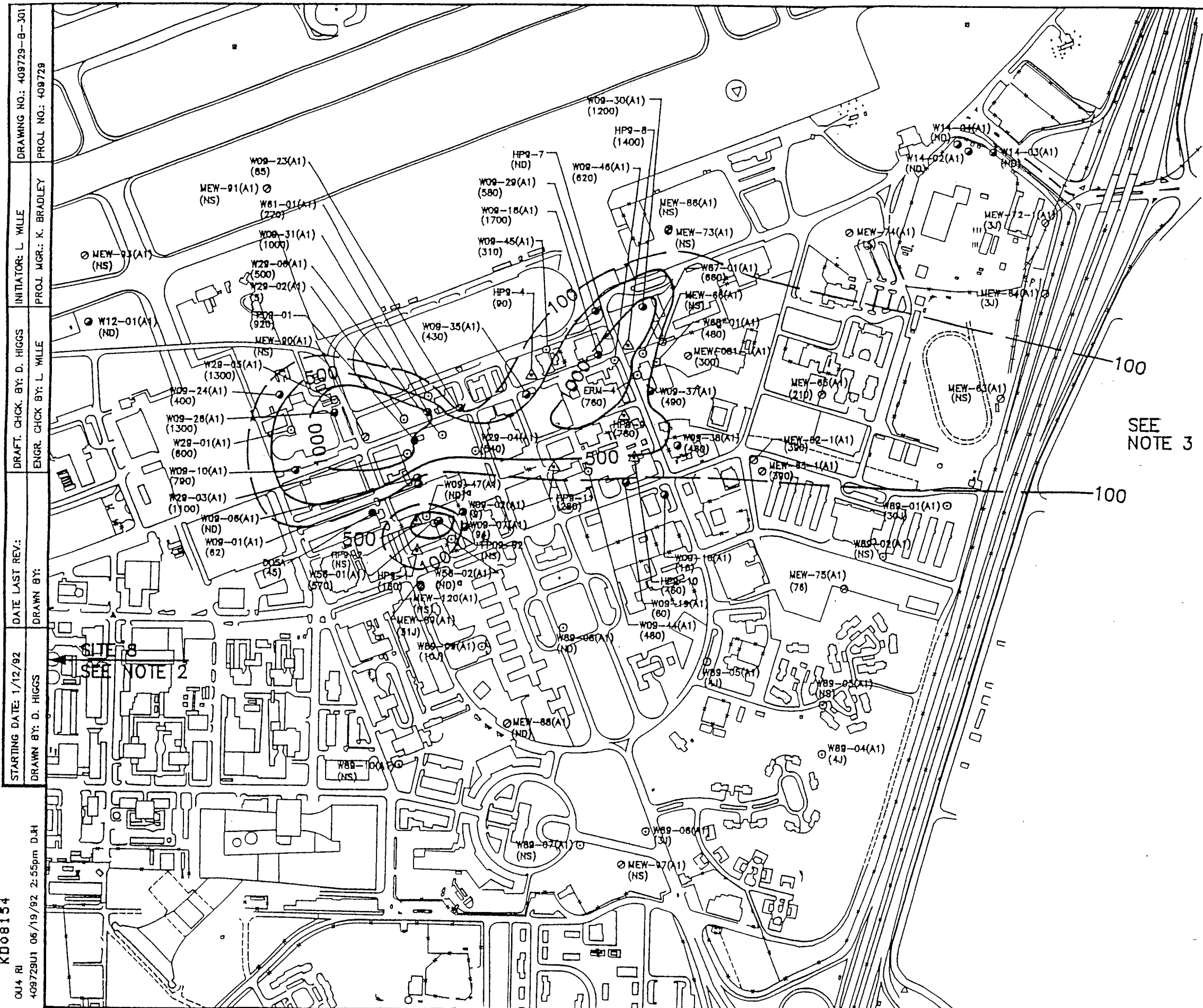
FIGURE 4.2-3  
WEST SIDE AQUIFER  
PCE GROUNDWATER  
CONCENTRATION CONTOUR MAP  
A1 AQUIFER ZONE  
PHASE II, 2nd QUARTER 1991

NAVAL AIR STATION  
MOFFETT FIELD, CALIFORNIA



- a DETECTION LIMIT OF 120 µg/l (ppb)
- b DETECTION LIMIT OF 200 µg/l (ppb)
- c DETECTION LIMIT OF 100 µg/l (ppb)
- d DETECTION LIMIT OF 50 µg/l (ppb)
- e DETECTION LIMIT OF 500 µg/l (ppb)

DWG. NO.: 408729-B-304  
INITIATOR: L. WILE  
PROJ. MGR.: K. BRADLEY  
DRAFT. CHK. BY: D. HIGGS  
ENGR. CHK. BY: L. WILE  
DATE LAST REV.:  
STARTING DATE: 3-28-92  
DRAWN BY: BILL SMITH  
QU4 RI  
408729U4 08/23/92 10:37am JAT



# LEGEND:

- 2000- CONTAMINANT CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- IT MONITORING WELL
- MEW MONITORING WELL
- CLEAN MONITORING WELL
- NASA MONITORING WELL (FEBRUARY 1991)
- (180) CONCENTRATION IN µg/l(ppb)
- (ND) NOT DETECTED
- (NS) NOT SAMPLED
- DETECTION LIMIT OF 100 µg/l(ppb)

## NOTES:

1. W09-46(A1) AND W29-02(A1) WERE NOT CONTOURED DUE TO INCONSISTENCIES WITH SURROUNDING DATA POINTS.
2. 1,2-DCE WAS NOT DETECTED IN SITE 8 MONITORING WELLS.
3. SEE FIGURE 4.2-5B AND 4.2-5C FOR MEW AREA 1,2-DCE GROUNDWATER DISTRIBUTION (OCTOBER 1986-JUNE 1987).
4. DATA VALIDATION CRITERIA FOR GROUNDWATER SAMPLES NOT ANALYZED BY IT CORPORATION IS PRESENTED IN SECTION 4.1.1.

## SCALE:

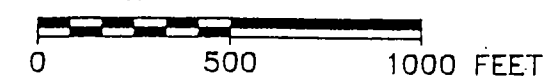


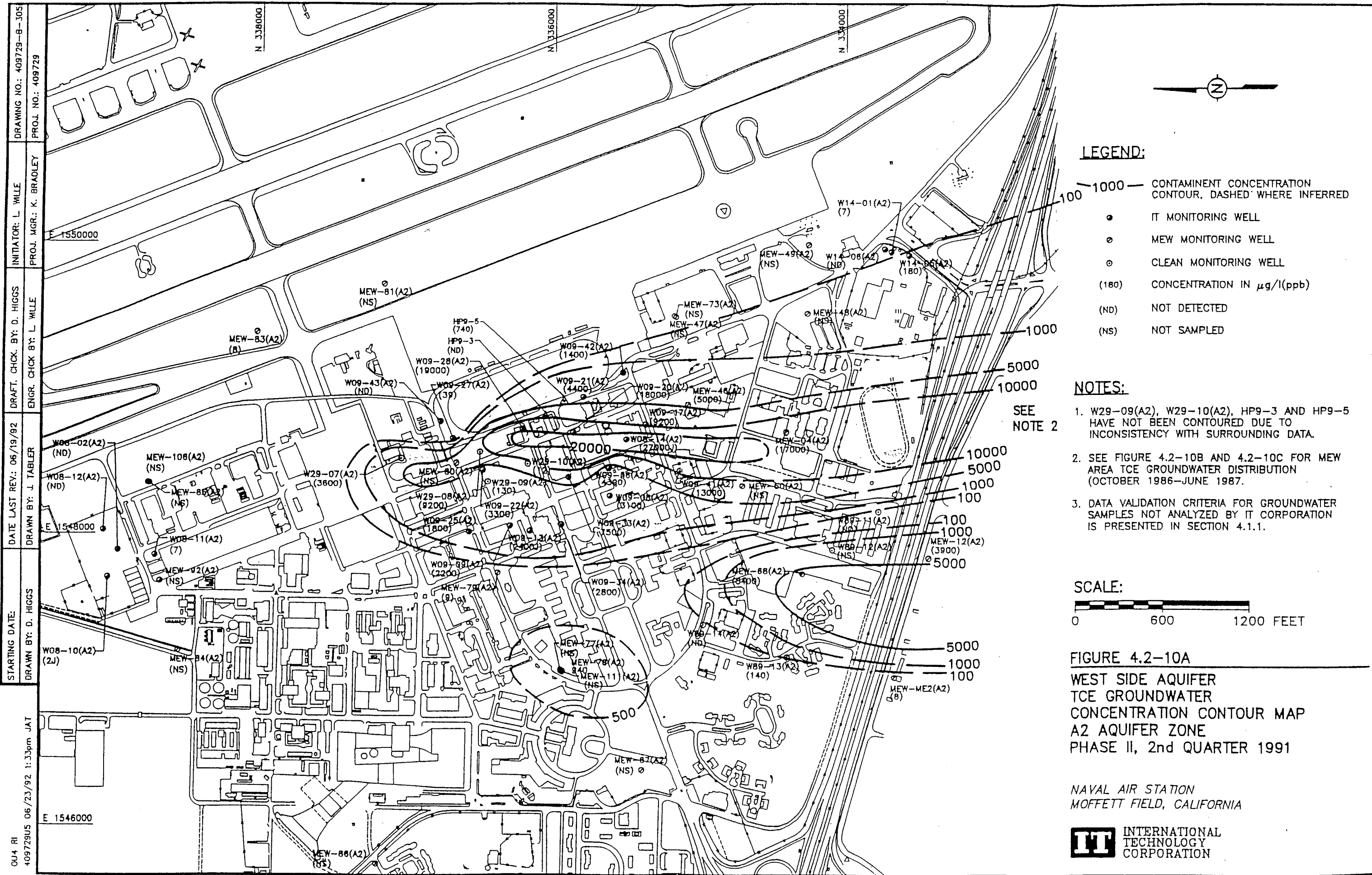
FIGURE 4.2-5A  
WEST SIDE AQUIFER  
1,2-DCE GROUNDWATER  
CONCENTRATION CONTOUR MAP  
A1 AQUIFER ZONE  
PHASE II, 2nd QUARTER 1991

NAVAL AIR STATION  
MOFFETT FIELD, CALIFORNIA



DRAWING NO.: 409729-B-301  
PROJ. MGR.: K. BRADLEY  
INITIATOR: L. WILLE  
DRAFT. CHK. BY: D. HIGGS  
ENGR. CHK. BY: L. WILLE  
DATE LAST REV.:  
DRAWN BY:  
STARTING DATE: 1/12/92  
DRAWN BY: D. HIGGS

QU4 RI  
409729U1 06/19/92 2:55pm D.H  
KD08154



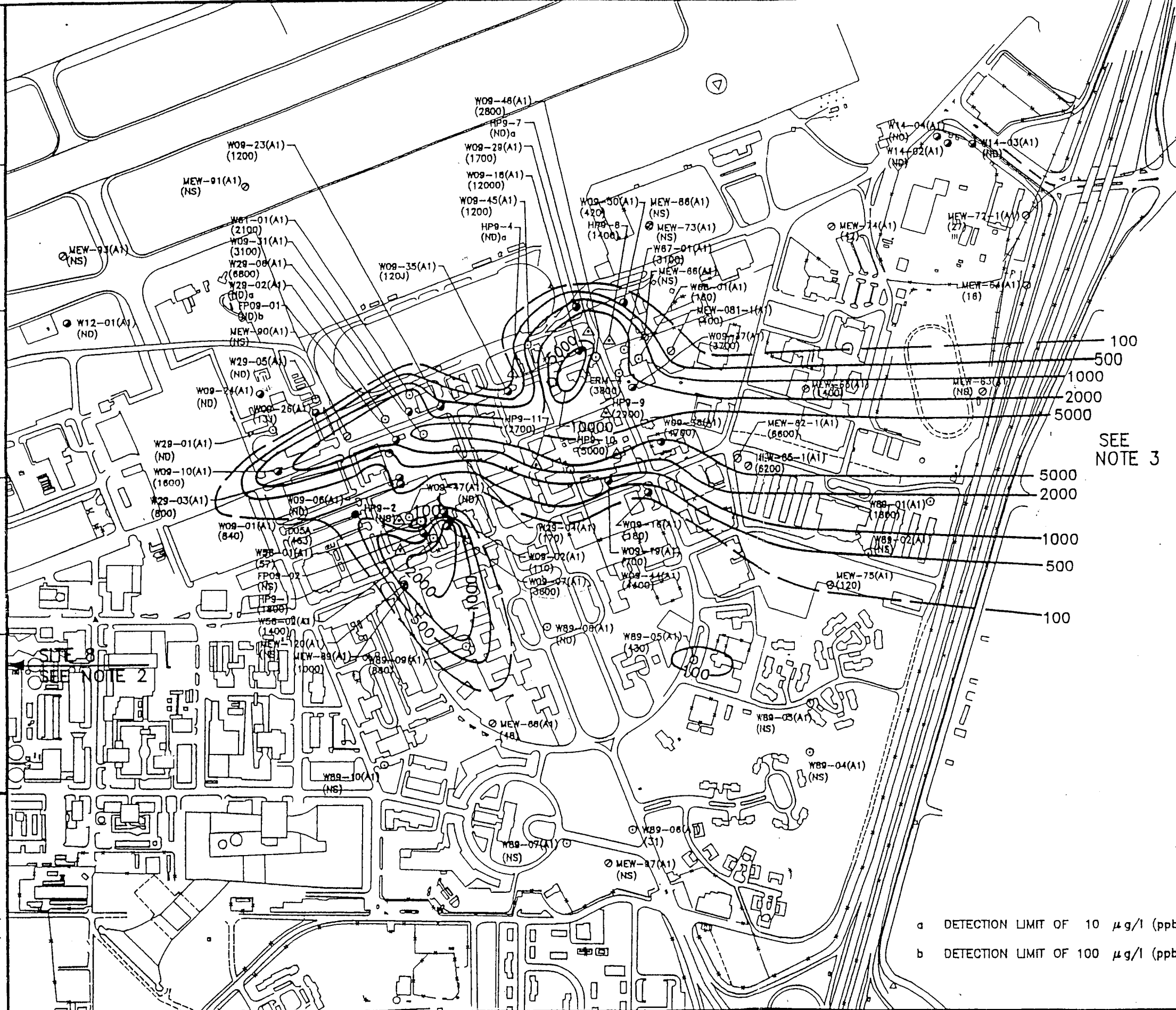
STARTING DATE: 06/19/92  
DATE LAST REV: 06/19/92  
DRAFT. CHK. BY: D. HIGGS  
INITIATOR: L. WILLE  
DRAWN BY: J. TABLER  
ENGR. CHK. BY: L. WILLE  
PROJ. MGR.: K. BRADLEY  
DRAWING NO.: 409729-8-305  
PROJ. NO.: 409729

OU4 RI  
409729US 06/23/92 1:33pm JAT



STARTING DATE: 03/28/92 DATE LAST REV.: 06/19/92 DRAFT, CHK. BY: J. HUBBARD INITIATOR: G. PLAMONDON DWG. NO.: 409729-B-411  
 DRAWN BY: S. CARDWELL ENGR. CHK. BY: G. PLAMONDON PROJ. MGR.: K. BRADLEY PROJ. NO.: 409729

044 RI  
 4097291F 06/26/92 9:46am JAT  
 KDO8170



# LEGEND:

- 2000- CONTAMINANT CONCENTRATION CONTOUR, DASHED WHERE INFERRED (µg/l)
- IT MONITORING WELL
- MEW MONITORING WELL
- CLEAN MONITORING WELL
- △ CLEAN HYDOPUNCH LOCATIONS
- NASA MONITORING WELL (SAMPLED FEB, 1991)
- (180) CONCENTRATION IN µg/l(ppb)
- (ND) NOT DETECTED
- (NS) NOT SAMPLED

## NOTES:

1. DATA FOR HYDOPUNCH LOCATIONS HP9-4&7 AND WELLS FP09-01, W68-01(A1) AND W29-04(A1) ARE NOT CONTOURED DUE TO INCONSISTENCIES WITH SURROUNDING DATA.
2. SITE 8 A1 AQUIFER ZONE MONITORING WELLS CONTAINING TRICHLOROETHENE ARE AS FOLLOWS: W08-01 (7 ppb), W08-04 (4J ppb), W08-05 (3J ppb), AND W08-08 (10 ppb). SEE FIGURE 4.2-4B.
3. SEE FIGURES 4.2-4B AND 4.2-4C FOR MEW AREA TCE DISTRIBUTION (OCTOBER 1896-JUNE 1987).
4. VALIDATION CRITERIA FOR GROUNDWATER SAMPLES NOT ANALYZED BY IT CORPORATION IS PRESENTED IN SECTION 4.1.1.
5. W09-35(A1) WAS NOT CONTOURED DUE TO INCONSISTENCY WITH HISTORIC DATA WHICH HAS AVERAGED APPROXIMATELY 5,500 ppb SINCE 06/07/90.

## SCALE:

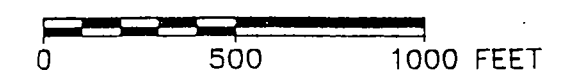


FIGURE 4.2-4A  
 WEST SIDE AQUIFER  
 TCE GROUNDWATER  
 CONCENTRATION CONTOUR MAP  
 A1 AQUIFER ZONE  
 PHASE II, 2nd QUARTER 1991

NAVAL AIR STATION  
 MOFFETT FIELD, CALIFORNIA



- a DETECTION LIMIT OF 10 µg/l (ppb)
- b DETECTION LIMIT OF 100 µg/l (ppb)

**APPENDIX 3**

**Methods and Procedures**

**APPENDIX 3**

**FIELD METHODS AND PROCEDURES**

**Center-Wide Sampling and Analysis Program  
NASA Ames Research Center  
Mountain View, California**

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## FIELD METHODS AND PROCEDURES

### 1. DRILLING AND SOIL SAMPLING METHODS

The field methods and procedures described below are the general procedures to be followed by field personnel employed by environmental contractors working for NASA Ames Research Center ("Contractors"). However, it should be recognized that variations from the procedures will occur as a result of the specific field conditions encountered and equipment employed. Deviations from the procedures described herein will be noted in work plans, proposals, or reports as necessary.

These procedures are in accordance with the Unified Quality Assurance Project Plan, Middlefield-Ellis-Whisman Study Area, Mountain View and Moffett Field, California (Canonie, 1991) ("the Unified QAPP") and supplement the procedures described therein. The procedures described below are intended to conform to the practices recommended in the Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells (Aller, et. al., 1989); A Compendium of Superfund Field Operations Methods (U.S. EPA, 1989); California Well Standards (Final Draft) (California Department of Water Resources, Bulletin 74-90, 1990); and Standards for the Construction and Destruction of Wells and Other Deep Excavations in Santa Clara County (Santa Clara Valley Water District, 1989).

#### 1.1 Permits and Clearance of Underground Conflicts

Permits will be obtained from the Santa Clara Valley Water District ("SCVWD"). Inspection of well installation or grout sealing is required by SCVWD and will be incorporated into the planning for the field work.

Preparation for conducting underground investigations will include marking investigation locations, notifying and questioning NASA Ames Facilities Engineering regarding potential underground conflicts, conducting utility surveys, and notifying Underground Services Alert ("USA") of the investigation activities. Contractors will rely on information provided by others regarding the presence of underground structures or utilities at the drilling locations. Contractors will not be held responsible for repairs necessitated by damages to underground utilities resulting from investigation activities if such utilities

have not been identified by the reasonable efforts described above.

### **1.2 Equipment Decontamination**

For all subsurface work, all downhole equipment will be decontaminated prior to drilling each boring in order to minimize the potential for cross-contamination of samples or the area being investigated. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Alconox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water. To the extent possible, decontamination water will be contained during the process and stored in labeled 55-gallon drums pending determination of the proper disposal method by NASA or other responsible party.

### **1.3 Lithologic Logging**

Borings will be logged for lithology by a qualified person using the Unified Soil Classification System. A qualified person is either:

- a professional geologist, engineering geologist, or civil engineer who is registered or certified by the State of California and who is trained and experienced in the use of the Unified Soil Classification System; or

- a geologist or engineer who is trained and experienced in the use of the Unified Soil Classification System and who is working under the supervision of one of the registered or certified professionals listed above.

Lithologic logging will consist of classifying the soil encountered using the Unified Soil Classification System, describing the color of the soil using the Rock or Soil Color Chart, recording blow counts, hammer weight, and drop during the driving of split spoon sampling devices, and recording other pertinent information. Blow counts are recorded for the purpose of general classification of soil and are not to be used in any engineering classifications.

### **1.4 Hollow-Stem Auger Drilling**

A drill rig with six or eight-inch ("in.") outside diameter ("OD") continuous-flight hollow-stem augers is appropriate for drilling soil borings in geologic settings where

unconsolidated sediments without large boulders are likely to be encountered. The depth of borings is generally limited to approximately 150 feet. Soil borings for lithologic sampling only will be drilled using the smallest possible diameter auger flights (generally 6 in. OD) to minimize the volume of soil cuttings generated. Soil borings that are to be completed as monitoring wells will be drilled using auger flights at least four (4) inches greater in outer diameter than the outer diameter of the well casing, so as to allow for a minimum of two (2) inches of sand pack to surround the well casing. Prior to and between each boring, the augers will be steam cleaned to minimize the potential of cross-contamination.

Soil samples will be collected in the borings at predetermined depth intervals by driving a clean split-spoon sampler into the undisturbed soil ahead of the augers. Split-spoon samplers that may be used include the Standard Penetration Test split spoon (1.5-in. inside diameter ("ID") by 2-in. OD), the California Modified split spoon (2-in. ID by 2.5-in. OD), or the Dames & Moore split-spoon (2.5-in. ID by 3-in. OD). The type of sampler employed will be recorded on the boring log. The split-spoon sampler will be fitted with precleaned brass or stainless steel tubes to retain samples. The sampler will be driven using a hammer having a weight of 140 lbs and a drop of 30 inches, or equivalent. The specific type of hammer will be recorded on the boring log. Blow counts for each six inches that the sampler is driven will be noted on the boring log. Soil sampling procedures are discussed further in Section 1.7 below.

Upon completion of sampling activities, each boring either will be backfilled using a cement and bentonite grout mixture, or will be completed as a monitoring well. Backfilling and well construction procedures are discussed respectively in Sections 1.8 and 2.1 below.

To the extent possible, soil cuttings from the drilling operations will be contained during the process. Soil cuttings will be stored in labeled 55-gallon drums, roll-off bins, or soil storage piles pending determination of the proper disposal method by NASA or other responsible party. If soil storage piles are used, the soil will be placed on plastic sheeting in a bermed area and securely covered with additional plastic sheeting.

### **1.5 Drive-Core Sampling of Soil**

The hydraulically driven dual-tube drive-core sampling system

is a relatively new soil sampling system offered by several contractors in the San Francisco Bay area. This sampling technique is appropriate for geologic settings of relatively fine-grained materials such as clay, silt, and fine sand. The total depth of this sampling technique is limited to approximately 50 feet.

The system consists of a hydraulically-operated sampling rig that simultaneously drives an outer drive casing and a sample barrel attached to inner sampling rods. The sample barrel, measuring 1 5/8 in. OD by three feet long, contains six 6-inch long, 1.5-inch diameter brass or stainless steel liners that retain soil cores as the sample barrel is driven into the ground. The sample barrel will be driven into the ground in intervals of 3 feet. After being driven three feet, the inner sampling rods and sample barrel will be removed from the borehole. The outer drive casing will remain in the borehole while the sample barrel is removed, in order to prevent the borehole from collapsing. In this manner, each boring will be continuously sampled from ground surface to the total depth of the boring.

A geologist or engineer will be present during drilling and sampling activities to document encountered lithology, perform field screening for chemicals of concern, and prepare selected soil samples for subsequent chemical analyses at the designated laboratory.

Upon completion of sampling activities, each boring will be backfilled using a cement and bentonite grout mixture. Backfilling procedures are discussed in Section 1.8 below.

#### **1.6 Surface and Shallow Subsurface Soil Sampling**

Surface soil samples are defined as samples collected from the first six inches of soil. Surface soil samples are collected from a fresh surface which is exposed by scraping with a clean tool. The surface to be sampled may be the ground surface or the wall or bottom of a trench or excavation. The preferred method of collection of surface soil samples is as follows:

- Undisturbed samples may be collected using a manually operated slide-hammer sampler to obtain an undisturbed sample in a precleaned six-inch long brass or stainless steel sample tube. Alternatively, the sample tube can be driven into the soil using a wooden mallet or a piece of wood and a hammer.

If a sample tube is not appropriate for the soil to be sampled (e.g. the soil is a semi-solid) or if the sample will be analyzed for non-volatile compounds only, surface soil samples may be collected as follows:

- Grab samples may be collected with a clean scoop and placed in clean glass jars that have screw-top lids fitted with Teflon® liners.

Near-surface samples, collected from depths of up to a few feet, may be collected using a manually operated slide-hammer sampler after using a hand auger to bore to the desired sampling depth.

### **1.7 General Soil Sample Handling Procedures**

Undisturbed soil samples may be collected using any of the following sampling tools:

- a split-spoon sampler driven ahead of hollow-stem auger,
- a hydraulically driven dual-tube sampler, or
- a manually operated slide-hammer sampler.

When using any of these tools, undisturbed soil samples for subsequent analysis will be collected in precleaned brass or stainless steel tubes fitted into the barrel of the sampler. When the sampler is removed from a borehole and opened, the brass tubes will be cut apart using a clean knife and removed. Both ends of the brass tube containing the desired sample will be covered with Teflon® sheets and capped with plastic end caps. *End caps will not be taped in place, in order to avoid sample contamination.*

A sample label will be attached to each brass liner. Information to be included on the sample label is described in Section 5.1 below. The sealed liners will be placed in zip-closure plastic bags, then placed on "blue" ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated at the time of sample collection.

### **1.8 Backfilling Soil Borings**

In accordance with SCVWD guidance, all soil borings will be backfilled using one of the following:

- neat cement, or
- grout composed of cement and up to 5 percent bentonite by weight of the cement ("cement/bentonite grout").

To prepare cement/bentonite grout, the appropriate volume of water will be placed in the mixing container (generally 5 to 7 gallons of water per 50 lb bag of cement), the bentonite added to the water, then the cement slowly added to the mixture. The cement, bentonite, and water will be mixed mechanically until a smooth consistency is obtained. For all backfill materials ("grout"), mixing will be completed prior to emplacing backfill material into the boring.

Grout will be emplaced in soil borings so that it extends from the termination depth of the boring to the surface. Backfilling will be accomplished by emplacing the grout into the boring from the bottom up using a tremie pipe. The tremmie pipe will be placed into the bottom of the boring and raised as the boring is filled, keeping the bottom of the tremmie pipe below the surface of the grout. The grout will be emplaced in one continuous lift from bottom of boring to ground surface so that water is displaced from the boring. The expected volume of grout should be calculated and the actual amount used checked against the estimate. Grouting must be done through the augers if the borehole is likely to collapse when the augers are withdrawn.

## **2. MONITORING WELL INSTALLATION AND SAMPLING**

Well specifications will be reviewed by the Project Manager before drilling and installing a monitoring well. Necessary permits and access agreements will be obtained before well installation begins, as described in Section 1. SCVWD will be notified as required by local regulations, as described in Section 1. Well installation will be observed by a qualified person as described in Section 1.

The following methods and procedures apply to wells screened in the uppermost aquifer zone. Monitoring wells in deeper aquifer zones are not planned for installation during the course of this investigation. If in the future, monitoring wells are planned for deeper aquifer zones, additional methods and procedures will be included in the work plan(s) for those wells.

### **2.1 Groundwater Monitoring Well Construction in Uppermost Saturated Zone**

Specified borings will be converted to monitoring wells upon reaching the designated depth. Monitoring wells will be constructed by installing 2- or 4-inch diameter, pre-cleaned PVC well casing through the hollow-stem auger or through the conductor casing, depending on the drilling method. The diameter of the well casing to be used will be specified in individual work plans. The soil boring will be of a diameter at least four inches greater than that of the well casing, so as to allow for a minimum of two (2) inches of sand pack to surround the casing.

Specifications for well materials will be included for each well in individual work plans. In general, the well casing will be composed of pre-cleaned, flush-joint, threaded, Schedule 40 PVC casing and the lower part of the well casing will consist of factory-slotted PVC or stainless steel well screen extending upward through the particular water-bearing zone. Different materials may be considered for special areas or situations. No solvents or glues will be used in the construction of monitoring wells.

The lower end of PVC well screens will be plugged with a threaded PVC end cap or a slip cap. Slip caps will be permanently attached to the PVC screen using a stainless steel screw or rivet. The lower end of stainless steel well screens will be factory sealed. If the well is to be completed at grade, the well casing will extend to approximately four inches below grade. If the well casing is

to be completed above grade, the well casing will extend above grade to a height appropriate to the well enclosure. The top of the casing will be fitted with a watertight, locking well cap.

Well construction includes placing a continuous filter pack in the annular space between the well screen and the wall of the boring. The filter pack will consist of pre-washed, packaged sand. The sand will be sized according to the slot size of the well screen and available information on grain size in the formation at nearby borings. In certain situations, sieve analyses may be performed on samples collected in the completion interval of the well to insure proper filter pack and screen design. The filter pack will extend from the bottom of the boring to not more than two feet above the top of the well screen. The sand will be poured slowly through the hollow-stem augers and the augers will be raised periodically to allow the sand to fill the annulus between the well screen and the wall of the boring. As sand is added, the level of the sand in the annular space will be measured frequently using a weighted tape.

Above the filter pack, a one- to two-foot-thick layer of bentonite pellets or chips will be emplaced to prevent downward migration of the grout seal into the filter pack. The bentonite pellets or chips will be emplaced through the augers in the same manner as the sand. If the layer of bentonite pellets or chips is above the water table, a approximately two to three gallons of clean water will be added to hydrate the bentonite prior to placement of the grout seal.

Cement/bentonite grout, emplaced using a hose or tremie pipe as discussed in Section 1.8 above, will extend continuously from the top of the bentonite layer to approximately six inches below grade. The grout will be composed of neat cement containing up to five percent bentonite powder by weight of cement to control shrinkage. The grout seal will be at least five feet thick, unless prior approval is obtained from SCVWD. SCVWD will be notified so that a SCVWD grout inspector can be present for the placement of the grout seal.

Monitoring wells will either be completed at the surface or above grade. Wells installed in paved areas will be completed at the surface and will be fitted with a traffic-rated steel and/or concrete utility box set in concrete. The utility box will be set so that it is slightly above grade.

Wells installed in open field areas will be completed above-



grade and will be fitted with a locking steel "stovepipe" enclosure over the well casing. The enclosure will be set into concrete. Additionally, steel bollards may be constructed to provide protection from vehicles.

The identification number of each well will be permanently marked on the well casing and/or the well enclosure.

## **2.2 Piezometer Construction**

Piezometer construction will follow the same procedures as those for monitoring well construction, except that piezometers will be constructed only of two-inch diameter Schedule 40 PVC casing and screen.

## **2.3 Well Development**

Prior to development of any well, all tools and equipment that are to be used in the well will be thoroughly decontaminated. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Alconox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water. To the extent possible, decontamination water will be contained during process and stored in labeled 55-gallon drums pending determination of the proper disposal method by NASA or other responsible party.

Following the completion of a monitoring well or a piezometer, the grout and concrete will be allowed to cure for at least 24 hours, or as required by the local agency. When possible, the wells will be allowed to sit for 72 hours before development activities are initiated. The well or piezometer will be developed to remove fine-grained materials inside the filter pack and casing, to stabilize the filter pack around the well screen, and to help produce more representative samples from the water-bearing zone. The well will be developed by bailing, pumping, surging, swabbing, or a combination of methods until (a) the extracted water is sediment-free, and pH, temperature, and conductivity of the extracted groundwater stabilize, or (b) no further improvement in water clarity (turbidity) is observed. Temperature, pH, conductivity, and turbidity of the extracted groundwater will be recorded during the development process.

Surging can be performed by a Smeal rig or by hand. For surging using a Smeal rig, the Smeal rig will be fitted with a surge block that is designed to fit snugly inside the well

casing. The rig operator will proceed to surge the well with shallow, smooth strokes forcing the water back and forth through the sand pack and screen. The surge block will then be removed, and the well will be pumped to remove the sediment. The operator will then alternately surge and pump the well until the above conditions are met.

Development by hand is accomplished using a hand held surge block and a hand bailer or pump. The well is developed until the above conditions are met.

Well development water will be temporarily contained in labeled, DOT approved, 55-gallon steel drums pending receipt of results of analyses of groundwater from the respective well(s). The well development water will then be disposed of properly by NASA or other responsible party.

## **2.4 Water Level Measurements**

Depth to groundwater is measured prior to and in conjunction with well purging and sampling. It will be measured from a mark on the top of each monitoring well casing or protective casing and recorded in hundredths of a foot.

Depth to groundwater will be measured using an electric or battery-powered sounder or probe. The equipment will be decontaminated between each well measurement and at the end of each day it is used. Decontamination will be accomplished by washing in a solution of Alconox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water.

## **2.5 Well Sampling**

Monitoring wells will be sampled in a sequence beginning with the well that has the lowest anticipated contaminant concentration and proceeding to wells exhibiting increasingly higher concentrations, based on the most recent chemical analyses of water samples from the wells and nearby wells, or other site information on suspected chemical source areas.

Prior to sampling any well, all tools and equipment that are to be used in the well will be thoroughly decontaminated. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Alconox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water. To the extent possible, decontamination water will be contained

during process and stored in labeled, DOT-approved, 55-gallon drums pending determination of the proper disposal method by NASA or other responsible party.

At each well to be sampled, the depth to water and the depth to the bottom of the well will be measured and recorded. This information will be used to calculate the volume of water in the well casing. Each well will also be checked for the presence of floating product on the water surface in the well, using either an oil/water interface probe or a clear bailer.

Prior to sampling, a pump, a Teflon® bailer, a stainless steel bailer, and/or a disposable bailer will be used to purge each well. A different disposable bailer will be used for each well that is purged with a disposable bailer. Each well will be purged by removing a minimum of three well casing volumes of water from the well. If a well dewateres during purging, it will be allowed to recharge to at least 75 percent of original volume before sampling. If a well contain less than one foot of water, a grab water sample will be collected instead, using a disposable bailer. During purging, each well will be monitored for temperature, conductivity, and pH. Purging will be considered complete when these parameters stabilize or a minimum of three casing volumes of water have been removed. The water level will be measured again immediately upon completion of purging.

Following purging, each well will be sampled with a Teflon®, stainless steel, or disposable bailer. Upon retrieval of the bailer, the water samples will be transferred to the appropriate laboratory-supplied bottles and preserved as appropriate for the analyses to be performed.

For low flow, high turbidity wells, purging and sampling may be accomplished using a bladder pump. The procedures described above will be followed with all extraction being accomplished with the bladder pump. The groundwater sample will be collected at the outlet of the bladder pump surface discharge.

A sample label will be attached to each sample container. The label will include a unique sample identification number, the well number, the sampler's initials, and the time and date when the sample was collected. The sealed containers will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated at the time the sample is collected.

Well purge water will be temporarily contained in labeled, DOT approved, 55-gallon steel drums pending receipt of results of analyses of groundwater from the respective well(s). Proper disposal of the development water will be the responsibility of the client or property owner.

### **3. CONE PENETROMETER AND HYDROPUNCH TECHNIQUES**

For all CPT and Hydropunch® work, all downhole equipment will be decontaminated prior to installing each boring to minimize the potential for cross-contamination. Decontamination may be accomplished by either (1) steam cleaning or (2) washing in a solution of Alconox® or equivalent non-phosphate detergent, followed by rinsing with clean water, then rinsing with distilled water. To the extent possible, decontamination water will be contained during process and stored in labeled, DOT approved, 55-gallon drums pending determination of the proper disposal method by NASA or other responsible party.

#### **3.1 Cone Penetrometer Testing**

Cone Penetrometer Testing ("CPT") is performed by pushing a 1 1/4-inch diameter pressure-sensitive probe attached to a string of steel rods into the ground. A 20-ton truck provides weight while hydraulic rams push the rods. Data on the penetration resistance recorded by the probe tip (tip resistance) and sleeve (local friction) is collected by computer as the probe is pushed into the soil. The ratio between tip resistance and local friction is calculated by the computer as the friction ratio. The data collected is then used to interpret the subsurface lithology according to information supplied by the CPT contractor.

After CPT is completed at a location, the hole is immediately grouted. This is achieved by pushing a string of hollow rods down to the bottom of the hole using the CPT truck. A disposable tip is fitted to the end of the rods to prevent soil from clogging the rods as they go down the hole. After the rods have been pushed to the final depth, plastic tubing is inserted down the rods. Cement grout is pumped down through the tubing as the rods are withdrawn, allowing the grout to backfill and seal the hole. This method of grouting clears the hole of any debris or caved-in material and reduces the risk of bridging in the hole. The placement of a continuous grout seal is thereby facilitated, reducing the possibility of vertical flow between water bearing zones.

Information obtained through CPT can immediately be used to aid in selecting depth intervals for soil and/or groundwater sampling.

### **3.2 Groundwater Sample Collection Using a Hydropunch® I**

The Hydropunch® I sampling tool is used at locations where a precise sampling depth (10-inch interval) within an aquifer is desired. In general, this sampler is used when investigations are targeted to determine concentrations of dissolved chemicals below the uppermost saturated zone. The Hydropunch® I sampling systems consists of two principal components: a 2-in. OD outer steel protective casing and an inner 10-in. long stainless steel screen. The Hydropunch I is attached to a string of steel rods and pushed with the CPT rig to the desired sampling depth, based on the CPT log. After reaching the desired sampling depth, the outer casing is retracted by pulling the CPT rods up slightly, and the screen is exposed.

Groundwater flows under hydrostatic pressure through the screen, through a check valve, into the stainless steel body of the tool, and out through the top of the tool past a second check valve. The groundwater continues to flow up the CPT rods until it reaches hydrostatic equilibrium. The groundwater sample is contained within the body of the tool, between the two check valves. When full, the entire device is retrieved to the surface, and the sample is decanted into the appropriate laboratory-supplied bottles and preserved as appropriate for the analyses to be performed.

A sample label will be attached to each sample container. The label will include the information described in Section 5.1 below. The sealed containers will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated at the time of sample collection.

After each sample is collected, the hole is grouted to the surface with cement/bentonite grout using the same method as for CPT holes.

### **3.3 Groundwater Sample Collection Using a Hydropunch® II**

The Hydropunch® II sampling tool is designed for sampling across the top of the water table in situations where floating product may be present. The Hydropunch® II sampling systems consists of two principal components: a 2-in. OD outer steel protective casing and an inner 1-in. OD PVC slotted screen which ranges from 3 to 5 feet long. An expendable stainless steel tip is attached to the end of the outer casing to prevent soil or groundwater from entering the

Hydropunch as it is being pushed into the ground. The Hydropunch® II is attached to a string of steel rods and pushed by the CPT rig to the desired sampling depth, based on the CPT log. After reaching the desired sampling depth, a clean retrievable weight is used to knock out the tip and the outer casing is retracted exposing the screen. The length of exposed screen used may vary depending on geologic conditions. A new, unused screen is used at each sampling interval.

When using the Hydropunch® II, groundwater samples are collected by lowering a precleaned Teflon® or stainless steel bailer through the hollow steel rods into the PVC screen. Upon retrieval of the bailer, water samples are transferred to the appropriate laboratory-supplied bottles and preserved as appropriate for the analyses to be performed.

A sample label will be attached to each sample container. The label will include the information described in section 5.1 below. The sealed containers will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated at the time of sample collection.

After each sample is collected, the hole is grouted to the surface with cement/bentonite grout using the same method as for CPT holes.

### **3.4 Groundwater Sample Collection Using a Push-in-PVC Piezometer**

Groundwater samples may also be collected with the CPT rig using the Push-in-PVC Piezometer ("PIPP"). The PIPP uses a high strength steel casing and disposable stainless steel tip to deploy a retrievable slotted PVC screen 5 feet in length, to the desired sample depth. Except for minor differences in equipment, this method is nearly identical to the Hydropunch II method. The procedures used for the two methods are therefore the same.

### **3.5 Soil Sampling Using a CPT Rig**

CPT is performed in the manner described in Section 3.1 above until reaching the desired depth for soil sampling. The CPT rods are then removed and a stainless steel soil sampling probe is inserted into the hole. The sampling probe has a solid drive tip that is released prior to sample collection.

Soil samples are retrieved in stainless steel or brass liners. Upon retrieval, the ends of the liners are covered with Teflon® sheets, and plastic end caps.

A sample label will be attached to each liner. The label will include the information described in Section 5.1 below. The sealed liners will be placed in zip-closure plastic bags, then placed on ice in a cooler for temporary storage and transport to the laboratory for chemical analysis. Chain-of-custody records will be initiated at the time of sample collection.

After the final sample is collected or CPT is completed to its final depth, the hole is grouted to the surface with cement/bentonite grout using the same method as for CPT holes.



#### **4. SAMPLE PREPARATION AND HANDLING PROCEDURES FOR ANALYSES**

Sample handling procedures for the following analytical methods are summarized below:

EPA 8010: Halogenated Volatile Organic Compounds  
EPA 8020: Aromatic Volatile Organic Compounds  
EPA 8015m: Petroleum Hydrocarbons  
EPA 8080: PCBs and Organochlorine Pesticides  
EPA 8240: Purgeable Volatile Organic Compounds  
EPA 8270: Extractable Semi-Volatile Organic Compounds.

A more detailed discussion of these methods and sample preparation and handling procedures in general is presented in the Unified QAPP.

##### **EPA Method 8010 - Halogenated Volatile Organic Compounds**

Water samples will be collected in 40 ml glass VOAs, leaving no headspace.

Preserved with HCl.

Detection limit is 0.5 to 2.0 ug/L; varies by compound.

Maximum hold time is 14 days.

Chill sample to 4°C.

Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, leaving no headspace, and sealed as discussed in Section 1.7 above.

No preservatives.

Detection limit is 5.0 to 20 ug/kg; varies by compound.

Maximum hold time is 14 days.

Chill sample to 4°C.

Deliver to laboratory within 24 hours.

##### **EPA Method 8020 - Aromatic Volatile Organic Compounds**

Water samples will be collected in 40 ml glass VOAs, leaving no headspace.

Preserved with HCl.

Detection limit is 0.5 ug/L.

Maximum hold time is 14 days.

Chill sample to 4°C.

Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, leaving no headspace, and sealed as discussed in Section 1.7 above.

No preservatives.  
Detection limit is 5.0 ug/kg.  
Maximum hold time is 14 days.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

**EPA Method 8015m - Petroleum Hydrocarbons**

Water samples will be collected in both 40 ml glass VOAs, leaving no headspace, and glass amber liter bottles.  
No preservatives.  
Detection limit is 50 ug/L.  
Maximum hold time is 7 days before extraction; 40 days to analyze sample following extraction.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, leaving no headspace, and sealed as discussed in Section 1.7 above, or glass jars with Teflon® lid liners, leaving no headspace.  
No preservatives.  
Detection limit is 1.0 mg/kg.  
Maximum hold time is 14 days before analysis for purge-and-trap method for volatile hydrocarbons. For extractable hydrocarbons, maximum hold time is 14 days before extraction; 40 days to analyze sample following extraction.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

**EPA Method 8080 - PCBs and Organochlorine Pesticides**

Water samples will be collected in glass amber liter bottles.  
No preservatives.  
Detection limit is 0.025 to 2.0 ug/L; varies by compound.  
Maximum hold time is 7 days before extraction; 40 days to analyze sample following extraction.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, or glass jars with Teflon® lid liners.  
No preservatives.  
Detection limit is 1.0 to 80 ug/kg; varies by compound.  
Maximum hold time is 14 days to before extraction; 40 days to analyze sample following extraction.

Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

**EPA Method 8240 - Purgeable Volatile Organic Compounds**

Water samples will be collected in 40 ml glass VOAs, leaving no headspace.

Preserved with HCl.  
Detection limit is 2.0 to 10 ug/L; varies by compound.  
Maximum hold time is 14 days.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, leaving no headspace, and sealed as discussed in Section 1.7 above.

No preservatives.  
Detection limit is 100 to 500 ug/kg; varies by compound.  
Maximum hold time is 14 days.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

**EPA Method 8270 - Extractable Semi-Volatile Organic Compounds**

Water samples will be collected in glass amber liter bottles.

No preservatives.  
Detection limit is 2.0 to 50 ug/L; varies by compound.  
Maximum hold time is 7 days before extraction; 40 days to analyze sample following extraction.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

Soil samples will be collected in brass or stainless steel liners, or glass jars with Teflon® lid liners.

No preservatives.  
Detection limit is 100 to 500 ug/kg; varies by compound.  
Maximum hold time is 14 days to before extraction; 40 days to analyze sample following extraction.  
Chill sample to 4°C.  
Deliver to laboratory within 24 hours.

Requirements for detection limits for each method of analysis are described in the Unified QAPP. For analyses by all methods, detection limits may vary due to matrix effects, the presence of other chemicals, and other factors. Detection limits for each analysis will be reported by the laboratory.

## **5. SAMPLE CHAIN-OF-CUSTODY**

This section describes standard operating procedures for sample chain-of-custody. The purpose of these procedures is to assure that the integrity of the samples is maintained during their collection, transportation, and storage prior to analysis. Additional information is provided in the Unified QAPP.

### **5.1 Field Procedures**

Each sample will be labeled and properly sealed immediately after collection. Sample tracking documents will be prepared so that chain-of-custody records can be maintained and sample disposition can be controlled. Forms and labels will be filled out with waterproof ink. Sample identification documents will include a daily field activity log, a sample label, and chain-of-custody records. Such records will be prepared during the performance of each sampling activity.

Each sample label will include the following information:

- Client and project number,
- Sample location,
- Field identification number or sample identification number,
- Date and time sample collected,
- Depth sample collected, if applicable,
- Preservative used (if any),
- Name or initials of sample collector, and
- Analyses requested.

Each chain-of-custody record will include the following information:

- Client and project number,
- Site name,
- Name or initials of sample collector, and
- Field identification number or sample identification number for each sample,
- Laboratory sample number for each sample,
- Date and time sample collected for each sample,
- Preservative used (if any) for each sample,
- Sample matrix of each sample,
- Type of sample container used for each sample,
- Any filtering performed or requested, if applicable,
- Analyses requested for each sample
- Name of the destination laboratory,
- Signatures of all persons involved in possession of the samples (i.e. relinquished by and received by),
- Dates and times of transfers of sample possession,

- Sample conditions and temperature, and
- Any applicable remarks by either sample collector or laboratory.

Samples will always be accompanied by a chain-of-custody record. When transferring samples to the analytical laboratory, the individuals relinquishing and the individuals receiving the samples will sign, date, and note the time on the chain-of-custody record. A separate chain-of-custody record will accompany each transfer of samples. The method of shipment and courier name(s) will be entered on the chain-of-custody records.

The contractor will keep a copy of the chain-of-custody form when samples are relinquished to the laboratory. The laboratory will furnish a final copy of the chain-of-custody form to the Contractor when laboratory data sheets are delivered.

## **5.2 Laboratory Procedures**

The California State-certified laboratory used for analysis of samples will have in place sample custody procedures designed to fulfill the objective of maintaining sample integrity and traceability.

## **6. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES**

Quality assurance/quality control ("QA/QC") in field sampling and laboratory analysis will be achieved through the analysis of sample blanks (e.g., equipment decontamination rinsate and travel blanks), travel blanks (prepared at the laboratory), these samples accompany the containers throughout the field operations until the samples are returned to the laboratory, and duplicate samples. Sample blanks are intended to evaluate whether the laboratory or field procedures represent a possible source of contamination of field samples. Duplicate samples are intended to evaluate data precision. The QA/QC samples to be collected and analyzed are discussed in the sections following below. A more complete discussion of QA/QC procedures is presented in the Unified QAPP.

### **6.1 Equipment Decontamination Rinsate Blanks**

Equipment decontamination rinsate blanks for water samples are prepared in the field by filling sample containers with organic-free water after passing the water through the typical sample collection device (e.g. pump or bailer) following decontamination of the device. This procedure will help assess whether cross-contamination is occurring between individual groundwater sampling events. The sample will be submitted "blind" to the laboratory; however, the duplicate sample will be clearly documented in the Field Log.

### **6.2 Travel Blanks**

Travel (or trip) blanks are QA/QC samples that are prepared by the laboratory and consist of sample containers filled with organic-free water. They are transferred with sample containers to the field and returned to the laboratory with the field samples collected in the accompanying containers. Travel blanks are not to be opened in the field. The chain-of-custody record will clearly indicate which sample is the travel blank.

### **6.3 Field Duplicates**

Field duplicate samples are QA/QC samples that are collected in series from the same location using the same sampling method (e.g., obtain two samples from the same well at the same time using the same method). Both samples are submitted to the laboratory for analysis. The sample will be submitted "blind" to the laboratory; however, the duplicate sample will

be clearly documented in the Field Log.

#### **6.4 Internal Laboratory QA/QC Samples**

Matrix spike and matrix spike duplicate samples ("MS/MSDs"), laboratory control spike samples, and surrogate spike samples are internal laboratory QA/QC samples used to evaluate the precision and accuracy of the analytical method and equipment used by the laboratory.

#### **6.5 Data Quality Management**

Results of all QA/QC analyses will be evaluated against specific data-quality criteria provided in the Unified QAPP. Results of analyses of travel blanks and equipment blanks are examined for detected concentrations of chemicals. Results of analyses of duplicate samples are compared to each other for consistency. Any anomalous analyses are highlighted and the laboratory is requested to investigate the results and, if necessary, re-analyze the sample. The field procedures and Chain-of-Custody information for the sample in question are also reviewed.

Laboratory precision and accuracy is evaluated by examining the results of analyses of MS/MSD samples.

## **7. MISCELLANEOUS LABORATORY PROCEDURES**

### **7.1 Fuel Fingerprint Analyses**

Soil samples and groundwater samples may be submitted to the laboratory for analysis for petroleum hydrocarbons using a "fuel fingerprint" method. This analysis allows the laboratory to evaluate the hydrocarbons present in the sample and then analyze for total petroleum hydrocarbons ("TPH") by EPA method 8015m using the standard most appropriate to the hydrocarbons occurring in the sample.

This method is a modification of EPA Method 8015m, used for TPH analyses. In standard TPH analyses using Method 8015m, the laboratory uses differing techniques to analyze for light petroleum hydrocarbons ("purgeable hydrocarbons"), such as gasoline, and heavy hydrocarbons ("extractable hydrocarbons"), such as diesel fuel. The technique used is selected on the basis of the request for analysis that accompanies the sample.

In the fuel fingerprint method, the sample is analyzed by both the purgeable hydrocarbon and the extractable hydrocarbon technique, but not immediately quantified. The chromatograms produced are compared to chromatograms of analytical standards for various hydrocarbon fractions. The standard corresponding to the chromatogram that best matches the chromatogram for the unknown sample is then used to quantify the unknown sample. This comparison step allows the most appropriate standard to be used, and eliminates the situation where a specific hydrocarbon fraction in a sample is quantified against several different standards, which give differing results.



Project 91-528-10  
December 1991

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## Project Plan

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# **Unified Quality Assurance Project Plan Middlefield-Ellis-Whisman Study Area Mountain View and Moffett Field, California**

Prepared for: Fairchild Semiconductor Corporation; General Instrument Corporation; Intel Corporation; the National Aeronautics and Space Administration at Ames Research Center; National Semiconductor Corporation; NEC Electronics, Inc.; Raytheon Company; Schlumberger Technology Corporation; Siltec Corporation; Sobato Development Companies; and Union Carbide Chemicals and Plastics Company, Inc.

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Project Plan

# **Unified Quality Assurance Project Plan Middlefield-Ellis-Whisman Study Area Mountain View and Moffett Field, California**

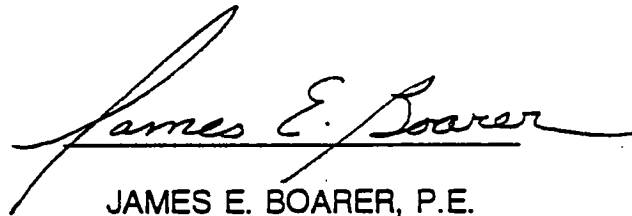
Prepared for: Fairchild Semiconductor Corporation; General Instrument Corporation; Intel Corporation; the National Aeronautics and Space Administration at Ames Research Center; National Semiconductor Corporation; NEC Electronics, Inc.; Raytheon Company; Schlumberger Technology Corporation; Siltec Corporation; Sobato Development Companies; and Union Carbide Chemicals and Plastics Company, Inc.

DECEMBER 13, 1991

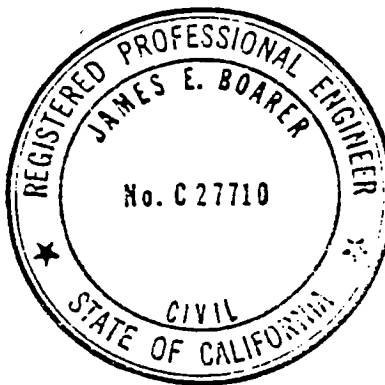
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CERTIFICATION

THIS DOCUMENT WAS PREPARED UNDER THE  
DIRECTION AND SUPERVISION OF A QUALIFIED  
PROFESSIONAL ENGINEER

A handwritten signature in cursive script, reading "James E. Boarer", written over a horizontal line.

JAMES E. BOARER, P.E.  
PROJECT MANAGER  
PROFESSIONAL ENGINEER (C 27710)



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Laboratories

## LIST OF ACRONYMS AND TERMS

ARC	Ames Research Center
CD	Consent Decree
CF	calibration factor
CLP	Contract Laboratory Program
CPT	cone penetrometer testing
Defendants	Raytheon Company and Intel Corporation
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
Fairchild	Fairchild Semiconductor Corporation
GC	gas chromatograph
GIC	General Instrument Corporation
Intel	Intel Corporation
LCL	lower control limit
LP number	laboratory project number
LWL	lower warning limit
MDL	method detection limits
MEW	Middlefield-Ellis-Whisman
mg/l	milligrams per liter
MS/MSD	matrix spike/matrix spike duplicate(s)
NAS	U.S. Naval Air Station
NASA	National Aeronautics and Space Administration
NASA-ARC	National Aeronautics and Space Administration, Ames Research Center
Navy	U.S. Department of the Navy
NEC	National Enforcement Investigation Center
NEIC	National Enforcement Investigation Center
NSC	National Semiconductor Corporation
106 Order	EPA's Administrative Order for Remedial Design and Remedial Action
PCBs	polychlorinated biphenyls
PRPs	potentially responsible parties
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
Raytheon	Raytheon Company
Respondents	Fairchild, GIC, NSC, NEC, STC, Siltec, Sobrato, Spectrace, and Union Carbide.
RPD	relative percent difference
RSA	Regional Study Area
SI	site inspection

## LIST OF ACRONYMS AND TERMS

Siltec	Siltec Corporation
Sobrato	Sobrato Development Companies
Spectrace	Spectrace Instruments, Inc.
STC	Schlumberger Technology Corporation
TCE	trichloroethene
U.S.	United States
UCL	upper control limit
$\mu\text{g/l}$	micrograms per liter
Union Carbide	Union Carbide Chemicals and Plastics Company, Inc.
UWL	upper warning limit
VOC	volatile organic compounds

## EXECUTIVE SUMMARY

### Purpose and Goals

This Unified Quality Assurance Project Plan (QAPP) has been prepared by Canonie Environmental Services Corp. (Canonie) for the Middlefield-Ellis-Whisman (MEW) Study Area located in Mountain View, California. This Unified QAPP has been prepared on behalf of the following potentially responsible parties (PRPs):

1. Fairchild Semiconductor Corporation; Schlumberger Technology Corporation; National Semiconductor Corporation; NEC Electronics, Inc.; Siltec Corporation; Sobrato Development Companies; General Instrument Corporation; Spectrace Instruments, Inc., formerly Tracor X-Ray, Inc.; and Union Carbide Chemicals and Plastics Company, Inc.; all of which were named Respondents in the Administrative Order for Remedial Design and Remedial Action (106 Order) (U.S. EPA Docket No. 91-4) issued by the U.S. Environmental Protection Agency (EPA);
2. Raytheon Company and Intel Corporation (Defendants), which have entered into a Consent Decree with the EPA (U.S. District Court Case No. C9120275JW); and
3. The National Aeronautics and Space Administration's (NASA) which is conducting an environmental investigation at its Ames Research Center (NASA/ARC) located at Moffett Field, California.

The preparation of this Unified QAPP involved the cooperation and technical participation of the different consultants representing individual PRPs. This was accomplished by the integration of the various protocols prescribed in the individual QAPPs that currently govern remedial work at the sites of the different PRPs and by technical review and consultation between Canonie and the different consultants.

The purpose of the Unified QAPP is to establish uniform baseline procedures, guidelines, and inspection protocols designed to produce environmental data of acceptable comparability and quality for the site investigation and remediation of the MEW Study Area by the different PRPs. Most of the field activities covered by this Unified QAPP involve the collection and analysis of representative soil and ground water samples. This Unified QAPP was designed to be used with a field sampling plan or work plan prepared by the individual PRPs for remedial work to be performed at the MEW Study Area. Together, the Unified QAPP and the related field sampling plan or work plan will constitute a Sampling and Analysis Plan (SAP), as described in EPA guidelines.

Individual PRPs may use the Unified QAPP for their work as required under the 106 Order and Consent Decree, elect to prescribe more stringent protocols than what is provided herein, or provide their own QAPP. Addenda to this Unified QAPP may be submitted by PRPs collectively or individually to address specific joint-work or facility-specific work activities. Any amendments or supplements to this Unified QAPP will be submitted to EPA for approval before incorporation in this plan.

However, data collected by any participating PRP that meets the basic standards established in this Unified QAPP will be deemed acceptable and comparable to other analogous data collected in other parts of the program or by other PRPs that also meet or exceed these basic standards. Differences in the specific methods used to implement the basic requirements, such as the use of different sample labels or field data forms that contain the same information, or the choice of functionally equivalent instruments or techniques to obtain the same type of data, shall not invalidate data meeting the basic requirements of this Unified QAPP. Similarly, data meeting the basic requirements of this Unified QAPP shall not be invalidated in comparison to data meeting more stringent or more extensive QA/QC standards.



## Scope

Section 1.0 contains the introduction to the Unified QAPP. Section 2.0 describes the site and the remedial work to be performed for the MEW Study Area. Section 3.0 provides the project organization and the responsibilities of key personnel. Section 4.0 describes the quality assurance objectives of this Unified QAPP. Section 5.0 provides sampling and field testing procedures. Section 6.0 describes the sample custody procedures. Section 7.0 sets forth equipment calibration procedures. Section 8.0 sets forth laboratory analytical procedures. Section 9.0 describes methods for data reduction, validation, and reporting. Section 10.0 describes internal laboratory quality control checks. Section 11.0 sets forth guidelines for performance and system audits. Section 12.0 describes preventive maintenance for equipment. Section 13.0 gives specific and routine procedures for assessing precision, accuracy, and completeness of data. Section 14.0 describes corrective action procedures. Section 15.0 describes quality assurance reports that will be provided to management.

## Strategy

This Unified QAPP is intended to provide a common basis for quality assurance of all work to be performed individually or jointly by the PRPs for the MEW Study Area in accordance with requirements established by EPA.

UNIFIED QUALITY ASSURANCE PROJECT PLAN  
MIDDLEFIELD-ELLIS-WHISMAN STUDY AREA  
MOUNTAIN VIEW, CALIFORNIA

1.0 INTRODUCTION

This Unified Quality Assurance Project Plan (QAPP) has been prepared by Canonie Environmental Services Corp. (Canonie) for the Middlefield-Ellis-Whisman (MEW) Study Area located in Mountain View, California. For purposes of this Unified QAPP, the MEW Study Area is divided into two geographic areas: north of U.S. Highway 101 and south of U.S. Highway 101. The MEW Study Area includes facilities owned or operated by, among others, the following Potentially Responsible Parties (PRPs):

1. U.S. Department of the Navy (Navy) at U.S. Naval Air Station Moffett Field (NAS Moffett Field) at Moffett Field, California;
2. Fairchild Semiconductor Corporation (Fairchild);
3. General Instrument Corporation (GIC);
4. Intel Corporation (Intel);
5. National Aeronautics and Space Administration (NASA) Ames Research Center (NASA-ARC) at Moffett Field, California;
6. National Semiconductor Corporation (NSC);
7. NEC Electronics, Inc. (NEC);
8. Raytheon Company (Raytheon);
9. Schlumberger Technology Corporation (STC);
10. Siltec Corporation (Siltec);
11. Sobrato Development Companies (Sobrato);
12. Spectrace Instruments, Inc. (Spectrace), formerly Tracor X-Ray, Inc.;
13. Union Carbide Chemicals and Plastics Company, Inc. (Union Carbide).

The area north of U.S. Highway 101 is further divided into the area of Moffett Field occupied by the NASA-ARC facility and the NAS Moffett Field.

## 2.0 PROJECT DESCRIPTION

### 2.1 Site Description

The MEW Study Area is located in Santa Clara County in the City of Mountain View, California (Figure 1). The MEW Study Area is defined in the Remedial Investigation Report (HLA, 1988) as the Regional Study Area (RSA). This area is bounded on the west by Stevens Creek, on the south by El Camino Real, on the east by Mathilda Avenue, and on the north by the salt evaporation ponds peripheral to San Francisco Bay.

The MEW Study Area defines the approximate limits within which remedial activities are expected to take place. The boundaries of the RSA, hence the MEW Study Area, were originally selected to provide a sufficient basis to evaluate the hydrogeological system within and downgradient of each individual PRP facilities and to determine the extent to which other activities near these facilities may affect chemicals emanating from them.

The MEW Study Area, as shown on Figure 1, encompasses approximately 8 square miles, including about 2.5 square miles of NAS Moffett Field, and NASA-ARC; about 2.5 square miles of light industrial and commercial land uses; about 1.5 square miles of residential, school, and motel land uses; and about .5 square mile of roads. Moffett Field and NASA-ARC cover most of the MEW Study Area north of U.S. Highway 101.

### 2.2 Site History

#### 2.2.1 Area South of U.S. Highway 101

The area south of U.S. Highway 101 around the intersections of Middlefield Road, Ellis Street, Whisman Road, and U.S. Highway 101 in Mountain View, California, has been

- o Implement the QA programs.
- o Supervise periodic review of engineering design procedures, standards and specifications, and field work.
- o Supervise the performance of audits.
- o Respond to requests for corrective actions.
- o Supervise and implement corrective actions.
- o Provide reports/memorandums regarding completion of the corrective actions.
- o Provide guidance on Quality Assurance and Quality Control (QA/QC) procedures.

### 3.8 Quality Assurance Staff

The QA Staff is responsible for the following, as a minimum:

- o Implement the procedures, guidelines and protocols for sample collection specified in the QAPP for the work.
- o Provide guidance or assistance on QA/QC procedures and guidelines.
- o Perform field performance and system audits.
- o Ensure that all incidents of noncompliance are reported correctly to the QA Officer, Project Manager, and Facility Coordinator, if necessary.

### 3.9 Health and Safety Manager

The Health and Safety Manager will develop and implement the Site Safety Plan for the Work and will consult with managers as needed. The Health and Safety Manager is responsible to:

1. Oversee distribution and implementation of the Site Safety Plan.
2. Assess the need for any changes in the Site Safety Plan.
3. Approve proposed changes in the Site Safety Plan.
4. Inform managers of any changes in the Site Safety Plan.
5. Be available for consultation on health and safety issues.
6. Work on audits of compliance with the Site Safety Plan.
7. Provide training materials and guidance on training to Site Safety Officers.

The Health and Safety Manager will direct the health and safety staff and has the authority to halt work to protect workers.

### 3.10 Health and Safety Officer(s)

The Health and Safety Officer(s) will assist the Health and Safety Manager, conduct safety training, investigate accidents, and develop procedures to prevent recurrence of accidents. They will inform workers of changes in the Site Safety Plan and consult with managers or workers as needed. They will use appropriate training materials to

#### 4.1 Data Quality Objectives

Accuracy, precision, completeness, comparability, and representativeness are defined in Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (EPA, 1980) as follows:

1. Accuracy: The degree of agreement of a measurement (or an average of measurements of the same parameter or property),  $X$ , with an accepted reference or true value,  $T$ , usually expressed as the difference between the two values,  $X-T$ , or the difference as a percentage of the reference or true value,  $100 (X-T)/T$ , and sometimes expressed as a ratio,  $X/T$ . Accuracy is a measure of the bias in a system.
2. Precision: A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation or relative percent difference (RPD). Various measures of precision exist depending upon "prescribed similar conditions."
3. Completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.
4. Representativeness: Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.
5. Comparability: Expresses the confidence with which one data set can be compared to another.

## 4.2 Laboratory Quality Requirements

The different PRP groups in the MEW Study Area employ different but generally comparable analytical methods for the chemical and physical analysis of samples. The analytical methods to be used by the different PRP groups for the analysis of their samples and reporting format(s) to be followed are discussed in the subsections that follow.

To ensure comparability, data will be reported in consistent units. Standard units of measurement will be reported for depths, distances, elevations, etc. and is discussed throughout this document. Water quality data will be reported in consistent units of micrograms per liter ( $\mu\text{g/l}$ ) or of parts per billion (ppb). Soil chemical data will be reported in consistent units of milligrams per kilogram (mg/kg) or parts per million (ppm). Consistent methodologies for sample collection, handling, and analysis provided herein will also provide for data comparability.

The drilling, well installation, and soil and water sample collection procedures will ensure that the data collected are representative by providing appropriately collected samples and by maintaining sample integrity with minimal chemical loss before analysis.

### 4.2.1 Test Methods for Evaluating Solid Waste (SW-846)

The three PRP groups consisting of the Defendants in the Consent Decree, the Respondents of the 106 Order, and NASA employ the analytical methods described in "Test Methods for Evaluating Solid Waste, Volume 1C: Laboratory Manual, Physical/Chemical Methods," SW-846, third edition (EPA, 1986) and "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, (EPA, 1983). This laboratory program will be distinguished as SW-846.

The desired maximum detection limits (analytical levels) for all primary chemicals of concern are presented in Tables 1 and 2. In the absence of interfering compounds or high concentrations of quantifiable compounds, which would result in the need for dilution, these detection limits will be considered the maximum acceptable for soil and ground water sample analyses. If dilution is required, the dilution ratio and resulting range of detection limits for the sample analyses will be reported with the results of the analyses.

Table 1 provides the maximum detection limits for chemicals of primary concern in ground water samples. However, the desired detection limit for the VOCs in ground water samples (chemicals of primary concern) is  $0.5 \mu\text{g/l}$ . This level is below the EPA ground water cleanup goal for the indicator chemical trichloroethene (TCE) of  $5.0 \mu\text{g/l}$  for shallow aquifers and of  $0.8 \mu\text{g/l}$  for deep aquifers and will allow for the evaluation of necessary remedial action.

The maximum detection limits for the chemicals of primary concern in soil at the site are presented in Table 2. However, the desired detection limit for TCE is  $0.002 \text{ mg/kg}$ . This is significantly below the EPA cleanup goal of  $0.5 \text{ mg/kg}$  for TCE in soils outside of slurry walls and of  $1.0 \text{ mg/kg}$  for soils inside slurry walls, as defined in the Record of Decision, May 1989. These analytical levels for soil analysis allow for the identification of potential source soils and for the characterization of the vertical and horizontal extent of known source areas.

The laboratory will retain documentation required by EPA's SW-846, Chapter One, Volume 1B for analytical results not included in the standard documentation packages as contained in laboratory reports. Included in the documentation retained by the laboratory will be:



1. The initial calibration curve and corresponding daily calibration curve, including raw data for initial instrument calibration, continuing calibration, and blank sample results;
2. A legible and complete set of chromatograms for cleaning blanks for all analyses performed where applicable.

Sample analytical results are referred to as "data deliverables." By requiring the analytical laboratory to retain documentation for later generation of data validation packages, if needed, the amount of paperwork produced by all of the sampling programs will be greatly reduced without sacrificing the verifiability of the quality of data.

The laboratory (or laboratories) to perform the work has not yet been designated. Once a California-Certified Analytical laboratory is selected, the laboratory will submit their quality assurance program to EPA for approval as an addendum before incorporation into this plan.

The goals for laboratory accuracy, precision, and completeness are presented in Table 3 for the water analyses and in Table 4 for the soil analyses. These goals are based on the analytical results of analyses of matrix spike/matrix spike duplicates (MS/MSD) using standard spike compounds for each method specified under the SW-846 protocol. The selected goals for precision are based upon a statistical evaluation of past laboratory MS/MSD analyses at the Canonie Environmental Analytical Laboratory. Laboratories performing analyses under this QAPP will achieve the goals prescribed herein. Table 5 provides additional prescribed laboratory QA/QC goals for both soil and ground water samples. QA/QC data are maintained and continually updated on the laboratory QC charts. The procedures for assessing accuracy, precision, and completeness are presented in Section 13.0. If 10 percent of the samples analyzed by the laboratory exceed the QC analytical acceptance criteria prescribed in Table 5, a request for corrective action will be submitted to the QA Officer and Project Manager immediately.

#### 4.2.2 Contract Laboratory Program Objectives

When following the Contract Laboratory Program (CLP), the Routine Analytical Services procedures for the analysis and reporting of semivolatile organic compounds, organochlorine pesticides/PCBs, and metals in soil and water samples will be used. The CLP Routine Analytical Services procedure will also be used for VOCs in soil samples. CLP Special Analytical Services (SAS) procedures, as described in U.S. EPA Region 9 SAS Methods Compendium (EPA, 1989c), will be used for the analysis of VOCs in water and for various inorganic and organic parameters in soil and water samples. Where an EPA method is not specified, other standard methods will be used. When other analytical methods not specified in this Unified QAPP are selected, an addendum will be submitted to EPA for approval before use of the methods.

The desired detection limits (analytical levels) for all chemicals analyzed under CLP protocols are provided in Appendix A. In the absence of interfering compounds or high concentrations of quantifiable compounds, which would result in the need for dilution, these detection limits will be used for soil and ground water sample analyses. If dilution is required, the dilution ratio and resulting range of detection limits for the sample analyses will be reported with the results of the analyses.

The laboratory (or laboratories) to perform the work has not yet been designated. Once a California-certified laboratory has been selected, its Laboratory Quality Assurance Program will be submitted to EPA for approval before incorporation into this plan.

The goals for laboratory accuracy, precision, and completeness for CLP analyses will be based on the results of analyses of MS/MSD using spike compounds as well as surrogate spikes for each method specified under the CLP protocol. The selected goals will be based on method-specific requirements and may be modified with EPA approval

following selection of the laboratory. The procedures for assessing accuracy, precision, and completeness are presented in Section 13.0.

## 5.0 SAMPLING AND FIELD TESTING PROCEDURES

### 5.1 Soil Sample Collection

Surface and subsurface soil samples collected for lithologic description, chemical analysis, and/or physical analysis will be collected using standard procedures as described herein. In general, soil samples will be collected by use of a drilling rig. Shallow soil samples may be retrieved using a hand-held auger and a hand-held drive sampler.

All on-site drilling may be conducted using drilling rigs capable of hollow-stem augering, mud rotary drilling, or air rotary drilling, and of advancing and retrieving split-spoon and or core-barrel samplers. Hand-drilling equipment or limited-access equipment may be used where appropriate. Sampling will be directed by the on-site geologist or engineer and will be performed according to the following procedures:

1. The on-site geologist or engineer will direct the drilling so that samples are collected at proper intervals as identified in individual work plans. Soil samples collected for chemical analysis will be collected with a split-spoon drive sampler using either stainless steel or brass tubes. If samples are also to be used for lithologic description, a core sampler may also be used.
2. Soil samples collected for lithologic description will be collected with either a split-spoon sampler, continuous coring sampler, thin-walled hydraulically driven sampler, or by collecting cuttings or drilling fluid from the bore hole.
3. Stainless steel or brass tubes, the split spoon, and the sampler shoe will be washed in detergent, and rinsed with clean water before each use to collect samples for chemical analyses or physical tests.

4. The driller will use either a 140-pound hammer falling 30-inches or a hydraulic system to drive the sampler into the undisturbed formation below.
5. The driller will provide the on-site geologist or engineer with information on the number of blows or the hydraulic pressure it takes to drive the sampler into the ground per six-inch interval. The blow count or the hydraulic pressure will be recorded on the boring-log sheet by the on-site geologist or engineer.
6. The brass tube nearest the tip of the sampler will be retrieved for laboratory analysis. If additional samples are required, the middle tube will be capped and labeled for laboratory analysis. The tube farthest away from the tip will not be used unless an additional sample is required and visual inspection indicates that the tube is filled with relatively undisturbed soil.
7. The amount of sample recovery from the sampler will be observed (by looking in the brass tubes to see whether they are all completely filled with sediment) and recorded. The sample lithology will be described on the basis of exposed areas at the ends of the brass tubes and of materials within the tip of the split-spoon sampler.
8. Samples collected in tubes will be capped on both ends with plastic caps and aluminum foil or Teflon™, and taped to the tube to minimize moisture loss.
9. The on-site geologist or engineer will label each sample container and complete appropriate chain-of-custody forms and sample identification forms (see Section 6.1.1), and will:
  - o Package the samples according to procedures outlined in Section 6.1.

- o Put the samples on ice for preservation and ship to the appropriate analytical laboratory.

Equipment that comes in contact with soil or ground water during the drilling of a borehole will be steam cleaned or washed with high pressurized water before its use at any other boring location (as discussed in Section 5.7).

#### 5.1.1 Surface Soil Samples

To evaluate possible source areas and/or to assess the potential health risks from chemicals, surface soil samples may be obtained. The samples will be collected by exposing a fresh surface (by scraping with a clean tool) before sampling. Surface soil sampling may be accomplished by driving a sample tube into the soil or by collecting a grab sample. Specific sample collection methods should be identified in individual work plans. Observations on sample collection and placement of backfill materials including sample depth, soil discoloration, odors, and any unusual characteristics will be recorded and kept.

#### 5.1.2 Lithologic Samples

Relatively undisturbed samples obtained for lithologic description will be collected with a split-barrel drive sampler, a thin-walled hydraulically driven sampler, or a continuous sampling system. Borings will be continuously sampled if precise lithologic identification is necessary. The sampler to be used may be any one of the several types, diameters, and lengths available. Samples of cuttings may be collected directly either from the drilling fluid circulating out of the borehole or from the cuttings returned to the surface by augers.

### 5.1.3 Samples for Chemical Analysis

Soil samples to be used for chemical analysis will be collected with a split-barrel drive sampler with brass or stainless steel tubes. If samples are also to be used for lithologic description, a core sampler may be used. After the sample has been retrieved from the sampler, the deepest one or two tubes will be capped on both ends with plastic caps and aluminum foil or Teflon™. The caps will be taped to the tube to minimize moisture loss. For shallow soil samples, a hand-held drive sampler with split spoon may be used. Alternatively, for loose surface soil, the brass or stainless steel tube may be driven by hand into the soils for sample collection. The brass or stainless steel tube representing the near-surface zone of interest will be selected and sealed as described. Chemical analytical methods and parameters will be discussed in Section 8.0. Specific container types and handling protocols for soil samples are given in Table 6.

### 5.1.4 Samples for Physical Analysis

Soil samples to be used for physical analysis (e.g., sieve analysis) will be collected using a split-barrel or thin-walled samplers and stored in appropriate containers. The sampling instrument used will depend on the tolerable sample disturbance for the required physical analysis and the volume of soil required.

Sample custody procedures including those for handling, packaging, transport, and chain of custody are described in Section 6.0.

### 5.1.5 Probe Soil Sampling

Soil samples may be obtained by hydraulically driving galvanized or stainless steel probes (small diameter tubes) to a designated depth. Note that if ground water samples will also to be collected using, the probe and analyzed for priority pollutant

metals, stainless steel probes should be used. To prevent soil from entering the casing through the probe point, a steel insert or rod is driven with the probe. When the target depth is reached, the steel insert is removed using a hydraulic ram or electric winch and the sample is obtained. As an alternative, a double rod sampling method can also be performed.

Soil samples will be collected by using a small-diameter sampler. The sampler will be lined with Teflon™, brass, or stainless steel tubing. If samples are to be analyzed for inorganics, brass tubing should not be used.

Before field work and between each soil sampling, probes and sampling equipment will be cleaned using detergent, steam, or washed with high pressurized water (as discussed in Section 5.7).

## 5.2 Field Testing of Soils

A complete log of conditions encountered during drilling will be maintained by the on-site geologist or engineer using the Unified Soil Classification System. A boring-log form will be used to record field observations. Individual facilities may use similar boring-log forms. Lithologic soil sampling frequency will consist of one of the following, as appropriate:

1. At every five-foot interval;
2. At perceived changes in lithology;
3. Continuous lithologic sampling.

The geologist or engineer will obtain a soil sample either as a grab sample from the drill cuttings or from a sampler (Section 5.1). The type of soil samples and the frequency



of sampling will be specified in the individual work plans. The observation log will contain the following information as a minimum:

1. Boring identification;
2. Boring location;
3. Sample depths;
4. Color of soil samples;
5. Grain size of soil samples;
6. Relative percentage of grain sizes;
7. Descriptive comments;
8. Estimated relative moisture content;
9. Depth where ground water is first encountered, if possible;
10. Variations in drilling rates and rig behavior;
11. Signature of observer.

#### 5.2.1 Cone Penetrometer Testing

Commercially available electronic cone penetrometer testing (CPT) may be used to identify lithology. CPT involves driving a cone-tipped probe into a soil deposit and recording the resistance of the soil to penetration. The test equipment consists of a

cone assembly, a hydraulic frame to advance the cone into the soil, a series of hollow sounding rods, an electric data-processing unit, and a truck to transport the CPT equipment and provide the necessary thrust capacity. The resistance of the soil to the conical tip and to the following sleeve indicates soil type. The resistance of the cylindrical friction sleeve and of the cone is measured and transmitted by an electronic cable that transmits signals from strain units in the cone to the processing unit, which indicates soil characteristics.

### 5.3 Installation of Ground Water Wells

Ground water wells will be constructed in accordance with the well details provided in the individual work plans and in the procedures specified in the following sections. All monitoring wells will be surveyed to existing benchmarks to provide adequate elevation control to allow an evaluation of ground water flow patterns.

To meet investigation objectives, standard protocols will be adhered to during well design and construction, geologic logging, water-level measurements, sampling, and aquifer testing. The QA/QC program will be implemented by documenting field observations and by implementation of the standard protocols described.

Well specifications will be reviewed by the Project Manager before drilling and installing monitoring wells. Necessary permits and access agreements will be obtained before well installation. Appropriate local agencies (Santa Clara Valley Water District and/or the City of Mountain View) will be notified as required by local regulations.

A geologist, engineer, or qualified field technician will supervise well installation, observe drilling, and prepare lithologic logs of borings. The geologist, engineer, or technician will be under the supervision of a registered civil engineer, registered geologist, or certified engineering geologist. The drilling and well installation methods will vary

hydrostratigraphic units. The well casing will be installed by lowering the casing through the hollow stem of the auger or through thinned drilling mud to the appropriate depth. The sand pack will consist of water-washed sand that will be placed adjacent to the entire screened interval. The sand pack will extend a recommended minimum distance of one foot above the top of the screen. The sand will be sized according to information on grain size in the formation at nearby borings and on the screen slots. The level of sand will be confirmed by sounding with a weighted tape. When using hollow-stem auger equipment, the sand pack will be installed by carefully pouring sand down the annulus between the hollow stem and the well casing. During this procedure, the auger will be raised periodically and auger flights removed to allow the sand to fill the annulus between the well casing and the borehole wall.

A one- to two-foot-thick bentonite pellet seal will be placed above the sand pack. The seal will be installed by the same procedures as for the sand pack and will be sounded with a weighted tape. The annulus above the bentonite seal will be grouted with a cement-bentonite grout. The grout will consist of clean water mixed with Portland cement and with a bentonite content not to exceed five percent by weight. The grout will be placed with a tremie when placed with standing water or drilling mud in the hole.

In areas where vehicular traffic is expected, a locking steel protective casing and/or a locking PVC cap will be placed on the monitoring well, below grade; and a traffic-proof utility box will be placed approximately one-fourth of an inch above ground over the steel protective casing. The utility box will be set in concrete. Whether wells are completed above or below grade, the steel protective casing will be footed in cement-bentonite grout. Once the well is installed, and at least 24 hours after the concrete and cement-bentonite grout have been placed, each well will be developed as described in Section 5.5.4.

The identification number of each well will be permanently marked on the well casing cap and/or on the locking steel protective casing.

### 5.3.2 Wells with Single Casings in the "B", "C", and Deep Aquifers

When constructing wells in the "B", "C", and deep aquifers, PRPs must determine whether or not the upper aquifers are contaminated. If an aquifer is suspected of contamination, then a conductor casing will be used. As a guideline, the single-casing method will be employed only in areas where an existing database on chemical distribution and water levels is available, and where the location of the proposed well is at least 250 feet outside any concentrations of TCE in ground water greater than 50 ppb. A geologist, engineer, or qualified field technician will supervise the well installation, observe drilling, and prepare lithologic logs of boring. The on-site geologist, engineer, or technician will be under the supervision of a registered civil engineer, registered geologist, or certified engineering geologist. The well will be drilled using either the direct rotary method with bentonite fluid; reverse rotary method; or dual-wall, reverse-circulation air method; or other equivalent, approved methods. The well casing and screen will be constructed of flush-joint-threaded Schedule 40, PVC or of stainless steel, with a minimum diameter of four inches. The screen openings will be of factory milled slots.

Slot size will be based on the available sieve analyses of the formation from nearby wells and borings, and on the evaluation of the interval to be screened in each well. No screen section will be installed that would create an interconnection between two or more hydrostratigraphic units. The sand pack will consist of water-washed sand that will be placed adjacent to the entire screened interval. The sand pack will extend a recommended minimum distance of one foot above the top of the screen. The sand will be sized according to information on grain size in the formation at nearby borings and on the screen slots. No screen or sand pack will be installed that would create an interconnection between two or more hydrostratigraphic units. All levels of sand and bentonite will be confirmed by sounding with a weighted tape.

A one- to two-foot-thick bentonite pellet seal will be placed above the sand pack. The seal will be installed following the same procedures as those for the sand pack and will be sounded with a weighted tape. The annulus above the bentonite seal will be grouted with a cement-bentonite grout, using a tremie pipe pumping from the bottom to the surface in the annulus space. The grout will consist of clean water mixed with Portland cement and a bentonite content not to exceed five percent by weight. The grout will be placed by the same procedures as those for the sand pack described.

In areas where vehicular traffic is expected, a locking steel protective casing and/or a locking PVC cap will be placed on the monitoring well, below grade; and a traffic-proof utility box will be placed approximately one-fourth of an inch aboveground over the steel protective casing. The utility box will be set in concrete. Whether wells are completed above or below grade, the steel protective casing will be footed in cement-bentonite grout. Once the well is installed, and at least 24 hours after the concrete and cement-bentonite grout have been placed, each well will be developed as described in Section 5.5.4. The identification number of each well will be permanently marked on the well casing cap and/or on the locking steel protective casing.

### 5.3.3 Wells with Double Casings in the "B", "C", and Deep Aquifers

When constructing wells in the "B1", "B2", "B3", "C", and deep aquifers; conductor casing will be used in areas of contamination. A geologist, engineer, or qualified field technician will supervise the well installation, observe drilling, and prepare lithologic logs of the borings. The geologist, engineer, or technician will be under the supervision of a registered civil engineer, registered geologist, or certified engineering geologist. The well will be installed by using the air-rotary, casing-hammer, rotary bucket, direct-rotary; or reverse rotary methods or other equivalent, approved methods.

Double-casing "B" and "C" aquifer wells will be drilled as follows. Boreholes will be drilled to allow a minimum annulus width of two inches between borehole and

conductor casing. The borehole will be drilled a minimum of two feet into the aquitard above the aquifer to be monitored. The conductor casing will allow a minimum annulus width of two inches between the well casing and the conductor casing. The conductor casing will be set into the borehole and hydraulically pushed approximately one foot into the aquitard. The annulus between the casing and the borehole will be grouted using a tremie pipe to pump a cement-bentonite grout from the bottom of the borehole. The grout will consist of clean water mixed with Portland cement and bentonite, the content of which is not to exceed five percent by weight. Once the conductor casing has been grouted, the fluid in the casing will be flushed out and displaced with clean water pumped from the bottom of the borehole using a tremie pipe. The on-site geologist, engineer, or technician will take an analytical sample of the flushed water to determine whether the fluid in the conductor casing is clean. If the fluid is clean after the grout has set for a minimum of 12 hours, the borehole may be drilled two feet into the aquitard beneath the aquifer to be monitored. Geophysical logs may be run if appropriate.

The well casing and screen will be constructed of flush-joint-threaded Schedule 40 PVC or stainless steel at least four inches in diameter. The screen openings will be of factory milled slots.

Slot size will be based on the available sieve analyses of the formation from nearby wells and borings and on the evaluation of the interval to be screened in each well. No screen section will be installed that would create an interconnection between two or more hydrostratigraphic units. The sand pack will consist of water-washed sand placed adjacent to the entire screened interval. The sand pack will extend a recommended minimum distance of one foot above the top of the screen. The sand will be sized according to information on grain size in the formation at nearby borings and on the screen slots. No screen or sand pack will be installed that would create an interconnection between two or more hydrostratigraphic units. All levels of sand and bentonite will be confirmed by sounding with a weighted tape.

A one- to two-foot-thick bentonite pellet seal will be placed above the sand pack. The seal will be installed by the same procedures as those for the sand pack and will be sounded with a weighted tape. The annulus above the bentonite seal will be grouted with a cement-bentonite grout using a tremie pipe pumping from the bottom to the surface, in the annular spaces. The grout will consist of clean water mixed with Portland cement and a bentonite content not to exceed five percent by weight. The grout will be placed by the same procedures as those described for the sand pack.

In areas where vehicular traffic is expected, a locking steel protective casing and/or a locking PVC cap will be placed on the monitoring well, below grade; and a traffic-proof utility box will be placed approximately one-fourth of an inch aboveground over the well casing. The utility box will be set in concrete. Whether wells are completed above or below grade, the steel protective casing will be footed in cement-bentonite grout. Once the well is installed, and at least 24-hours after the concrete and cement-bentonite grout have been put in place, each well will be developed as described in Section 5.5.4. The identification number of each well will be permanently marked on the well casing cap and/or on the locking steel protective casing.

#### 5.3.4 Well Development

Upon completion of well installation, the wells will be developed to remove fine-grained materials inside the filter pack and casing, to stabilize the filter pack around the well screen, and to produce representative water samples from the water-bearing zone. Twenty-four hours or more after the installation of the concrete and cement-bentonite grout, each well will be developed by swabbing, surging, bailing, and/or pumping.

Each well will be developed until its water is visually clear and free of sediment or until it is determined that further significant reductions in turbidity are not feasible. If swabbing, surging, and/or bailing are insufficient to develop a well, then either a pump will be placed near the bottom of the well and pumped at a discharge rate that can be

continuously maintained until the water is free of turbidity, or other procedures described in the relevant individual work plans will be used. The turbidity of the water purged from the well during well development will be measured and documented. Although turbidity will be measured and documented, it must be noted that a complete removal of turbidity may not be feasible in some wells installed in fine-grained soils. Well development will be considered complete when well parameters, such as pH, temperature, conductivity, and turbidity stabilize, as determined by the PRPs field representative. Well development equipment will be steam cleaned or washed with high pressurized water before use in each well.

#### 5.3.5 Grouting

Grouting will consist of backfilling boreholes, probe holes, and cone penetrometer test holes with a bentonite cement slurry to ground surface. A SCVWD inspector will be notified and permitted to be present during the construction of grout seals for monitoring wells. Monitoring wells and bore holes will be grouted according to SCVWD specifications.

#### 5.4 Collection of Ground Water Samples

Surface and subsurface water samples will be collected using standard procedures as described herein. Ground water samples for chemical analysis will be collected from the monitoring wells at the frequency and to fulfill the analytical requirements described in individual work plans.

All sampling equipment will be decontaminated before purging and sampling of each monitoring well. A water level measurement will be obtained at each monitoring well before purging and sampling. Before sampling, if a dedicated pump does not exist, each well will be purged using a Teflon™ or stainless steel bailer or a submersible pump, depending on individual well conditions.



The standard monitoring well purging procedure will consist of, at a minimum, the removal of three times the initial volume of water contained by the well casing before purging. Physical parameters such as pH, conductivity, and temperature will be monitored and noted in the field logbook while the well is being purged. This will verify that complete purging of the static water has been accomplished. Depending on individual well conditions, if recharge of the monitoring well is too slow to allow purging at a reasonable rate, the well may be completely evacuated prior to removing three casing volumes. In this case, the samples will be taken when sufficient recharge has occurred.

#### 5.4.1 Well Purge Volumes

The purge volumes for any type of well are calculated by using the following formula.  
 $PV = C (X - Y)$

Where: PV = purge volume in gallons.

X = well depth in feet.

Y = static water level in feet.

C = constant for various purge volumes and casing diameters.

For wells requiring three purge volumes, constants from the following table are used.

<u>Casing Diameter</u>	<u>Constant (C)</u>
2 inches	0.489
4 inches	1.96
6 inches	4.4
8 inches	7.83
10 inches	12.24
16 inches	31.33

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6 inches	4.4
8 inches	7.83
10 inches	12.24
16 inches	31.33

#### 5.4.2 Field Sampling Logbook

Sample container types, preservation methods, and holding times for ground water are specified in Table 6. Sample containers for VOCs should contain no headspace after being filled and sealed. Water samples will be analyzed and/or extracted within the holding times specified in the table. The following information will be entered on a field sampling log at the time of sampling:

1. Name of sampler, date, and physical/environmental conditions during field activity;
2. Well identification;
3. Sample collection or measurement method(s);
4. Number and volume of sample(s) taken;
5. Purge volume and purge times;
6. Date and time of collection or measurement;
7. Sample identification number(s);
8. Water level measurements before sampling;
9. Sample preservation;
10. QA/QC sample information;
11. Sample distribution (e.g., laboratory);

12. Field observations during sampling;
13. Field measurement data (pH, conductivity, and temperature);
14. Field instrument identification.

Each sample will be packaged and transported appropriately as described in the following protocol:

1. Collect samples in appropriate containers (Table 6).
2. Print clearly in waterproof ink on the label the preservative that has been added to each aliquot as provided in Section 6.1.1.
3. Seal and package sample containers as appropriate.
4. Fill out field sample log and chain-of-custody form as described in Section 6.1.3 of this Unified QAPP.
5. Separate and place samples into coolers according to laboratory destination.
6. Ice samples if necessary.
7. Include the bottom two copies of the completed chain-of-custody form inside the cooler. Chain-of-custody forms will be protected from moisture by placing them inside Ziploc™ bags, which will then be taped to the inside of the lid of the cooler.
8. Seal the cooler with strapping tape or other appropriate mechanical fastening.

9. Fasten custody seals.

#### 5.4.3 Surface Water Sampling

Surface Water Sampling will be conducted as described herein. In general, samples will be collected by dipping laboratory supplied sample jars or by using Teflon™ or stainless steel bailers in the desired location. If necessary, samples may be obtained by using a device for sampling water at discrete depths such as a Kemmerer sampler. Sample containers for VOCs should contain no headspace after being filled and sealed. Information to be documented will include identification number, sample location, depth of sample, specific conductance, pH, temperature, turbidity, color, odor, and any unusual characteristics (see Section 5.4.2).

#### 5.4.4 Hydropunch™ and Geoprobe™ Sampling

The Hydropunch™ is a commercially available sampling tool that can be used to collect ground water samples. Cone penetrometer equipment may be used to push or conventional drilling equipment may be used to drive the Hydropunch™ to the desired sampling depth.

The Hydropunch™ has a stainless steel or Teflon™ sample chamber that can be easily cleaned in the field. The Hydropunch™ has an adapter to connect the unit to the drill rod or penetrometer punch, a stainless steel drive point, and a perforated section of stainless steel pipe for sample intake. The sample intake pipe is shielded in a watertight housing as it is pushed or driven through the soil. At the desired depth, the housing is retracted about 1.5 feet, exposing the perforated intake pipe to the saturated zone. The Hydropunch™ is pulled upward as soon as the chamber is filled. Hydrostatic pressure in the unit closes two Teflon™ check valves. This prevents entry of soil or ground water from depths other than that sampled.

The Geoprobe™ is another commercially available tool for ground water sampling. It is similar to the Hydropunch™ and may also be used.

#### 5.4.5 Ground Water Probe Sampling

Ground Water Probe Sampling will be conducted either as specified herein or as specified in individual work plans. Samples are collected after advancing a standard probe assembly one to two feet into the first saturated area. The assembly is then withdrawn to create a void space for ground water to recharge. The steel rod is removed and ground water enters the probe. Before sample collection, a peristaltic pump or a stainless steel bailer is used to remove approximately two probe volumes of ground water. This purge volume will be recorded for each sample location. A double-rod system can also be used, which involves the removal of the inner rod (soil sampler) and insertion of a small-diameter, slotted PVC casing. The outer rods are removed to create a temporary ground water monitoring well.

Ground water samples for analysis of VOCs are collected by stainless steel bailers. For analysis of non-volatile organic compounds, either a peristaltic pump or a stainless steel bailer can be used to obtain samples. Ground water samples will be put into appropriate laboratory supplied glassware and labeled.

### 5.5 Collection of Soil-Gas Samples

#### 5.5.1 Soil-Gas Survey

A soil-gas survey may be used to delineate the approximate extent of soil or shallow ground water contamination by VOCs. The soil-gas survey also provides information for selecting the location of shallow aquifer monitoring wells and reduces the probability of drilling unnecessary monitoring wells.

To replicate measurements, the data should be compared to previous measurements obtained at the well site. If large discrepancies with previous measurements not explained by local ground water activities, changes, or trends occur; the equipment should be recalibrated and the measurements repeated. If possible, an alternative instrument should be used to verify the accuracy of the data.

The following protocols will be employed while collecting water level measurements with an electrical sounder for investigations at the MEW Study Area:

1. A battery powered sounder will be used for water level measurements. The sounder will have firmly affixed or permanent marks on the sounder line at regular intervals of five feet or less. A steel measuring tape or a ruler will be used to measure between marked intervals.
2. All measurements will be made to the nearest hundredth of a foot relative to the marked surveyed point. These data will be converted to mean sea level using the known elevation of the marked survey point.
3. Electrical sounders will be calibrated monthly and after any incident that may affect the accuracy of the sounder. Markings should be checked for the proper spacing by physically comparing the spacing with a graduated steel tape.
4. Sounders will be kept clean and in working order. The sounder and portions of the cable that are submerged below fluid levels in wells will be sprayed with deionized water. The sprayed water will be collected in buckets and disposed of in the same manner as purged water, as discussed in Section 5.9.

Field personnel conducting the water level surveys will be responsible to see that the electrical sounder is calibrated before its use.

#### 5.6.2 Conductivity, Temperature, and pH

Specific conductivity, water temperature, and pH measurements will be made during purging and when a water sample is collected. A representative water sample will be placed in a container used solely for field parameter determinations. A commercial pH meter with a combination electrode will be used for field pH measurements. A commercial conductivity meter will be used for field-specific conductance measurements. Temperature measurements will be performed using standard thermometers or equivalent temperature meters. Combination instruments capable of measuring two or all three of the parameters may also be used.

All instruments will be calibrated in accordance with Section 7.0. The values for conductivity standards and pH buffers used in calibration will be recorded daily in the calibration notebook. All probes will be thoroughly cleaned and rinsed with distilled water before and after measurements.

Regardless of the sample collection method (bailer or pump), a representative water sample will be placed in the container used solely for field-parameter determinations unless it is possible to make measurements directly at the well discharge point. Measurements will be made as follows:

1. The container will be rinsed with sample water before filling.
2. Probes will be immediately submerged in the container and measurements will be taken accordingly.



3. All field measurements will be recorded on the field logbook along with the sample location and the time and date of measurement.
4. After parameters are measured the container and the probes(s) will be decontaminated by rinsing with distilled water. If the container cannot be cleaned, a new container will be used.

### 5.6.3 Aquifer Testing

The specific testing technique, monitoring locations, and test duration will vary according to the purpose of the test and the physical conditions at the test location. Detailed procedures for each aquifer test and its field measurements will be developed by the hydrogeologist or engineer conducting the test. During aquifer tests, the following procedures should be used.

Water levels in wells to be pumped and in monitoring wells will be measured for a sufficient period before the test so that any trend before the test is delineated.

The range of discharge rates and length of time for pumping will be estimated before the test. The pump selected will have adequate capacity to produce the desired flow rates.

Methods of measuring pump discharge and water level changes will be field checked and calibrated before beginning the test. Copies of the documentation of instrument calibration will be obtained by the field hydrogeologist and later filed with the test data records. The calibration records will consist of calibration measurements and, if performed, any on-site zero adjustment and/or calibration.

Discharge measurements will be made a minimum of twice during each log cycle of time. Measurements will be made after any change in running speed of the pump, power surge, or other condition that may affect pump performance.

As appropriate, given the detailed test procedures, water levels will be measured to give at least 10 observations of drawdown for each log cycle of time during an aquifer test.

If required by the detailed test procedure, measurement of recovering water levels will be performed. If recovery measurements are taken in the pumping well or in a nearby observation well, the hydrogeologist or engineer supervising the test will ensure that the pump is equipped with a check valve to prevent backflow of pumped water into the pumping well.

A graphical and tabular record of the test will be prepared. Log and/or semi log plots of water levels or transducer response will be made for both drawdown and recovery cycles.

Field observations in an actual test will be compared with estimates made before the test. If anomalous drawdowns are found, equipment, instruments, and surrounding wells will be checked.

An arithmetic graph of time versus discharge will be generated during the test to denote both planned and anomalous changes in discharge.

Specific conductance, pH, and temperature of discharge water will be monitored when discharge rates are measured.

If required by the test procedure, water samples for chemical analyses will be taken from the pumping well by sampling the pump discharge. If samples are taken from

observation wells, they should be taken immediately following the recovery part of the test.

Analysis of aquifer test data will be performed according to published techniques and the professional judgment of an experienced hydrogeologist.

### 5.7 Equipment Decontamination

All equipment that comes in contact with potentially chemically affected soil, drilling fluid, or water will be decontaminated before and after use. In addition, all soil sampling tubes well installation material, and well development equipment will be cleaned before use. Drilling equipment, field measurement equipment, sampling equipment, and materials will be decontaminated as follows:

1. Soil sampling tubes will be prewashed as follows:
  - o Wash with detergent.
  - o Rinse with tap water.
  - o Rinse with distilled water.

Alternatively, soil sampling tubes may be washed with detergent and steam cleaned.

2. The split-spoon sampler will be steam cleaned or washed with high pressurized water before each boring. This sampler will first be washed with detergent and rinsed with tap water to remove any large deposits of drill cuttings or visible foreign matter. After this first wash, the split-spoon sampler will be steam cleaned or washed with high pressurized water for final decontamination. Drill cuttings will be placed in labeled 55-gallon drums

or as appropriate and disposed of as discussed in Section 5.8, Disposal Procedures.

3. Augers, drill strings, and coring bits will be decontaminated before each boring and before demobilization from the work area. These items will be initially cleaned of any large deposits of drill cuttings before steam cleaning for final decontamination. Initial cleaning will be accomplished by the following methods:
  - o Drill cuttings will be scraped manually from between the auger's flights and the drill strings as they are retrieved from the boring. Drill cuttings will be placed in labeled 55-gallon drums or as appropriate and disposed of as discussed in Section 5.8, Disposal Procedures.
  - o Coring bits will be cleaned of drill cuttings by washing with detergent and rinsing with clean water. Drill cuttings will be placed in labeled 55-gallon drums or as appropriate and disposed of as discussed in Section 5.8, Disposal Procedures.
4. New well materials such as casings, screens, couplings, and caps that will be used in the installation of monitoring wells will be steam cleaned or washed with high pressurized water before installation. Any visible foreign matter will be removed before cleaning and installation.
5. Accessible interior portions and all exterior surfaces of submersible pumps or Teflon™ or stainless steel bailers, and of any associated tubes or hoses used for monitoring well purging will be steam cleaned or washed with high pressurized water before use. All visible soils or other materials will be removed. If necessary, detergent will be used before a final steam clean rinse cleaning to achieve this result.

6. All monitoring well sampling gear potentially affected by chemicals will be decontaminated as in Item 5. Moreover, a final organic-free water rinse of the sampling device will precede sampling of a monitoring well for organic parameters.

Any cord utilized for bailing monitoring wells will be kept in a clean, dust-free environment before use and will be disposed after use in a well.

7. Field measurement equipment not used for sampling will be steam cleaned or washed in high pressurized water before removal from the site, as appropriate.

#### 5.8 Disposal Procedures

Purge water and water collected from steam cleaning of sampling equipment will be collected and disposed as appropriate. This water may be disposed as follows:

- o Treated through a ground water treatment system with air stripping towers or equivalent and discharged or reused under NPDES permit.
- o Collected in labeled U.S. Department of Transportation (DOT)-approved 55-gallon drums, Baker™ tanks, sumps, or equivalent; analyzed, profiled, and disposed off-site as appropriate.

Soil cuttings generated during drilling will be collected and placed in labeled DOT-approved 55-gallon drums, roll-off containers, or equivalent. The collected soils will be held until receipt of laboratory analysis of the soils from the corresponding boring(s). The collected soil will then be disposed in an appropriate manner.

## 6.0 SAMPLE CUSTODY PROCEDURES

This section describes standard operating procedures for sample custody during the investigations of the MEW Study Area. Sample custody procedures will be followed through sample collection, transfer, analysis, and ultimate disposal. The purpose of these procedures is to assure the following:

1. That the integrity and traceability of samples is maintained during their collection, transportation, and storage before analysis;
2. That postanalysis sample material is properly disposed.

Sample custody is divided into field procedures and laboratory procedures, as described in this section.

### 6.1 Field Procedures

Each sample will be labeled and sealed immediately after collection. Sample tracking documents will be prepared so that identification and chain-of-custody forms can be maintained and sample disposition can be controlled. Forms will be filled out with waterproof ink. The following are sample identification documents to be used during the investigations of the MEW Study Area:

1. Sample Label;
2. Field Logbook;
3. Chain-of-Custody Form.

### 6.1.1 Sample Labels

Sample labels are necessary to ensure proper sample identification. Preprinted sample labels can be provided. The following information will be specified on each label:

1. Client and Project number;
2. Sample location;
3. Field identification number or sample identification number;
4. Date and time of sample collection;
5. Preservative used (if applicable);
6. Name of collector (sampler);
7. Analyses required.

### 6.1.2 Field Logbook

Field logbooks are intended to provide sufficient information to reconstruct the previous events of a field investigation. Logbooks are to be bound with sequentially numbered pages to record all field activities. Entries in the logbook will contain the following as appropriate:

1. Name of author, time and date of entry, physical/environmental conditions;
2. Location of sampling or measurement activity;
3. Names of field crew;
4. Type of sampled or measured media (e.g. soil, sediment, ground water);
5. Sample collection or measurement method(s);
6. Number and volume of sample(s) taken for each analysis;
7. Description of sampling point(s);
8. Date and time of collection or measurement;
9. Sample identification number(s);
10. Sample preservation (if any);

11. Sample distribution (e.g., laboratory);
12. Field observations during sampling;
13. Field measurements (conductivity, temperature, and pH);
14. Summary of daily activities;
15. Equipment on-site;
16. Descriptions of deviations from sampling plans;
17. Chain-of-custody number, sample destination, and time of pickup;
18. Project number;
19. Analyte(s);
20. Name of sampler(s);
21. Sampling methods;
22. Personal protective equipment used.

#### 6.1.3 Chain-of-Custody Form

Every sample will be listed on a chain-of-custody form. The form will accompany every sample shipment to the analytical laboratories to establish the documentation necessary to trace sample possession. A form designating the firm that collected the samples for the given event will be used. The form will contain the following information:

1. Sample identification number;
2. Signature of collector (sampler);
3. Date and time of collection;
4. Site name and project number;
5. Sample matrix;
6. Signature of persons involved in chain of possession (relinquished by and received by);
7. Date and time of sample receipt;
8. Sample container description;
9. Analyses requested;



10. Special analytical procedures requested;
11. Sample condition and temperature;
12. Laboratory sample number;
13. Volatile organic analysis headspace;
14. Remarks (expected interferences, hazards, unusual events at the time of sampling);
15. Preservatives added (if any);
16. Filtering (if applicable);
17. Destination of samples (laboratory name).

#### 6.1.4 Sample Transfer and Shipment

Samples are always accompanied by a chain-of-custody form. When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody form. Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis. Sample containers will be sealed with custody seals and a separate chain-of-custody form will accompany each shipment. The method of shipment and courier name(s) will be entered on the chain-of-custody form.

#### 6.2 Laboratory Operations

Procedures used by an equivalent California-certified laboratory may vary from the procedures specified herein as long as they fulfill the objective of maintaining sample integrity and traceability.

The sample custodian at the laboratory is to receive and assume custody of samples coming in by courier. The sample custodian will verify the following:

1. All samples are present.
2. All samples are in good condition.
3. All samples are accompanied by a chain-of-custody form.
4. The sample identification is complete and corresponds to the chain-of-custody form.
5. Condition of custody seals and temperature of the chest.

If sample integrity is questionable, the sample custodian will immediately notify the laboratory's project administrator, who in turn will notify the party concerned of the sample's condition. Arrangements can then be made for sample replacements to be shipped to the laboratory. The sample custodian will document the sample condition on the sample custody log.

When samples are received by the sample custodian and pass the inspection procedures, the sample custodian will then formally sign off on the chain-of-custody form after the courier relinquishes possession by signature.

The samples(s) are formally said to be under laboratory custody by the sample custodian when the following criteria have been objectively met:

1. The samples are in the physical possession of the laboratory.
2. The samples are in view of the sample custodian after his taking possession.

3. The samples are secured by the sample custodian so that no one can tamper with them and/or are secured by the sample custodian in an area that is restricted to authorized personnel.

#### 6.2.1 Logging of Laboratory Samples

After chain-of-custody procedures are complete and acceptable, the sample custodian will assign laboratory sample numbers. Laboratory sample identification numbers may be written on the chain-of-custody form for tracing purposes.

The sample custodian is also responsible for maintaining sample control at all times. Additionally, the sample custodian is responsible for maintaining refrigerated sample storage at a temperature of 4°C.

Pertinent, relevant information from the chain-of-custody form is entered into the laboratory's information management system as a means of sample tracing. All final reports are approved for release by the department supervisor and/or chemist/analyst.

#### 6.3 Corrections to Documentation

Original data recorded in field logbooks, on chain-of-custody forms, and on other forms should be written in waterproof ink. None of these documents should be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document assigned to one individual, that individual should make corrections by drawing a line through the error, entering the correct information, and initialing and dating the change. The erroneous information should not be obliterated. If possible, any subsequent error(s) discovered on a document should be corrected by the person who made the entry.

## 7.0 PROCEDURES FOR AND FREQUENCY OF CALIBRATION

Procedures for the calibration of equipment and instrumentation to be used in the performance of remedial work at the MEW Study Area are described in this section. Included are descriptions of the procedures or references to applicable standard operating procedures, frequency of calibration, and the calibration standards to be used. The calibration and precision requirements for field measurements are summarized in Table 8. The procedures and frequencies for equipment maintenance are summarized in Table 9.

### 7.1 Field Instruments

#### 7.1.1 Portable Gas Analyzers

Portable gas analyzers that may be used during field operations at the MEW Study Area include Foxboro Analytical's Century™ organic vapor analyzer and HNU and MicroTIP™ photoionization detectors, or equivalents. The factory-supplied instruction manual will be used in calibrating the instrument. Calibration of each portable gas analyzer will be completed daily upon startup and when apparently anomalous data is observed. The calibration of the instrument will be verified with check standards before each use. [i.e., gases, e.g., methane, Hydrocarbon Free Air)].

#### 7.1.2 Water Level Measurements

Water levels may be taken from two different kinds of wells: extraction wells with dedicated pumps and monitoring wells with no pumps. The procedures used for obtaining water level measurements will vary according to the type of well being measured. In addition, special procedures apply to wells pumping at the time of measurement.

The measuring devices to be used will be an electric sounder and/or steel tape. The protocols outlined below will be employed while collecting water level measurements.

#### 7.1.2.1 Electric Sounder

A battery-powered sounder (or equivalent) will be used for water level measurements. The sounder will have marks on the sounding line at regular intervals (e.g., 1, 5, 10, 50, and 100 feet).

Each sounder will be accompanied by a calibration logbook which will show:

1. Time and date of last calibration (before entering the field);
2. The point of calibration (either the center of a mark on the sounding line or along the extreme end of the mark near the probe);
3. Who did the calibration;
4. How calibration was accomplished.

Electrical sounders will be calibrated at least once a month or as needed. Markings should be checked for the proper spacing by physically comparing the spacings with a graduated steel tape.

The electrical probe audible or visual alert signal should be checked by placing the probe in a bucket with a known water level and observing whether the alert signal is accurate. If the signal is not accurate, then adjustment of the sensitivity may be necessary.

Each well will be sounded twice for depth to water; the variation must be less than 0.01 foot between the two measurements.

#### 7.1.2.2 Steel Tape Method

The steel tape will be continually checked for kinks and will have the lowest section dried and chalked before each measurement. The tape will be lowered down the well so as to avoid contact with the casing. Once the approximate water level is established each well will be sounded twice for depth to water; the variation must be less than 0.01 foot between the two measurements.

#### 7.1.3 Field Parameters

Conductivity, temperature, and pH measurements will be made during purging of monitoring wells and when each water sample is collected. All instruments will be periodically calibrated according to manufacturers' specifications to ensure accuracy. All probes will be thoroughly rinsed with distilled water before any measurements.

Additional field instruments that will require calibration include combustible-gas indicator, noise dosimeter, ground penetrating radar, and electromagnetometer. The frequency and methods of calibration will be dependent on the recommendations from the manufacturers.

#### 7.1.4 Flow Rates for Wells During Aquifer Tests

Flowmeter calibration: The flowmeter will be factory calibrated and checked before any field event. Timed volumetric measurements will occur periodically during tests, as follows:

For water wells measured using a properly calibrated bucket, QC can be achieved by performing at least two measurements in immediate succession while pumping conditions are held constant to calculate the discharge rate. If variation between the replicate measurements is greater than 10 percent, additional measurements should be taken. The most representative measurement will be determined by the judgment of the field technician and recorded in the field notebook or on the appropriate field-data form.

In addition to replicate measurements, the data should be compared to previous measurements taken at the well site. If variations between measurements exceed 10 percent and cannot be accounted for by changes in pumping or ground water yield, the bucket should be recalibrated and the measurement repeated.

#### 7.1.5 Water Level Measurements During Aquifer and Slug Tests

Pressure Transducer: Calibrate and check the pressure transducer in accordance with factory recommendations before each aquifer or slug test. A Hermit Data Logger manufactured by In-Situ, Inc., or equivalent will be used. The transducer will be secure and mounted so that no movement will occur and the pressure transducer cable will be marked in such a way to determine if any movement of the transducer has occurred during the test. A conventional water level measurement, using a measuring tape or electrical sounder, will confirm that the pressure transducer and data logger are accurately placed and calibrated in the well.

Electric Sounder and/or Steel Tape: An electric sounder or steel tape may be used for water level measurements as described in Section 7.1.2.

## 7.2 Laboratory Instruments

The calibration of laboratory instruments will be in accordance with and at the frequency recommended by EPA guidelines and the laboratory QA manual (which will be provided by the contracted laboratory).



## 8.0 ANALYTICAL PROCEDURES

The chemical and physical analyses of soil, sediment, ground water (including decontamination water or rinseate and treated ground water), and product samples collected in the MEW Study Area will be performed at a California-certified analytical laboratory.

The different PRP groups in the MEW Study Area employ different analytical methods for the chemical and physical analysis of collected samples and the reporting of results. The analytical methods to be used by the different PRP groups for the analysis of their samples and reporting format(s) to be followed are discussed in the following sections.

### 8.1 Test Methods for Evaluating Solid Waste (SW-846)

The three PRP groups consisting of NASA, the Defendants in the Consent Decree, and the Respondents of the 106 Order follow the analytical methods described in "Test Methods for Evaluating Solid Waste, Volume 1C: Laboratory Manual, Physical/Chemical Methods," SW-846, third edition (EPA, 1986) and "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020 (EPA, 1983).

Analytical QA/QC for the laboratory will be based on the laboratory's specific QA/QC procedures and EPA's method manuals for determination of various chemical parameters. Method detection limits (MDL) will initially be used to verify the integrity of the stated detection limits and reporting limits. The laboratory will perform MDL analysis according to Title 40, Part 136 of the Code of Federal Regulations, Appendix B (40 CFR Appendix B) Definitions and Procedures for the Determination of Method Detection Limits, Revision 1.11, at least once a year. Additionally, the laboratory will define the analytical calibration range by using standards at concentrations that start at the reporting limit and go to the upper linear limits of the instrument. Furthermore, the

laboratory will verify daily the calibration of the instrument with an acceptance criteria of plus or minus 15 percent from true value. Calibrations that exceed the criteria will be reanalyzed before the performance of any analysis.

Because samples collected north of U.S. Highway 101 may contain petroleum hydrocarbons, the following steps will be performed

1. A review of existing data for the area north of U.S. Highway 101 will be performed. This review will reveal whether there is any existing petroleum contamination, and, if so, the areas and wells affected.
2. If samples collected north of U.S. Highway 101 are suspected to contain petroleum hydrocarbon contamination, these samples will be identified on the chain-of-custody form for analysis for total petroleum hydrocarbons (TPH) as diesel. Results from these analyses will guide subsequent analyses on whether to analyze for TPH diesel or TPH gasoline.
3. If petroleum contamination is detected, the laboratory may use two different types of gas chromatographs to identify and quantitate purgeable halocarbons and petroleum hydrocarbons. A GC-Hall electrolytic conductivity detector (GC-HECD) will be used to analyze for purgeable halocarbons, and a GC with a flame ionization detector will be used to analyze for petroleum hydrocarbons.

Selected soil and ground water samples will be analyzed for some or all of the VOCs, phenol, and metals as shown in Tables 1 and 2. EPA standard methods to be used for chemical analysis are given in these tables.

Standard SW-846 methods and QC procedures will be followed and analytical results reported in the laboratory's standard report format. All validation data will be held on file at the laboratory for EPA's review, if requested.

Soil samples will be analyzed individually and not composited without prior arrangement with EPA. If composited samples are required, the compositing procedures will be detailed in the individual work plan which requires it.

Field QC checks and laboratory QC checks, as provided in Section 10.0, will be employed to evaluate the performance of field procedures and laboratory analytical procedures. The QC checks introduce controlled samples into the sample analysis stream, and these samples are used to calculate the accuracy and precision of the chemical program.

## 8.2 Contract Laboratory Program (CLP) Method

When following the CLP method, the Routine Analytical Services procedures for the analysis and reporting of semivolatile organic compounds, organochlorine pesticides/PCBs, and metals in soil and in water samples will be used. The CLP Routine Analytical Services procedure will only be used for VOCs on soil samples. CLP Special Analytical Services procedures, as described in the U.S. EPA Region 9 SAS Methods Compendium (EPA, 1989c), will be used for the analysis of VOCs in water and for various inorganic and organic parameters in soil and water samples. Where an EPA method is not specified, other standard methods will be used. When other analytical methods not specified in this Unified QAPP are selected, an addendum will be submitted to EPA for approval before its use.

The analytical level for CLP work will be modified Level D. This level is similar to EPA Level 4 (EPA, 1987a). In addition to meeting Level D QC requirements, the selected laboratory must also be certified by the California Department of Health Services Toxic

Substances Control Division to perform hazardous waste testing. As part of the Level D program, the analytical laboratory must successfully perform the following:

- o Submit a QA plan,
- o Analyze a performance sample,
- o Undergo an audit,
- o Correct any deficiencies found during an audit,
- o Provide monthly progress reports on QA.

The selected laboratory will also exhibit experience with EPA CLP procedures and be able to generate CLP deliverables.

## 9.0 DATA REDUCTION, VALIDATION, AND REPORTING

The procedures presented in this section are peculiar to the analytical laboratory. Analyses of soil and ground water samples for performance of the Work will be completed by a California-certified analytical laboratory. This section presents the guidelines for data reduction, validation, and reporting. Laboratories performing analyses under this Unified QAPP will submit their procedures for data reduction, validation, and reporting as an addendum to the EPA for approval before incorporation into this plan.

### 9.1 Data Reduction

Data reduction is a description of the calculations performed to transform a measured parameter into a parameter in reported format or units. The exact equations used to calculate the analyte concentrations will vary for analytical laboratories, but the general equations used to reduce analytical data follow.

For Water:

$$C = \frac{M_a}{V_w}$$

Where:

C = Concentration of analyte

M<sub>A</sub> = Mass of analyte

V<sub>w</sub> = Volume of aliquot

For Soil:

$$C = \frac{M_a}{M_s}$$

Where:

C = Concentration of analyte

M<sub>A</sub> = Mass of analyte

M<sub>s</sub> = Mass of soil aliquot

The mass of the analyte detected can be expressed in mg or  $\mu$ g depending upon the units desired. The method of detecting the mass of analyte depends on the EPA method chosen.

## 9.2 Internal Data Validation

The routine validation of analytical data will be performed by the laboratory and the consultant. The individual QA Officer of the PRP's consultant will also perform random reviews of the work performed to verify documentation and reported results. The routine data validation process involves the evaluation and/or calculation of the precision, accuracy, and completeness of the chemical data. The specific routine procedures for assessing data precision, accuracy, and completeness are discussed in Section 13.0

The principal criteria that will be used by the laboratory or the PRP's consultant to validate data integrity on a routine basis follow:

1. Correct sampling procedures were followed.
2. Chain-of-custody was properly completed.

3. Samples are extracted and/or analyzed before the holding time limit specified by the EPA test method.
4. Calculations are performed correctly and units are reported correctly.
5. The results obtained are either within the working calibration range of the given instrument or the sample was diluted into the working calibration range.
6. The QC results meet acceptance criteria.

The PRP's consultant will examine "outlying data" for internal data validation. Outlying data for soil will be defined as sample concentrations that exceed or are less than the highest or lowest concentrations previously detected on the site by more than one order of magnitude. Similarly for water, outlying data will be defined as concentrations that differ from previous sample episodes by more than one order of magnitude. The data produced from the first sample from a new well will be analyzed qualitatively with respect to nearby wells to determine if results are reasonable. If outlying data are found, a rationale for the difference will be investigated. If no credible rationale can be found, additional samples may be obtained for analysis to confirm the apparently anomalous data.

### 9.3 Data Reporting Requirements

Analyses requested for a sample will be documented on the sample labels and the chain-of-custody form in addition to entry in the Field Logbook as outlined in Section 6.1.2. The transfer of custody from the field personnel to the laboratory custodian is outlined in Section 6.0.

After the sample has entered the laboratory system for analysis, data gathering from the analysis process is generally automated. Upon completion of the analysis, the data are reviewed and validated as described in Section 9.2. Upon validation, a final report is generated by computer and sent to the PRP. This report can be either in digital format on magnetic tape or disk or in hard copy.



## 10.0 INTERNAL QUALITY CONTROL CHECKS

Field QC checks and laboratory QC checks will be employed to evaluate the performance of the laboratory's analytical procedures for soil and water samples. The QC checks use the controlled samples introduced into the sample analysis stream to calculate the accuracy and precision of the chemical analysis program.

Soil sample transfer procedures are described in EPA's methods manuals for determination of various chemical parameters. The portion of the soil sample to be used for chemical analyses will be removed from the central section of the soil sample. Any required replicate portions of the soil sample will be taken immediately adjacent to the original portion of the same soil sample.

### 10.1 Soil Samples for Field Quality Control

Using currently accepted soil sampling procedures, there is no known accurate method to obtain or produce consistent blanks for soil samples in the field.

Duplicate soil samples, however, may be taken from adjacent brass or stainless steel liners retrieved within the same split-spoon sampler. Alternatively, a laboratory duplicate analysis may be requested for soil samples collected, as specified in individual work plans. If requested, this duplicate analysis will be performed by instructing laboratory personnel to remove two soil aliquots from adjacent portions of the sample for the same analysis. Because these requests are not blind to the laboratory, they will be requested on the chain-of-custody form as a separate analysis for the same sample. For example, to request a duplicate analysis for EPA Method 8010, the sampler would place 8010 in one analysis request column and 8010 DUP in another analysis request column and place an "x" next to the sample that the request applies to. The type of soil duplicate to be taken and frequency of analysis will be given in specific work plans.

### 10.1.1 Matrix Spike/Matrix Spike Duplicates

One MS/MSD will be requested for five percent of field samples collected and analyzed. To request these analyses, the sampler should write "Lab QC" in the comments section to instruct the laboratory to perform MS/MSD analyses. The MS/MSD will be performed using standard spike compounds for each method specified under SW-846 protocols. If a nonstandard spike suite is desired, this should be requested as a separate analysis in one of the analysis request columns on the chain-of-custody. The sampler will provide sufficient water if "Lab QC" is specified for the sample.

## 10.2 Water Samples for Field Quality Control

Field QC checks are accomplished by submission of controlled samples that are introduced blind to the laboratory from the field. Blank and duplicate samples will be used. QC samples will be noted in the field logbook and will be given a unique sample identification number that does not indicate to the laboratory the type of QC check. The two QC types are described in the following subsections.

### 10.2.1 Matrix Spike/Matrix Spike Duplicates

One MS/MSD will be requested for five percent of field samples collected and analyzed. To request these analyses, the sampler should write "Lab QC" in the comments section to instruct the laboratory to perform MS/MSD analyses. The MS/MSD will be performed using standard spike compounds for each method specified under SW-846 protocols. If a nonstandard spike suite is desired, this should be requested as a separate analysis in one of the analysis request columns on the chain-of-custody. The sampler will provide sufficient water if "Lab QC" is specified for the sample.

### 10.2.2 Blanks

One field blank will be submitted and analyzed for every 20 field water samples. Blanks will consist of organic-free water for organic analyses and of deionized water for inorganic analyses. The field sampling log will clearly indicate which samples are field blanks in the sample description. Providing adequate sample volume for analytical analysis will be the responsibility of field personnel. When uncertainty exists with respect to sample volume, field personnel are to contact the Laboratory Project Administrator. One travel (trip) blank will be submitted per each shipping container for VOC analysis.

### 10.2.3 Duplicates

Field duplicate water samples will be submitted to the laboratory performing the analyses. One duplicate water sample will be collected and submitted to the laboratory for every 20 field samples. Other QC samples will be used at the project management's discretion.

## 10.3 Laboratory Quality Control Checks

As indicated in Section 9.0, different but equivalent laboratory protocols may be submitted as an addendum to this Unified QAPP. The contracted laboratory will submit specific laboratory protocols as an addendum to EPA for approval before incorporation into this plan. Analyses performed in accordance with SW-846 (EPA, 1986) protocols will follow the procedures delineated in Chapter One of Volume 1B for documentation remaining at the laboratory.

The following laboratory QC procedures will be followed and documented:

1. The initial or working calibration curve is verified each day by at least one or more calibration standards, typically with a mid-scale standard. The RPD for each analyte is calculated between the initial calibration factor (CF) and the continuing CF; deviations greater than 15 percent for organic analyses or 10 percent for metal analyses prompt a new calibration to be performed for the analyte failing the criteria. Samples that have positive results for analytes that have not met the calibration criteria on an instrument are then analyzed on an instrument where calibration criteria are met.
2. One internal laboratory blank will be analyzed for every 20 samples analyzed (i.e., 0 to 19 samples analyzed = No QC samples analyzed, 20 to 39 samples = 1 QC sample analyzed, etc.)
3. One MS/MSD will be analyzed for every 20 samples analyzed (i.e., 0 to 19 samples analyzed = No QC samples analyzed, 20 to 39 samples = 1 QC sample analyzed, etc.)
4. One Laboratory Control Standard will be analyzed for every 20 samples analyzed (i.e., 0 to 19 samples analyzed = No QC samples analyzed, 20 to 39 samples = 1 QC sample analyzed, etc.)
5. A surrogate compound is routinely used for all analyses performed.

Each laboratory has internal QA/QC procedures that are followed during routine operations. Laboratories performing analyses under this Unified QAPP will submit their laboratory QA/QC Manual to EPA for approval as an addendum before incorporation in this plan.

#### 10.4 Field Quality Control Checks

Field QC will be maintained by proper calibration procedures. The procedures for each field instrument are given in Section 7.0.

## 11.0 PERFORMANCE AND SYSTEM AUDITS

During the course of performance of the remedial work, both system and performance audits of the field and analytical QC programs will be performed. System audits involve inspection of equipment for sampling, data gathering, and soil or water treatment to evaluate for effectiveness of the methods and technologies employed. A system audit is performed early in the initial stages of a field activity. Performance audits involve the inspection of field and laboratory activities to verify that the standardized procedures established herein are executed to provide for accurate data generation and conformance to specifications. QA staff will be designated to perform audits for the work by the firm selected to perform the QA for the work. Facility-specific audits may conform to the following procedures or be submitted in an addendum to this Unified QAPP. Any QA variances and/or problems that would necessitate resampling of a well or wells, delay the delivery of a submittal, or delay the completion or implementation of a required task will be promptly reported to EPA.

### 11.1 Field Activities

To assure implementation of the procedures and standards established in this Unified QAPP, the QA staff will perform audits of the project field work. Audits will include, but not be limited to, inspection of field operations and records, laboratory testing and chain-of-custody records, and maintenance of field activity project files.

Before beginning work on a project, an audit plan consistent with the project scope of work, schedule, and requirements will be outlined by the QA staff. As necessary, the audit schedule and scope will be adjusted to reflect changes in the project. The audits appropriate for a project will be based upon the types discussed here.

A field activities audit will involve an on-site visit by a member of the QA staff. The scheduling of field audits will depend upon the PRPs notifying the QA Officer staff that a field operation is to commence. The QA Officer should be notified before beginning work in order to schedule a system audit in the early stages of field work so that the resolution of corrective action will not adversely affect the project schedule nor impact a significant portion of the field work. The field audit schedule will be dependent upon the extent of the field activities.

Field audits may include the following:

1. Confirm that proper calibration of testing equipment is performed and recorded on field activity forms.
2. Verify collection of field measurements and proper record keeping.
3. Verify sample collection, shipping, and chain-of-custody procedures. This will include inspection of decontamination of sample collection equipment.
4. Verify internal QA/QC programs of analytical and physical testing laboratories. This may include collecting split samples or submitting blind samples for chemical analysis.
5. Periodically inspect field tasks such as surveying, drilling, aquifer testing, and water or air extraction well installation.
6. Verify record maintenance for measurements and quantities where appropriate.

During the course of field activities of extended duration, performance audits will be conducted by the QA staff at a regular frequency, and at least every three months

depending upon the project activity. This frequency may be adjusted by the manager of the QA staff, as appropriate. The performance audits are to assure that the work is progressing in a controlled manner, satisfies data quality requirements, and satisfies all quality requirements as specified in this Unified QAPP. Additionally, as part of the performance review, the QA staff may audit material that is maintained in the MEW data management files.

Corrective action resulting from an audit will be requested through the QA staff. Compliance to requests for corrective action will be made through memorandum from the group (e.g., field crew) making the request to the QA staff, with possible re-auditing as stipulated in the audit report. Note that requests for corrective action must be resolved to the QA staff's satisfaction.

The method for verification of corrective action and the time period for completion will be stipulated in the QA staff's audit report. Completion of corrective action will be verified by the QA staff and documented as a QA record. After verification of corrective action is complete, the QA staff will issue a statement closing the audit.

The responsible member of the QA staff will prepare a letter report to notify the QA Officer and Project Manager of audit findings. The letter report will be prepared as soon as possible after the audit and contain the findings of the audit. As part of the audit report, the items requiring corrective action will be presented with a reasonable period of time established for correction and the means for correction discussed. The QA staff will be informed in writing by the QA Officer of corrective actions completed within the stipulated time period and will re-audit, if required, to assure compliance. Audit reports will be submitted as specified in Section 15 and will be maintained in the QA staff project file.



### 11.2 Laboratory Activities

Each laboratory will have its own system of routine performance and system audits. The contracted analytical laboratories will submit internal audit procedures to EPA for approval as an addendum to this QAPP. PRPs will perform a laboratory performance audit at least annually.

## 12.0 PREVENTIVE MAINTENANCE

All equipment will receive routine maintenance checks to minimize equipment breakdowns in the field. Any items found to be inoperable will be taken out of service. A description of the maintenance work completed and when it was performed will be noted in the instrument calibration/maintenance log. All laboratory equipment will be routinely maintained as specified by the standard operating procedures for analysis of the contracted laboratory.

A schedule of field equipment maintenance is shown in Table 9.

### 13.0 SPECIFIC ROUTINE PROCEDURES FOR ASSESSING DATA PRECISION, ACCURACY, AND COMPLETENESS

This section summarizes the QA/QC procedures for assessing the validity of the chemical data generated during the performance of remedial work at the MEW Study Area. These procedures are to be followed by the laboratory and the PRPs' consultant in the routine data validation process. The results of the QA/QC analysis will be presented in the project reports submitted to EPA.

#### 13.1 Data Quality Assurance Procedures

Chemical data generated during the performance of remedial work at the MEW Study Area will be validated for accuracy, precision, and completeness (see Section 4.0 for definitions) for the field sample collection program. The primary goal of the data validation procedures is to ensure that the data reported are representative of conditions in the study area. Both statistical and qualitative evaluations are used in the data validation process. If the data are found to deviate significantly from previous analyses or surrounding conditions, the data will be invalidated, but will not be eliminated from the database.

The qualitative criteria for evaluating the representativeness of individual data points may consist of the following:

1. Comparison with historical data;
2. Comparison with regional data trends;
3. Evaluation of the possible influence of facility activities on data;

4. Confirmation of analyses from the analytical laboratory;
5. Review of sampling procedures;
6. Review of other data collected on the same date.

If the procedures given above do not provide definitive results for ground water or soil samples, resampling may be performed, if appropriate.

The QA/QC program will evaluate chemical data using the three types of controlled samples listed in Section 10.0 (spikes, blanks, duplicates). The definitions of these types of samples are as follows:

1. Spikes: Matrix spike analyses are intended to evaluate both accuracy and precision. Sample performance will be assessed by means of percent recovery for accuracy and matrix spike duplicate for precision. Percent recoveries and RPDs will be assessed against historically derived data control limits as shown in Tables 3 and 4.
2. Blanks: Blanks are intended to evaluate whether the laboratory or field procedures represent a possible source of contamination of the field samples. There are three types of blanks that will be analyzed during sampling activities:
  - o Travel blanks are QA/QC samples prepared by the laboratory that are transferred with the field samples and are submitted from the field to the laboratory for appropriate chemical analyses.

- o Field blanks are QA/QC samples prepared in the field by filling sample containers with organic-free or distilled water and are submitted to the laboratory for appropriate chemical analyses.
  - o Internal laboratory blanks are QA/QC samples prepared and analyzed internally as part of the individual's laboratory's QA programs.
3. Duplicates: Duplicate samples are intended to evaluate data precision. Two types of duplicate samples will be analyzed during the sampling activities:
- o Field duplicates are QA/QC samples collected in series from the same location using the same sampling method. Both samples are submitted to the laboratory for appropriate chemical analyses. Field duplicates will be collected for water samples as discussed in Section 10.0. Duplicates for soil samples will be taken as specified in the specific individual work plans.
  - o Laboratory duplicates are QA/QC samples from which duplicate aliquots are prepared in the laboratory.

The completeness of the data consists of an estimate of the amount of data expected from the field programs versus the amount of data actually entered into the database that is available for interpretation. Invalidated data will not be eliminated from the database, but valid data must constitute 90 percent of the total data collected.

The statistical and qualitative methods for evaluating the field QA/QC data for QA/QC blank, spike, and duplicate samples follow.

### 13.1.1 Blanks

The results of blank sample analyses will be qualitatively reviewed. The procedure for evaluating blank samples is as follows:

1. Identify any travel or field blank samples in which chemicals have been detected.
2. Prepare a separate summary table of travel and field blank samples in which chemicals were detected. The chemicals will be identified and the levels at which they were detected.
3. If chemicals are detected in blank samples, the project QA Officer will notify the laboratory and will review other recent results from blank samples from that laboratory to determine whether it is an isolated incident. Field samples associated with the travel or field blanks in which compound(s) were found will be reviewed, evaluated, and noted. However, the sample data will not be adjusted on the basis of results of the analyses of the blank samples.

### 13.2 Accuracy

MS/MSD samples will be evaluated as follows:

1. Tabulate spike sample data and calculate the percent recovery as shown below for each spiked compound.

$$\text{Percent recovery} = \frac{(T - X)}{A} \times 100$$

Where:

T = Total concentration of compound found in spiked sample

X = Original concentration of compound in sample before spiking

A = Actual spike concentration of compound added to sample

2. Qualitatively evaluate the significance of data points that fall outside of control limits. The lower control limit (LCL) and upper control limit (UCL) for the spiked compounds are presented as accuracy goals in Tables 3 and 4.

If the UCL and/or LCL is exceeded, the laboratory will be notified, the data from that period of time will be evaluated and noted for the compound that exceeds the limits, and corrective action will be taken, as appropriate.

### 13.3 Precision

#### 13.3.1 Field Precision

Duplicate samples will be assessed for precision as follows:

1. Calculate the RPD as shown below for each compound of each duplicate pair:

$$RPD = \frac{(X_1 - X_2)}{X} \times 100$$

Where:

$X_1$  = Concentration of compound for Sample 1 of duplicate

$X_2$  = Concentration of compound for Sample 2 of duplicate

X = Average of Samples 1 and 2

2. Calculate the average for the RPDs for all duplicate pairs.
3. Calculate the standard deviation(s) for the RPDs. The standard deviation represents the precision of the data set.
4. Calculate the upper warning limit (UWL) and the lower warning limit (LWL) using the following formulas:

$$\text{UWL} = 2(s), \text{LWL} = -2(s)$$

Where s is the calculated standard deviation.

5. Next, calculate the UCL and the LCL using the following formulas:

$$\text{UCL} = 3(s), \text{LCL} = -3(s)$$

6. The UCL and LCL will be used as data evaluation criteria for field data.

### 13.3.2 Laboratory Precision

MS/MSD samples will be assessed for precision by calculating the RPDs for all MS/MSD sample spike analytes and comparing these values against the precision goals listed in Tables 3 and 4. If these data do not meet these precision goals, these data will be evaluated and corrective action will be taken as outlined in Section 14.0. If the contracted laboratory establishes precision goals specific to its operations different from what has been specified in this Unified QAPP, an addendum will have to be submitted to EPA for approval before incorporation in this plan. If RPD values for MS/MSD analyses repeatedly fall outside of the established precision goals, further evaluation of laboratory QA/QC data will be performed. If the evaluation indicates that RPD values are falling outside of the precision goals as a result of matrix interference associated



with site-specific conditions, a written request will be made to EPA for the adjustment of these goals on the basis of these data.

## 14.0 CORRECTIVE ACTIONS

Corrective action measures will be promptly implemented to minimize, if not eliminate, noncompliance with the procedures, guidelines, and inspection protocols set forth in this Unified QAPP. The degree of noncompliance will warrant the type of corrective action to be used to correct the error. Noncompliance may either be field or laboratory related and observed during the performance of an activity or an audit. The following sections describe the problems that may be encountered in both the field and laboratory and the appropriate corrective actions.

### 14.1 Field Activities

Field noncompliance that would warrant corrective action may include the following:

1. Incorrect use of the field equipment;
2. Field equipment malfunction;
3. Improper sample collection, preservation, or shipping;
4. Inadequate or improper documentation (e.g., field and calibration logs, manifests, chain-of-custody forms);
5. Failure of the field or performance audit (as discussed in Section 11.1).

Corrective actions implemented in the field during the course of the activity will be recorded in the field logbook. However, the corrective action resulting from an audit will be requested through the QA staff.

Requests for corrective action will be made by a memorandum to the QA staff from an auditor or any individual who suspects that any aspect of data integrity is being compromised through noncompliance. Each memorandum will be limited to a single problem to avoid confusion. The memorandum will be distributed to the respective Project Manager, Field Supervisor, QA Officer, and the project file. A meeting of the Project Manager, Field Supervisor, QA Officer, and the author of the memorandum will then be held to address and propose corrective actions to resolve the issue at hand.

The meeting will address the following aspects of the problem:

1. Define the problem (including when and how the problem developed).
2. Determine if additional investigation of the problem is necessary.
3. Determine the corrective action to be implemented.
4. Determine a schedule to implement the corrective action.
5. Determine responsibility for implementation of the corrective action.
6. Verify completion of the corrective action and the elimination of the problem.

Once the corrective action is complete, the QA staff will verify that the problem has been adequately and permanently corrected. The corrective action process will be documented as a QA record. After verifying that the corrective action is complete, the QA staff will issue a statement that the problem described in the original memorandum requesting corrective action has been resolved and corrected.

#### 14.2 Laboratory Activities

The method of assessing data acceptability will be to compare duplicate RPD data against the UCL and LCL as calculated in Section 13.3.1. The method for assessing the MS/MSD accuracy data is outlined in Section 13.2 while the method for assessing MS/MSD precision data is in Section 13.3.2. The acceptance goals are listed in Table 3 for water and in Table 4 for soil. If the MS/MSD data does not meet these established goals, an evaluation will be made for an explanation as outlined in Section 13.3.2.

Laboratory noncompliance that would warrant corrective action may include:

1. Data that fall outside the established acceptance criteria;
2. Incorrect calculation of accuracy, precision, or completeness of the chemical data;
3. Data that exceed the UCL or LCL;
4. Data that were obtained outside the working calibration range of the given instrument or from samples diluted to concentrations outside of the calibration range;
5. Samples that were extracted and/or analyzed after the holding time specified by the EPA test method.

The corrective action procedures for dealing with laboratory noncompliance are contained in the Laboratory QA Plan.

The project QA officer will be notified of laboratory noncompliance by either the Laboratory Project Manager or the Laboratory QC Coordinator within two days of

identifying a problem. The notification will include the following (if applicable at the time of notification):

1. Nature and cause of the problem;
2. Corrective action being implemented;
3. Status of the corrective action;
4. Schedule of implementation of the corrective action;
5. Verification of the completion of the corrective action.

In addition, a corrective action report will be provided to the Project Manager and the Project QC Officer after verification that the problem has been corrected.

## 15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The results of the QA/QC audits and assessments will be reported in the Work Progress Reports at least quarterly. The report will include summaries of the following:

1. Status of the project;
2. Results of performance audits (if conducted);
3. Results of system audits;
4. Results of periodic data quality assessments;
5. Significant QA problems encountered;
6. Corrective actions implemented.

A final project report will be produced for each field investigation and will include appendices that contain data quality information summaries. Data quality information includes:

1. Results of performance audits;
2. Results of system audits;
3. Significant QA problems encountered;
4. Corrective actions implemented;

5. Data quality summary and evaluation.

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U.S. Environmental Protection Agency, 1990a, Laboratory Documentation Requirements for Data Validation, EPA/9QA-07-90, January.

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TABLE A-1

DESIRED DETECTION LIMITS  
FOR WATER SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/l}</math>)</u>
Aroclor-1254	CLP	1.0
Aroclor-1260	CLP	1.0
Azinphos methyl	Method 8140	10.0
Bolstar	Method 8140	10.0
Chlorpyrifos	Method 8140	10.0
Coumaphos	Method 8140	10.0
Demeton-O	Method 8140	10.0
Demeton-S	Method 8140	10.0
Diazinon	Method 8140	10.0
Dichlorvos	Method 8140	10.0
Disulfoton	Method 8140	10.0
Ethoprop	Method 8140	10.0
Fensulfothion	Method 8140	10.0
Fenthion	Method 8140	10.0
Merphos	Method 8140	10.0
Mevinphos	Method 8140	10.0
Naled	Method 8140	10.0
Parathion methyl	Method 8140	10.0
Phorate	Method 8140	10.0
Ronnel	Method 8140	10.0
Stirophos (tetrachlorvinphos)	Method 8140	10.0
Tokuthion (Prothiofos)	Method 8140	10.0
Trichloronate	Method 8140	10.0
Dalapon	Method 8150	1.0
Dicamba	Method 8150	1.0
2,4-DP (Dichloroprop)	Method 8150	1.0
2,4-D	Method 8150	1.0
MCPP	Method 8150	1.0
MCPA	Method 8150	1.0
2,4,5-TP (silvex)	Method 8150	1.0
2,4,5-T	Method 8150	1.0
2,4-DB	Method 8150	1.0
Dinoseb	Method 8150	1.0
Aluminum	CLP	200

DESIRED DETECTION LIMITS  
FOR WATER SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/l}</math>)</u>
Antimony	CLP	60
Arsenic	CLP	10
Barium	CLP	200
Beryllium	CLP	5
Cadmium	CLP	5
Calcium	CLP	5,000
Chromium	CLP	10
Cobalt	CLP	50
Copper	CLP	25
Iron	CLP	100
Lead	CLP	3
Magnesium	CLP	5,000
Manganese	CLP	15
Mercury	CLP	0.2
Nickel	CLP	40
Potassium	CLP	5,000
Selenium	CLP	5
Silver	CLP	10
Sodium	CLP	5,000
Thallium	CLP	10
Vanadium	CLP	50
Zinc	CLP	20

TABLE A-2  
DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
Chloromethane	CLP	10
Bromomethane	CLP	10
Vinyl Chloride	CLP	10
Chloroethane	CLP	10
Methylene Chloride	CLP	5
Acetone	CLP	10
Carbon Disulfide	CLP	5
1,1-Dichloroethene	CLP	5
1,1-Dichloroethane	CLP	5
1,2-Dichloroethene	CLP	5
Chloroform	CLP	5
1,2-Dichloroethane	CLP	5
2-Butanone	CLP	10
1,1,1-Trichloroethane	CLP	5
Carbon Tetrachloride	CLP	5
Vinyl Acetate	CLP	10
Bromodichloromethane	CLP	5
1,2-Dichloropropane	CLP	5
cis-1,3-Dichloropropene	CLP	5
Trichloroethene	CLP	5
Dibromochloromethane	CLP	5
1,1,2-Trichloroethane	CLP	5
Benzene	CLP	5
trans-1,3-Dichloropropene	CLP	5
Bromoform	CLP	5
4-Methyl-2-pentanone	CLP	10
2-Hexanone	CLP	10
Tetrachloroethene	CLP	5
Toluene	CLP	5
1,1,2,2-Tetrachloroethane	CLP	5
Chlorobenzene	CLP	5
Ethylbenzene	CLP	5
Styrene	CLP	5
Total Xylenes	CLP	5
1,1-Dichloroethane	METHOD 5030/8010	0

TABLE A-2

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g}/\text{kg}</math>)</u>
1,1-Dichloroethene	METHOD 5030/8010	1.0
1,1,1-Trichloroethane	METHOD 5030/8010	1.0
1,1,2-Trichloroethane	METHOD 5030/8010	1.0
1,1,2,2-Tetrachloroethane	METHOD 5030/8010	1.0
1,2-Dichlorobenzene	METHOD 5030/8010	1.0
1,2-Dichloroethane	METHOD 5030/8010	1.0
1,2-Dichloropropane	METHOD 5030/8010	1.0
1,3-Dichlorobenzene	METHOD 5030/8010	1.0
1,4-Dichlorobenzene	METHOD 5030/8010	1.0
2-Chloroethylvinyl ether	METHOD 5030/8010	1.0
Bromodichloromethane	METHOD 5030/8010	1.0
Bromoform	METHOD 5030/8010	1.0
Bromomethane	METHOD 5030/8010	1.0
Carbon Tetrachloride	METHOD 5030/8010	1.0
Chlorobenzene	METHOD 5030/8010	1.0
Chloroethane	METHOD 5030/8010	1.0
Chloroform	METHOD 5030/8010	1.0
Chloromethane	METHOD 5030/8010	1.0
cis-1,3-Dichloropropene	METHOD 5030/8010	1.0
Dibromochloromethane	METHOD 5030/8010	1.0
Dichlorodifluoromethane	METHOD 5030/8010	1.0
Methylene Chloride	METHOD 5030/8010	1.0
Tetrachloroethene	METHOD 5030/8010	1.0
trans-1,2-Dichloroethene	METHOD 5030/8010	1.0
trans-1,3-Dichloropropene	METHOD 5030/8010	1.0
Trichloroethene	METHOD 5030/8010	1.0
Trichlorofluoromethane	METHOD 5030/8010	1.0
Vinyl Chloride	METHOD 5030/8010	1.0
Benzene	METHOD 5030/8020	1.0
Chlorobenzene	METHOD 5030/8020	1.0
1,4-Dichlorobenzene	METHOD 5030/8020	1.0
1,3-Dichlorobenzene	METHOD 5030/8020	1.0
1,2-Dichlorobenzene	METHOD 5030/8020	1.0
Ethylbenzene	METHOD 5030/8020	1.0

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
Toluene	METHOD 5030/8020	1.0
Total Xylenes	METHOD 5030/8020	1.0
Tetrachloro-dibenzo-p-dioxins (TCDD)	METHOD 8280	0.1-0.5
Pentachloro-dibenzo-p-dioxins (PeCDD)	METHOD 8280	0.1-0.5
Hexachloro-dibenzo-p-dioxins (HxCDD)	METHOD 8280	0.5-1.0
Heptachloro-dibenzo-p-dioxins (HpCDD)	METHOD 8280	1.0-5.0
Octachloro-dibenzo-p-dioxins (OCDD)	METHOD 8280	1.0-5.0
Tetrachloro-dibenzo-furans (TCDF)	METHOD 8280	0.1-0.5
Pentachloro-dibenzo-furans (PeCDF)	METHOD 8280	0.1-0.5
Hexachloro-dibenzo-furans (HxCDF)	METHOD 8280	0.5-1.0
Heptachloro-dibenzo-furans (HpCDF)	METHOD 8280	1.0-5.0
Octachloro-dibenzo-furans (OCDF)	METHOD 8280	1.0-5.0
Phenol	CLP	330
bis(2-Chloroethyl) Ether	CLP	330
2-Chlorophenol	CLP	330
1,3-Dichlorobenzene	CLP	330
1,4-Dichlorobenzene	CLP	330
Benzyl Alcohol	CLP	330
1,2-Dichlorobenzene	CLP	330
2-Methylphenol	CLP	330
bis(2-Chloroisopropyl) Ether	CLP	330
4-Methylphenol	CLP	330
N-Nitroso-di-n-propylamine	CLP	330
Hexachloroethane	CLP	330
Nitrobenzene	CLP	330
Isophorone	CLP	330
2-Nitrophenol	CLP	330
2,4-Dimethylphenol	CLP	330
Benzoic Acid	CLP	1600
bis(2-Chloroethoxy)methane	CLP	330
2,4-Dichlorophenol	CLP	330
Naphthalene	CLP	330
4-Chloroaniline	CLP	330
Hexachlorobutadiene	CLP	330

TABLE A-2

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
4-Chloro-3-methylphenol (para-Chloro-meta-cresol)	CLP	330
2-Methylnaphthalene	CLP	330
Hexachlorocyclopentadiene	CLP	330
2,4,6-Trichlorophenol	CLP	330
2,4,5-Trichlorophenol	CLP	1600
2-Chloronaphthalene	CLP	330
2-Nitroaniline	CLP	1600
Dimethylphthalate	CLP	330
Acenaphthylene	CLP	330
2,6-Dinitrotoluene	CLP	330
3-Nitroaniline	CLP	1600
Acenaphthene	CLP	330
2,4-Dinitrophenol	CLP	1600
4-Nitrophenol	CLP	1600
Dibenzofuran	CLP	330
2,4-Dinitrotoluene	CLP	330
Diethylphthalate	CLP	330
4-Chlorophenyl-phenyl Ether	CLP	330
Fluorene	CLP	330
4-Nitroaniline	CLP	1600
4,6-Dinitro-2-methylphenol	CLP	1600
N-Nitrosodiphenylamine	CLP	330
4-Bromophenyl-phenylether	CLP	330
Hexachlorobenzene	CLP	330
Pentachlorophenol	CLP	1600
Phenanthrene	CLP	330
Anthracene	CLP	330
Di-n-butylphthalate	CLP	330
Fluoranthene	CLP	330
Pyrene	CLP	330
Butylbenzylphthalate	CLP	330
3,3'-Dichlorobenzidine	CLP	660
Benzo(a)anthracene	CLP	330



TABLE A-2

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
Chrysene	CLP	330
bis(2-Ethylhexyl)phthalate	CLP	330
Di-n-octylphthalate	CLP	330
Benzo(b)fluoranthene	CLP	330
Benzo(k)fluoranthene	CLP	330
Benzo(a)pyrene	CLP	330
Indeno(1,2,3-cd)pyrene	CLP	330
Dibenz(a,h)anthracene	CLP	330
Benzo(g,h,i)perylene	CLP	330
alpha-BHC	CLP	8.0
beta-BHC	CLP	8.0
delta-BHC	CLP	8.0
gamma-BHC (Lindane)	CLP	8.0
Heptachlor	CLP	8.0
Aldrin	CLP	8.0
Heptachlor epoxide	CLP	8.0
Endosulfan II	CLP	8.0
Dieldrin	CLP	16.0
4,4'-DDE	CLP	16.0
Endrin	CLP	16.0
EndosulfanII	CLP	16.0
4,4'-DDD	CLP	16.0
Endosulfan sulfate	CLP	16.0
4,4'-DDT	CLP	16.0
Methoxychlor	CLP	80.0
Endrin Ketone	CLP	16.0
alpha-Chlordane	CLP	80.0
gamma-Chlordane	CLP	80.0
Toxaphene	CLP	160.0
Aroclor-1016	CLP	80.0
Aroclor-1221	CLP	80.0
Aroclor-1232	CLP	80.0
Aroclor-1242	CLP	80.0
Aroclor-1248	CLP	80.0

TABLE A-2

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
Aroclor-1254	CLP	160
Aroclor-1260	CLP	160
Azinphos methyl	Method 8140	100
Bolstar	Method 8140	100
Chlorpyrifos	Method 8140	100
Coumaphos	Method 8140	100
Demeton-O	Method 8140	100
Demeton-S	Method 8140	100
Diazinon	Method 8140	100
Dichlorvos	Method 8140	100
Disulfoton	Method 8140	100
Ethoprop	Method 8140	100
Fensulfothion	Method 8140	100
Fenthion	Method 8140	100
Merphos	Method 8140	100
Mevinphos	Method 8140	100
Naled	Method 8140	100
Parathion methyl	Method 8140	100
Phorate	Method 8140	100
Ronnel	Method 8140	100
Stirophos (tetrachlorvinphos)	Method 8140	100
Tokuthion (Prothiofos)	Method 8140	100
Trichloronate	Method 8140	100
Dalapon	Method 8150	10
Dicamba	Method 8150	10
2,4-DP (Dichloroprop)	Method 8150	10
2,4-D	Method 8150	10
MCPP	Method 8150	10
MCPA	Method 8150	10
2,4,5-TP (silvex)	Method 8150	10
2,4,5-T	Method 8150	10
2,4-DB	Method 8150	10
Dinoseb	Method 8150	10
Aluminum	CLP	200

TABLE A-2

DESIRED DETECTION LIMITS  
FOR SOIL SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/kg}</math>)</u>
Antimony	CLP	60
Arsenic	CLP	10
Barium	CLP	200
Beryllium	CLP	5
Cadmium	CLP	5
Calcium	CLP	5,000
Chromium	CLP	10
Cobalt	CLP	50
Copper	CLP	25
Iron	CLP	100
Lead	CLP	3
Magnesium	CLP	5,000
Manganese	CLP	15
Mercury	CLP	0.2
Nickel	CLP	40
Potassium	CLP	5,000
Selenium	CLP	5
Silver	CLP	10
Sodium	CLP	5,000
Thallium	CLP	10
Vanadium	CLP	50
Zinc	CLP	20

TABLE 1  
MAXIMUM DETECTION LIMITS  
FOR WATER SAMPLES

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Maximum Detection Limit<sup>a</sup> (µg/l)</u>
VOCs	Method 601 or 8010	2.0
VOCs	Method 602 or 8020	4.0
VOCs	Method 624 or 8240	10
VOCs	Method 625 or 8270	50
Phenol	Method 604 or 8040	20
Metals	200 Series	100
Metals	300 Series	5000
PCBs	Method 608	1.0
PAHs	Method 610	2.5
OPPs	Method 614 or 622	5.0
Herbicides	Method 509B	10
Carbamates	Method 632	0.5
TPH-D	Cal LUFT	50

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Sources: EPA, 1983, Chemical Analysis for Water and Wastewater; EPA, 1986, Test Methods for Evaluating Solid Waste.

<sup>a</sup>Check methods for values of specific species.

TABLE 2  
MAXIMUM DETECTION LIMITS  
FOR SOIL SAMPLES

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Maximum Detection Limit<sup>a</sup> (µg/kg)</u>
VOCs	Method 601 <sup>b</sup> or 8010	20
VOCs	Method 602 <sup>b</sup> or 8020	40
VOCs	Method 624 <sup>b</sup> or 8240	1000
VOCs	Method 625 <sup>b</sup> or 8270	5000
Phenol	Method 604 <sup>b</sup> or 8040	200
Metals	Section 66700	600
Metals	7000 Series	1000
Metals	9000 Series	10000
Metals	300 Series	100000
PCBs	Method 8080	10
PAHs	Method 8100	20
OPPs	Method 8140	20
Herbicides	Method 8150	1000
TPH-D	Cal LUFT	1000

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Sources: EPA, 1983, Chemical Analysis for Water and Wastewater; EPA, 1986, Test Methods for Evaluating Solid Waste.

<sup>a</sup>Check methods for values of specific species.

<sup>b</sup>600-series analytical methods were routinely modified and used to analyze soil samples in the early 1980's. Such analyses are deemed acceptable under this QA/QC plan.

TABLE 3

QA/QC GOALS FOR LABORATORY  
MATRIX SPIKE/MATRIX SPIKE DUPLICATE FOR WATER SAMPLES

<u>Analyte</u>	<u>EPA Test Method</u>	<u>Accuracy Goal (% Recovery)</u>	<u>Precision Goal RPD (%)</u>	<u>Completeness Goal (%)</u>
VOCs	Method 601 or 8010	40-150	100	90
VOCs	Method 602	40-150	100	90
VOCs	Method 624	50-150	100	90
VOCs	Method 625	10-150	100	90
Phenol	Method 604 or 8040	12-110	42	90
Metals	200 Series	50-150	100	90
Metals	300 Series	85-115	15	90
PCBs	Method 608	85-115	10	90
PAHs	Method 610	80-120	15	90
OPPs	Method 614 or 622	50-120	20	90
Herbicides	Method 509B	60-110	15	90
Carbamates	Method 632	40-110	15	90
TPH-D	Cal LUFT	24- 93	46	90

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Note: RPD denotes relative percent difference.

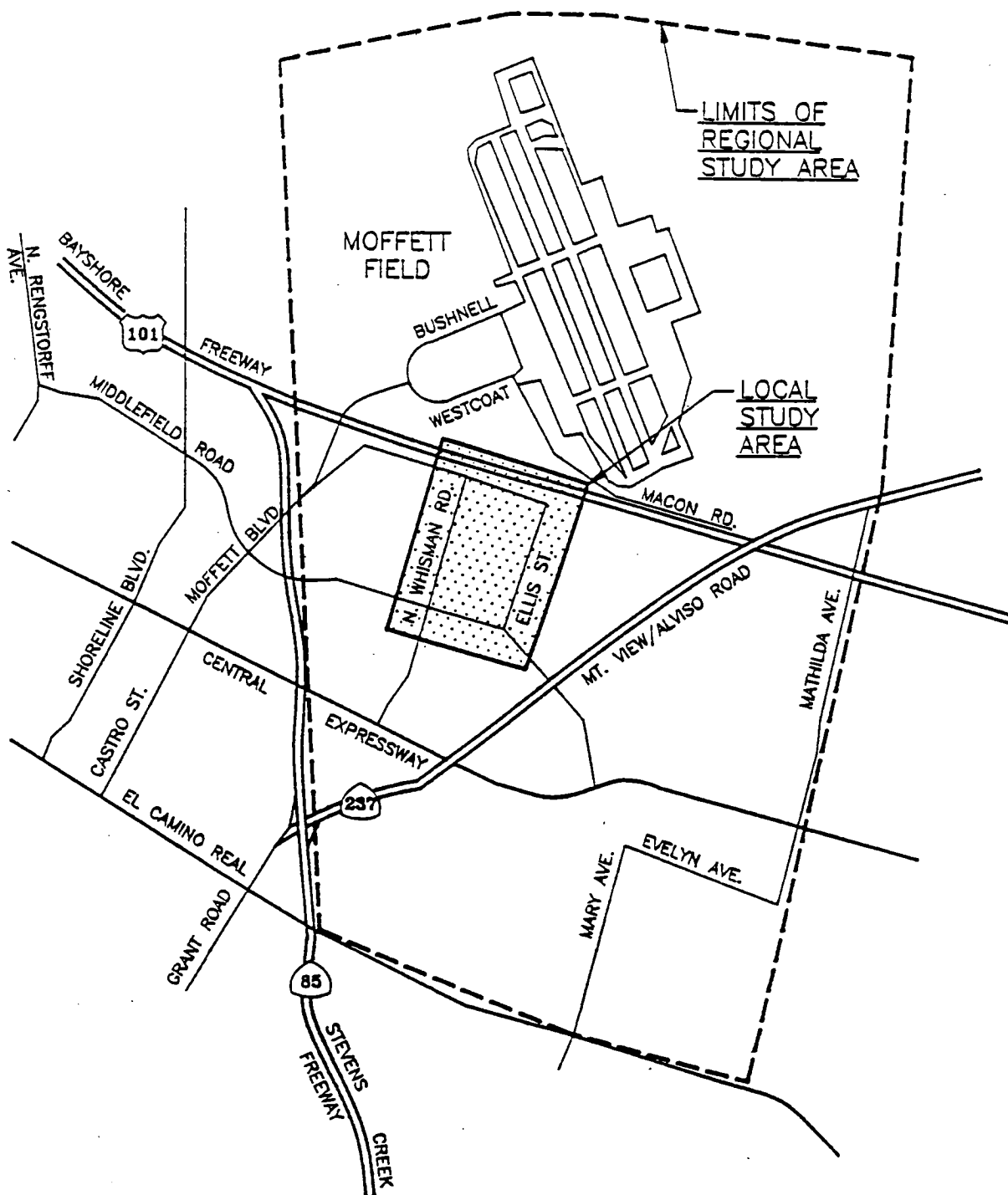
TABLE 4

QA/QC GOALS FOR LABORATORY  
MATRIX SPIKE/MATRIX SPIKE DUPLICATE FOR SOIL SAMPLES

<u>Analyte</u>	<u>EPA Test Method</u>	<u>Accuracy Goal (% Recovery)</u>	<u>Precision Goal RPD (%)</u>	<u>Completeness Goal (%)</u>
VOCs	Method 8010	30-140	50	90
VOCs	Method 8020	30-110	50	90
VOCs	Method 8240	60-140	20	90
VOCs	Method 8270	30-140	50	90
Phenol	Method 8040	26-140	40	90
Metals	Section 66700	72-125	35	90
Metals	7000 Series	75-125	35	90
Metals	9000 Series	80-120	15	90
Metals	300 Series	80-120	20	90
PCBs	Method 8080	25-140	25	90
PAHs	Method 8100	50-120	25	90
OPPs	Method 8140	50-120	25	90
Herbicides	Method 8150	50-110	20	90
TPH-D	California LUFT	48-105	26	90

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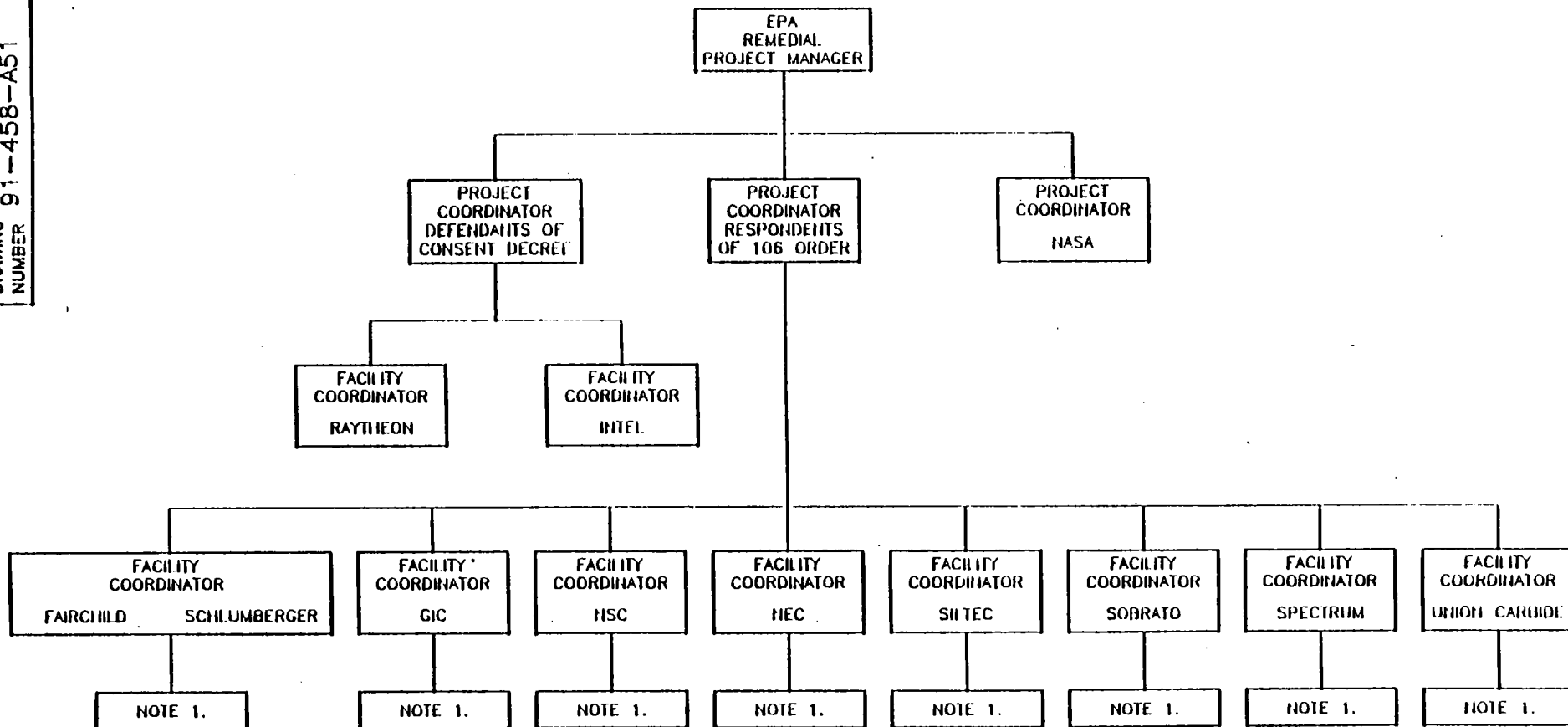
Note: RPD denotes relative percent difference.



# Canonie Environmental

No.	DATE	ISSUE / REVISION	OWN. BY	CK'D BY	DATE: 12-11-91	FIGURE 1	DRAWING NUMBER 91-458-A53
					SCALE: N.T.S.		





**NOTES:**

1. SEE CONTINUATION ON DRAWING NO. 91-458-A52.

OVERALL  
GENERAL PROJECT ORGANIZATION  
MEW STUDY AREA  
MOUNTAIN VIEW, CALIFORNIA  
PREPARED FOR  
MIDDLEFIELD-ELLIS-WHISMAN  
STUDY AREA

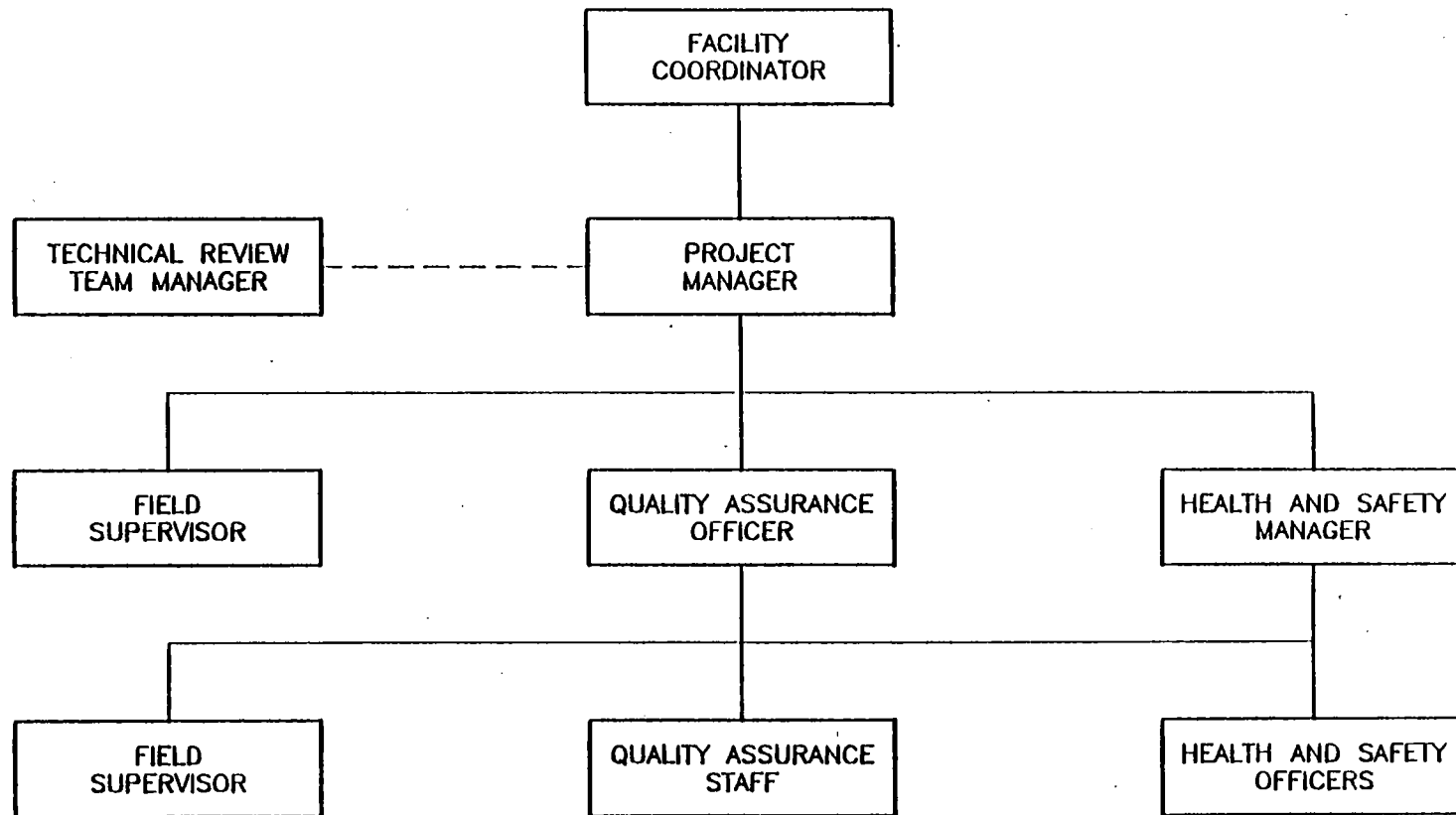
**Canonie** Environmental

12-13-91	ISSUED FOR QAPP REPORT	DS/VLC	SDL	DL
No.	DATE	ISSUE / REVISION	OWN	CHK'D BY

DATE: 11-26-91  
SCALE: AS SHOWN

FIGURE 2

DRAWING NUMBER  
91-458-A51



**LEGEND:**

- LINES OF AUTHORITY  
 - - - - LINES OF COMMUNICATION

FACILITY PROJECT ORGANIZATION  
 MEW STUDY AREA  
 MOUNTAIN VIEW, CALIFORNIA  
 PREPARED FOR  
 MIDDLEFIELD-ELLIS-WHISMAN  
 STUDY AREA  
**Canonie** Environmental

12-13-91	ISSUED FOR QAPP REPORT	VZC	SDL	DL
No.	DATE	ISSUE / REVISION	OWN. BY	CHK'D BY
			AP'D BY	

DATE: 11-26-91	FIGURE 3	DRAWING NUMBER 91-458-A52
SCALE: AS SHOWN		

TABLE A-1

DESIRED DETECTION LIMITS  
FOR WATER SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/l}</math>)</u>
Toluene	METHOD 5030/8020	1.0
Total Xylenes	METHOD 5030/8020	1.0
Tetrachloro-dibenzo-p-dioxins (TCDD)	METHOD 8280	1.0- 5.0
Pentachloro-dibenzo-p-dioxins (PeCDD)	METHOD 8280	1.0- 5.0
Hexachloro-dibenzo-p-dioxins (HxCDD)	METHOD 8280	5.0-10.0
Heptachloro-dibenzo-p-dioxins (HpCDD)	METHOD 8280	10.0-50.0
Octachloro-dibenzo-p-dioxins (OCDD)	METHOD 8280	10.0-50.0
Tetrachloro-dibenzo-furans (TCDF)	METHOD 8280	1.0- 5.0
Pentachloro-dibenzo-furans (PeCDF)	METHOD 8280	1.0- 5.0
Hexachloro-dibenzo-furans (HxCDF)	METHOD 8280	5.0-10.0
Heptachloro-dibenzo-furans (HpCDF)	METHOD 8280	10.0-50.0
Octachloro-dibenzo-furans (OCDF)	METHOD 8280	10.0-50.0
Phenol	CLP	10
bis(2-Chloroethyl) Ether	CLP	10
2-Chlorophenol	CLP	10
1,3-Dichlorobenzene	CLP	10
1,4-Dichlorobenzene	CLP	5
Benzyl Alcohol	CLP	10
1,2-Dichlorobenzene	CLP	10
2-Methylphenol	CLP	10
bis(2-Chloroisopropyl) Ether	CLP	10
4-Methylphenol	CLP	10
N-Nitroso-di-n-propylamine	CLP	10
Hexachloroethane	CLP	10
Nitrobenzene	CLP	10
Isophorone	CLP	10
2-Nitrophenol	CLP	10
2,4-Dimethylphenol	CLP	10
Benzoic Acid	CLP	50
bis(2-Chloroethoxy)methane	CLP	10
2,4-Dichlorophenol	CLP	10
Naphthalene	CLP	10
4-Chloroaniline	CLP	10
Hexachlorobutadiene	CLP	10

TABLE A-1

DESIRED DETECTION LIMITS  
FOR WATER SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (µg/l)</u>
4-Chloro-3-methylphenol (para-Chloro-meta-cresol)	CLP	10
2-Methylnaphthalene	CLP	10
Hexachlorocyclopentadiene	CLP	10
2,4,6-Trichlorophenol	CLP	10
2,4,5-Trichlorophenol	CLP	50
2-Chloronaphthalene	CLP	10
2-Nitroaniline	CLP	50
Dimethylphthalate	CLP	10
Acenaphthylene	CLP	10
2,6-Dinitrotoluene	CLP	10
3-Nitroaniline	CLP	50
Acenaphthene	CLP	10
2,4-Dinitrophenol	CLP	50
4-Nitrophenol	CLP	50
Dibenzofuran	CLP	10
2,4-Dinitrotoluene	CLP	10
Diethylphthalate	CLP	10
4-Chlorophenyl-phenyl Ether	CLP	10
Fluorene	CLP	10
4-Nitroaniline	CLP	50
4,6-Dinitro-2-methylphenol	CLP	50
N-Nitrosodiphenylamine	CLP	10
4-Bromophenyl-phenylether	CLP	10
Hexachlorobenzene	CLP	10
Pentachlorophenol	CLP	50
Phenanthrene	CLP	10
Anthracene	CLP	10
Di-n-butylphthalate	CLP	10
Fluoranthene	CLP	10
Pyrene	CLP	10
Butylbenzylphthalate	CLP	10
3,3'-Dichlorobenzidine	CLP	20
Benzo(a)anthracene	CLP	10

DESIRED DETECTION LIMITS  
FOR WATER SAMPLES,  
CLP LABORATORIES  
(Continued)

<u>Analyte</u>	<u>EPA Method for Analysis</u>	<u>Desired Detection Limit (<math>\mu\text{g/l}</math>)</u>
Chrysene	CLP	10
bis(2-Ethylhexyl)phthalate	CLP	10
Di-n-octylphthalate	CLP	10
Benzo(b)fluoranthene	CLP	10
Benzo(k)fluoranthene	CLP	10
Benzo(a)pyrene	CLP	10
Indeno(1,2,3-cd)pyrene	CLP	10
Dibenz(a,h)anthracene	CLP	10
Benzo(g,h,i)perylene	CLP	10
alpha-BHC	CLP	0.05
beta-BHC	CLP	0.05
delta-BHC	CLP	0.05
gamma-BHC (Lindane)	CLP	0.05
Heptachlor	CLP	0.05
Aldrin	CLP	0.05
Heptachlor epoxide	CLP	0.05
Endosulfan I	CLP	0.05
Dieldrin	CLP	0.10
4,4'-DDE	CLP	0.10
Endrin	CLP	0.10
Endosulfan II	CLP	0.10
4,4'-DDD	CLP	0.10
Endosulfan sulfate	CLP	0.10
4,4'-DDT	CLP	0.10
Methoxychlor	CLP	0.5
Endrin Ketone	CLP	0.10
alpha-Chlordane	CLP	0.5
gamma-Chlordane	CLP	0.5
Toxaphene	CLP	1.0
Aroclor-1016	CLP	0.5
Aroclor-1221	CLP	0.5
Aroclor-1232	CLP	0.5
Aroclor-1242	CLP	0.5
Aroclor-1248	CLP	0.5

**APPENDIX 4**

Unified QAPP

TABLE 5

QA/QC GOALS FOR LABORATORY  
SOIL AND GROUND WATER SAMPLES

<u>Quality Control Type</u>	<u>Frequency</u>	<u>Acceptance Criteria</u>
Method Blank	1 per 20 samples	Less than Reporting Limit
Daily Calibration	1 per 10 samples analyzed	15% from True Value
Laboratory Control Samples	1 per 20 samples	80% to 120% Recovery
Retention Time Windows (if applicable)		Column and Compound Specific
Matrix Spike/Matrix Duplicate Samples	1 per 20 samples	See Table 3 for ground water samples See Table 4 for soil samples.

TABLE 6

SAMPLE CONTAINERS AND HANDLING PROTOCOLS  
FOR SOIL SAMPLES

<u>Analyte Group</u>	<u>EPA Test Method</u>	<u>Type of Container</u>	<u>Number of Containers Sample Size</u>	<u>Preservation</u>	<u>Maximum Holding Time</u>
VOCs	Method 8010	Brass or stainless steel tube, air tight and completely full	One 4- or 6-inch long tube	Cool to 4°C (ice in cooler)	14 days
Phenol	Method 8040	Brass or stainless steel tube or 8-oz glass jar	300 grams	Cool to 4°C (ice in cooler)	30 days <sup>a</sup>
Metals	Methods 6010, 7041, 7421	Lexan™, brass or stainless steel tube, 8-oz glass jar	400 grams	Cool to 4°C (ice in cooler);	6 months
TPH-D	Cal LUFT	Brass or stainless steel tube or 8-oz glass jar	200 grams	Cool to 4°C (ice in cooler)	14 days

<sup>a</sup>Samples are extracted within 7 days and analyzed within 30 days.



TABLE 7  
SAMPLE CONTAINERS AND HANDLING PROTOCOLS  
FOR WATER SAMPLES

<u>Analyte Group</u>	<u>EPA Test Method</u>	<u>Container Type and Sample Volume</u>	<u>Number of Containers</u>	<u>Preservation</u>	<u>Holding Time</u>
VOCs	Method 8010	Glass, 40-ml Teflon-lined Septum (completely filled)	3	Cool to 4°C (ice in cooler)	14 days
Phenol	Method 8040	Amber Glass, 1 Liter	3	Cool to 4°C (ice in cooler)	30 days(a)
Metals	Methods 200.7, 206.2, and 239.2	Plastic or Glass, 1 Liter	1	Field filter (b) Cool to 4°C (ice in cooler) HNO <sub>3</sub> to pH < 2	6 months
TPH-D	Cal LUFT	Glass, 1 liter	3	Cool, 4°C HCL to pH 2	14 days

---

(a) Samples are to be extracted within 7 days and analyzed within 30 days.

(b) Ground water samples collected for metals analysis will be field filtered in order to distinguish between metals dissolved in the ground water as opposed to metals which are contained in the ground water as sediment.

TABLE 8  
FIELD MEASUREMENTS

<u>Field Measurement</u>	<u>Instrument</u>	<u>Calibration Procedure</u>	<u>Precision</u>
Water Level Survey	Electrical Sounder or Steel Tape	Reference to Steel Tape Reference to New Tape Manufacturer's User Manual	0.01 foot 0.01 foot
Elevation of Sample Site	Level and Rod	Surveyor Calibration	0.01 foot
Location of Sample Site	Steel Tape	Reference to New Tape	0.01 foot
Soil Sample Depth	Steel Tape Length of Drill Rod	Reference to New Tape Reference to Steel Tape	0.1 foot 0.5 foot
Water pH	pH Meter	2-Point Buffer Solutions	0.1 pH unit
Specific Conductance	Conductivity Meter	KCl Reference Solution Manufacturer's User Manual	S= $\pm 120 \mu\text{mhos/cm}$
Field Water Alkalinity	Titration Kit, pH Meter	Buffer Solutions, Standard Titrants	S= $\pm 5$ milligrams per liter (mg/l) as $\text{CaCO}_3^*$
Water Temperature	Thermistor on SCT Meter or Temperature Meter with Temperature Compensation probe	Reference to Mercury Thermometer Manufacturer's User Manual	0.1°C

**TABLE 8**  
**FIELD MEASUREMENTS**  
**(Continued)**

<u>Field Measurement</u>	<u>Instrument</u>	<u>Calibration Procedure</u>	<u>Precision</u>
Water Flow Rate	Bucket and Watch	Reference to Calibrated Containers and Clock	0.1 gallon per minute (gpm)
Water Flow Rate	In-Line Flow Meter	Reference to Calibrated Volumes and Clock, Manufacturer's User Manual	0.1 gpm
Portable Gas Analyzers	GC/PID or GC/FID	3 Dilutions of Standard Calibration Gas Manufacturer's User Manual	1 part per million (ppm)
Noise Level	Noise Dosimeter	Manufacturer's User Manual	Indication of standard value
	Ground Penetrating Radar (GPR)	Performance Radar Survey	Radar reflection consistency
Turbidity	Electromagnetometer	Sensitivity Test	Deflection of 25%
	Turbidity Meter	Manufacturer's User Manual Standard Solution	Standard Solution value

TABLE 8  
FIELD MEASUREMENTS  
(Continued)

<u>Field Measurement</u>	<u>Instrument</u>	<u>Calibration Procedure</u>	<u>Precision</u>
Combustible Gas Indicator		Manufacturer's User Manual Standard Calibration gas (pentane)	Indication of standard percent of lower explosive limit and zero settings

\* Precision specified by "Methods for Chemical Analysis of Water and Wastes," Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, 1983, EPA-600/4-79-020.

TABLE 9  
EQUIPMENT MAINTENANCE SCHEDULE

<u>Equipment</u>	<u>Maintenance</u>
Organic Vapor Analyzer (OVA)	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge, or replace battery as needed.</li> <li>o Check hydrogen supply level prior to use; recharge supply as needed.</li> <li>o Check inlet tube for blockage; clear passage or replace inlet tube as needed.</li> <li>o Replace filters as needed.</li> </ul>
Photo Ionization Detector	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge or replace battery as needed.</li> <li>o Check condition of UV lamp and ion chamber prior to use; clean UV lamp surface or probe if deposits develop.</li> <li>o Check fan or pump; clean or replace as needed.</li> </ul>
Electrical Water Level Sounder	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge or replace battery as needed.</li> <li>o Check condition of cable and electrical connections; repair or replace as needed.</li> <li>o Clean probe after each use.</li> </ul>
pH Meter	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge or replace battery as needed.</li> <li>o Rinse probe with distilled water after each use.</li> <li>o Make sure probe's sensor is stored in its appropriate container.</li> </ul>
Conductivity Meter	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge or replace battery as needed.</li> <li>o Rinse meter with deionized water after each use.</li> </ul>
Temperature Meter	<ul style="list-style-type: none"> <li>o Check battery charge prior to use; recharge or replace battery as needed.</li> <li>o Rinse meter with deionized water after each use.</li> </ul>

EQUIPMENT MAINTENANCE SCHEDULE  
(Continued)

<u>Equipment</u>	<u>Maintenance</u>
Combustible Gas Indicator	<ul style="list-style-type: none"><li>o Check battery charge prior to use; recharge or replace battery as needed.</li><li>o check alarm to ensure it is functioning correctly.</li><li>o Check for leaks by plugging the air inlet.</li><li>o Check hoses and filters, replace as needed.</li></ul>
Noise Dosimeter	<ul style="list-style-type: none"><li>o Check battery charge prior to use; recharge or replace battery as needed.</li><li>o Clean instrument regularly and maintain according to manufacturer's instructions.</li></ul>
Ground Penetrating Radar/Electromagnetometer	<ul style="list-style-type: none"><li>o Check battery charge prior to use; recharge or replace battery as needed.</li><li>o Regularly clean instrument and maintain according to manufacturer's instructions.</li></ul>