

National Aeronautics and
Space Administration
Ames Research Center
Moffett Field, CA 94035-1000



Reply to Attn of:

JQ:204-15

April 22, 2013

Ms. Alana Lee
US Environmental Protection Agency
Region IX
75 Hawthorne Street (SFD-7-3)
San Francisco, CA 94105

Dear Ms. Lee:

Enclosed is the *Draft Building-Specific Vapor Intrusion Air Sampling report* for the National Aeronautics and Space Administration (NASA) Ames Research Center (Ames). This draft report is being forwarded for review and comment. Once review comments are received, NASA Ames will provide responses to comments and make the necessary revisions. Please provide comments by May 22, 2013.

If you have any questions, you can contact me at 650-604-0237 or by e-mail at Donald.M.Chuck@nasa.gov.

Cordially,

A handwritten signature in blue ink that reads "Donald M. Chuck".

Donald M. Chuck
Remedial Project Manager
Environmental Management Division

Enclosure

cc: (electronically)

Ms. Penny Reddy, USEPA

Ms. Yvonne Fong, USEPA

Ms. Jennifer Ledesma, CH2M Hill

Ms. Elizabeth Wells, RWQCB

Mr. Xavier Bryant, DTSC

Mr. Scott Anderson, US Navy

Mr. Jim Whitcomb, US Navy

Ms. Joyce Adams, Weiss Associates

Mr. John Gallinatti, Geosyntec Consultants

Ms. L. Maile Smith, Northgate EM

Mr. Elie Haddad, Haley & Aldrich

Mr. William Berry, Moffett RAB

Reddy.Penny@epa.gov

Fong.YvonneW@epa.gov

Jennifer.Ledesma@ch2m.com

ewells@waterboards.ca.gov

xbryant@dtsc.ca.gov

scott.d.anderson@navy.mil

james.h.whitcomb@navy.mil

jea@weiss.com

JGallinatti@Geosyntec.com

maile.smith@ngem.com

EHaddad@haleyaldrich.com

wmberry@comcast.net

Mr. Lenny Siegel, CPEO
Mr. Peter Strauss, PM Strauss and Assoc.
204-15\L. Pirbazari
213-8\G. Sutton
T20G-4\J. Lukas
File
Chron

lsiegel@cpeo.org
petestrauss1@comcast.net
lili.pirbazari-1@nasa.gov
george.w.sutton@nasa.gov
joseph.r.lukas@nasa.gov



DRAFT
BUILDING-SPECIFIC
VAPOR INTRUSION
AIR SAMPLING REPORT
NASA Ames Research Center
Moffett Field, CA

September 2012

Prepared for:
NASA Ames Research Center
Environmental Management Division
M/S 237-14
Moffett Field, CA 94035-1000

Prepared by:

M/S T20G-4
NASA Ames Research Center,
Moffett Field, CA 94035-1000



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Acronyms

BRAC	Base Closure and Realignment Commission
bgs	Below Ground Surface
CCR	California Code of Regulations
CFR	Code of Federal Regulations
COC	Chemical of Concern
cy	Cubic Yards
DTSC	Department of Toxic Substances Control
EMD	Environmental Management Division
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ft	Feet
GIS	Geographical Information System
IP	Implementation Plan
IR	Implementation Report
IRP	Installation Restoration Program
µg/kg	Micrograms per Kilogram
mg/kg	Milligram per Kilogram
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASMF	Naval Air Station Moffett Field
PCBs	Polychlorinated Biphenyls
PMO	Program Management Office
ppb	parts per billion (ppb)
ppm	parts per million (ppm)
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SWRP Storm	Water Retention Pond
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substance Control Act
VOCs	Volatile Organic Compounds
WATS	Westside Aquifer Treatment System

1 Introduction

At the request of the National Aeronautics and Space Administration (NASA) Ames Research Center (NASA Ames) Environmental Management Division (EMD), Integrated Science Solutions, Inc. (ISSi) has prepared this Report of Findings (ROF). The purpose of this ROF is to present the results of vapor intrusion sampling performed at six buildings at NASA Ames, Moffett Field, California. The air samples were collected in the buildings listed below:

- N144
- N212
- N213
- N240
- N245
- T20-G

This data was acquired to satisfy requirements of the United States Environmental Protection Agency (USEPA) Superfund Division concerning vapor intrusion of contaminants from contaminated groundwater. Vapor sample collections were performed as per the approved *“Indoor Air Sampling and Analysis Work Plan (SAWP) for Existing, Unsampled Commercial Buildings for the MEW and Moffett Field Vapor Intrusion Study Area”* (Haley, 2011) and the *“NASA Building Specific Sampling Plan VI Workplan”* (NASA, 2012).

1.1 Location and Background

NASA Ames is located at the southern end of the San Francisco Bay. NASA Ames is 35 miles south of San Francisco, California, and 10 miles north of San Jose, California (Figure 1). NASA Ames is located at the southern end of the San Francisco Bay in Santa Clara County and adjacent to the cities of Mountain View and Sunnyvale

Since 1988, numerous investigations have been performed at NASA Ames to study suspected sources of soil and groundwater contamination. During 1992, Erler & Kalinowski, Inc. (EKI, 1992) completed an EPA Listing Site Inspection (LSI). The primary objective of the 1992 LSI was to generate a preliminary site ranking using the revised Hazardous Ranking System (HRS) developed by the EPA. The HRS is the primary method used by the EPA to determine whether a site is to be included on the National Priorities List (NPL), commonly known as Superfund. Based on the final HRS score of 15.77, the NASA Ames site was classified as a non-NPL site.

A *“Center-Wide Sampling and Analysis Program”* investigation task completed in 1994 (EKI, 1994) provided an overview of the requirements for a comprehensive site evaluation. As part of this plan, ARC was divided into 12 Areas of Investigation (AOIs) for detailed studies that currently are in various stages of characterization, cleanup, or have received closure. For the most part, investigations have been related to a particular building, incident, or chemical release. The majority of the remaining site contamination is from former leaking underground fuel storage tanks plus PCB and lead impacted surface soils.

ARC is also located down gradient of two (2) EPA Superfund sites where subsurface groundwater contamination has been identified from leaking storage tanks with associated lines,

and poor waste management practices. These sites, the former Navy Air Station Moffett Field (NASMF) and the area bounded by local streets Middlefield Road, Ellis Street and Whisman Road (MEW), utilized solvents and petroleum's as part of daily operations. The one known solvent source area on ARC is located on the northern portion of the facility at the Navy IRP Site 8 North, the former Navy drum storage and waste oil disposal site. One other suspected ARC solvent source site is located upgradient of Building N144; however, based on recent groundwater data, it appears that this contamination is from an upgradient, non ARC source.

Figure 1: Site Location Map



The USEPA issued a Record of Decision (ROD) Amendment (EPA, 2010) to the 1989 Middlefield-Ellis-Whisman Study Area (MEW) ROD (EPA, 1989). The ROD Amendment addresses the vapor intrusion pathway attributed to the regional plume underlying the MEW/Moffett/NASA areas. The regional plume originates from the MEW area south of Highway 101 and has migrated north of Highway 101 into the former Naval Air Station Moffett Field (NASMF) and NASA Ames. The area above the regional plume defines the vapor intrusion study area. Figure 2 illustrates the vapor intrusion study area. According to the USEPA ROD Amendment and the SAWP, “*The vapor intrusion study area is defined as the area where trichloroethylene (TCE) concentrations in the shallow groundwater are greater than 5 micrograms per liter (µg/L).*” (Haley, 2011). The Chemicals of Concern (COC) as listed in the ROD amendment and MEW SAWP include:

- PCE: Tetrachloroethene
- TCE: Trichloroethene
- cis-1,2-DCE: Dichloroethene
- trans-1,2-DCE
- 1,1-DCE
- 1,1-DCA: Dichloroethane
- vinyl chloride

NASA Ames, while not a signatory to the MEW ROD and ROD Amendment, has agreed to perform vapor intrusion sampling in buildings within the NASA Ames campus over the vapor intrusion study area. NASA Ames has also agreed to adopt the Sampling Plan developed for the MEW Companies and referenced above. NASA Ames produced a building-specific work plan based on a walkthrough survey of each building. The work plan contained maps of the floor plans for each building along with sampling locations (included in Attachment A).

Solvent based volatile organic compound (VOC) sources in indoor air could include one or a combination of the following:

- Volatilization from the subsurface into the building structure;
- Occupational or consumer product sources within the building space (background indoor air); and/or
- Contribution from outdoor air infiltrating into the building through open doors or windows, or through heating, ventilation, and air conditioning (HVAC) systems (background outdoor air). This outdoor air can include contributions from off-site background (i.e., regional or area-wide) concentrations and nearby industrial emissions (e.g., dry cleaners).

1.2 Site

The study area is divided into two portions at Highway 101. The area south of Highway 101 will be addressed by the MEW Companies. The area north of Highway 101 is further divided into three areas of responsibility (AOR) among the Potential Responsible Parties (PRP): MEW Companies, NASA Ames and United States Navy (Navy). These AORs are shown on Figure 2.

Each PRP will be responsible for sampling buildings within the vapor intrusion study area in their respective AOR. In accordance with the Statement of Work (SOW) for the vapor intrusion pathway, NASA is implementing the vapor intrusion work in the areas of the Vapor Intrusion Study Area on Moffett Field designated as the “NASA” area as shown in Figure 2. The NASA Ames AOR extends from King Road within the NASA Ames campus north to the distal end of the regional plume. NASA is responsible for sampling the following buildings in accordance with the 7 June 2011 Haley & Aldrich “Indoor Air Sampling and Analysis Work Plan for Existing, Unsampled Buildings, Middlefield-Ellis-Whisman (MEW) and Moffett Field Study Area,” ([Site-wide Work Plan], Haley & Aldrich, 2011a) approved by the United States Environmental Protection Agency (EPA) on 1 July 2011:

- 1) N144
- 2) N212
- 3) N213
- 4) N240
- 5) N245
- 6) T20-G

The locations of these NASA buildings are shown on Figure 2 below.

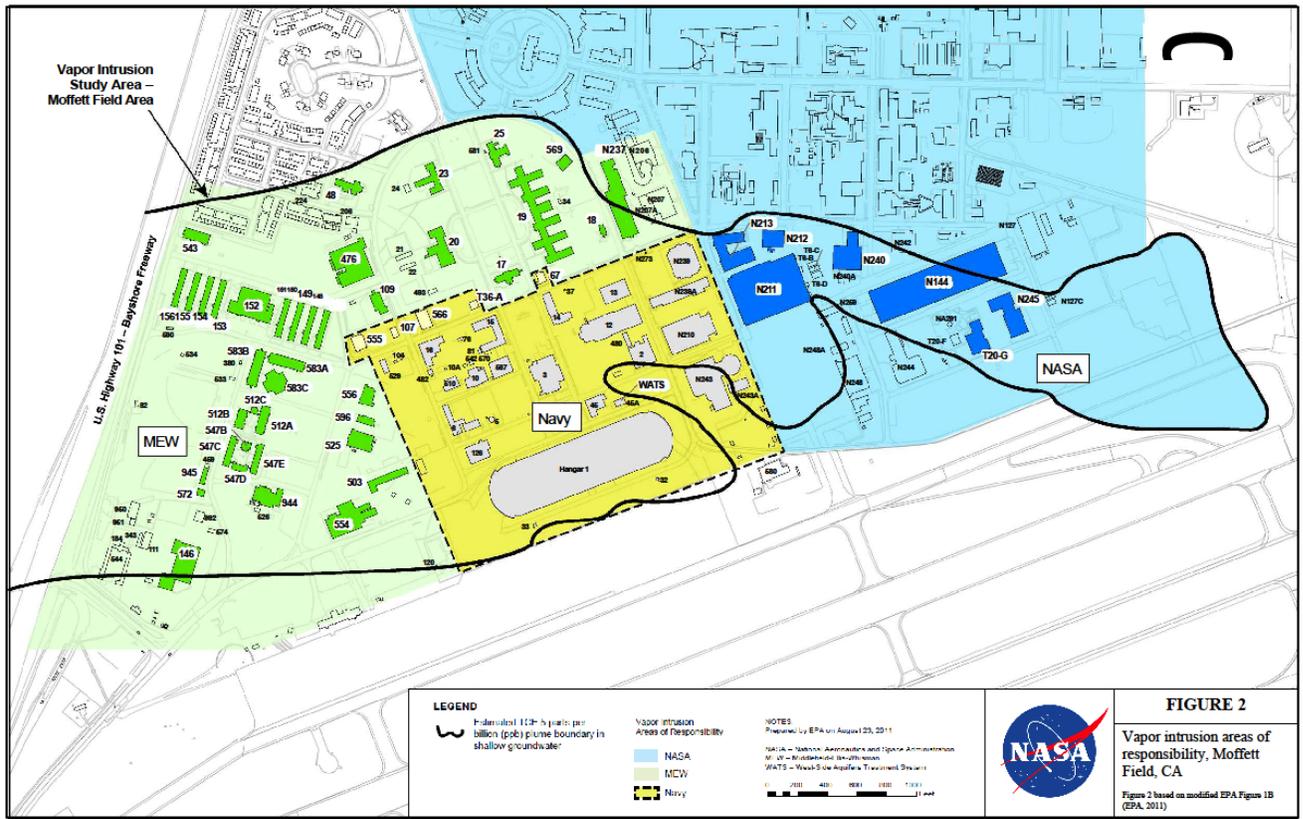


Figure 2: Vapor Intrusion Areas of Responsibility & Building Location Map

1.3 Objectives

The goal of the vapor intrusion sampling task was to collect indoor air samples in selected buildings within the NASA Ames AOR. The objectives for obtaining this information were:

- to determine whether or not the designated buildings are affected by vapor intrusion;
- to determine if additional sampling will be needed to tier the building as provided in the MEW ROD Amendment; and
- to determine if remedial action is warranted.

1.4 Report Contents

The Report includes the items identified below and a cross reference to where those items can be found.

Item	Location in Report
Building conditions, occupancy and use conditions, and a summary of all building/property-specific data, including identification of potential pathways for subsurface vapor intrusion.	Sections 3.1 through 3.6, and Attachment C
Evaluation of current indoor air ventilation system (e.g., heating, ventilation, and air conditioning) operations and completed building surveys.	Attachment C (Building Questionnaires)
Map of building/property layout and actual sampling locations, including photographs, where permitted.	Maps: Figures 1 through 4, & Attachment A Photographs: Attachment B
Summary of all sampling and data collection results	Sections 3.1 through 3.6, Table 2. Figures 5 through 8.
Laboratory analytical data reports	Attachment D
Quality Assurance/Quality Control data and activities	Sections 2 and 3, & Appendix D

To expedite the sampling process, EPA agreed that building-specific work plans for these six buildings were not necessary, and that the information typically included in these work plans would be provided in this Report. Below is a list of the information typically included in those work plans and where they are located:

Item	Location in Report
Proposed sampling locations and rationale for each sampling location	Sections 2 and 3, Attachment A, Figures 1 through 9
Proposed field activity schedule	Sampling was performed between 18 Feb. and 20 Feb., and between 23 Feb. and 24 Feb., 2012. EPA was notified in advance of sampling schedule, and was present during the HVAC on sample collections to collect 5-minute grab samples on 24 Feb., 2012.
Sampling method, sampling duration, and operating status of indoor air ventilation prior to and during sampling events.	Section 3.0
Completed building questionnaire/survey	Attachment C
Findings and recommendations	Section 4.0

2 Vapor Intrusion Sampling

2.1 Pre-Sampling Activity

Vapor intrusion sampling in the buildings referenced in the proceeding section required the collection of indoor air samples with the building HVAC system on (HVAC-ON) and the HVAC system off (HVAC-OFF). To facilitate both the HVAC-OFF and HVAC-ON air sample collections, building Facility Safety Managers (FSMs) for each building were contacted prior to the collection of each type of OFF/ON air samples.

A building walkthrough was conducted on June 29, 2011, for each of the buildings to be sampled. The walkthrough team included the Environmental Management project manager, EPA project manager and project contract personnel from ISSi.

During the walkthrough, sample locations and types were determined. The proposed locations are shown for each building on maps included in *Attachment A*. Sample collection locations were selected to best determine the potential impact to building occupants, locations that included office and work spaces, high traffic hallway areas, plus potential exposure pathways at elevator shafts and in basement equipment utility rooms. A list of the buildings proposed for vapor intrusion air sampling and analysis, the sample identification numbers, and the room numbers are presented in *Table 1: Building Sampling List*.

Building surveys, included in *Attachment C: Building Questionnaire Forms*, were also conducted to determine building occupancy, chemical usage, existing infrastructure and HVAC conditions. During the walkthroughs, NASA and EPA jointly selected locations and duration of air samples in each building.

2.2 Sampling Methodology

To ensure a minimal to no impact effect on site operations, including NASA mission critical operations, the HVAC-OFF vapor samples were collected over the February Presidents Day holiday weekend (2/18-20/12), with the HVAC systems being shut down at approximately 6 P.M. on Friday February 17, 2012 through 6 A.M. Tuesday February 21, 2012. This allowed for a 48-hour HVAC-OFF timeframe (2/17-2/19 - 12 P.M.) prior to the start of a 24-hour HVAC-OFF vapor sample collection timeframe (2/19-2/20 - 12 P.M.). Building vapor sample location maps are included as *Attachment A*, and vapor sampling location photographs are included as *Attachment B*.

As per the approved work plan, five minute (5-min) grab vapor samples were also collected inside buildings **N213** and **N240**, from approximately 3:30 P.M. to 4:30 P.M. on Wednesday February 22, 2012. These grab vapor samples were collected in the presence and direction of the EPA Region 9 vapor intrusion project manager (PM) for the Moffett Field site.

The 24-hour HVAC-ON vapor samples were collected beginning A.M. Thursday February 23, and were completed A.M. Friday February 24, 2012 (A.M. 2/23-24/12 A.M.).

Samples were collected at the majority of the proposed vapor sampling locations. Several proposed locations were relocated to enhance vapor intrusion representativeness or due to interference with mission critical operations. At two locations, vapor samples could not be collected due to the mission critical operations that required 24/7 operation of the HVAC system. **Table 1** includes the list of proposed vapor sample locations plus changes in sample locations due to the above listed conditions. Both the NASA EMD and EPA PM's were notified either verbally or via email of these changes prior to vapor sample collections.

All vapor sample collections complied with the requirements as specified in the Site-wide Work Plan (Haley & Aldrich, 2011a) and as per ASTM Standard Test Method , D 5466-01 (ASTM, 2007).

2.3 Evaluation Criteria

EPA's *Record of Decision Amendment for the Vapor Intrusion Pathway, Middlefield-Ellis-Whisman (MEW) Superfund Study Area, Mountain View and Moffett Field, California*.([EPA's 2010 VI ROD Amendment]; EPA 2010) lists the COCs for the vapor intrusion pathway to be TCE, PCE, vinyl chloride, 1,1-DCE, 1,1-DCA, cis-1,2-DCE, and trans-1,2-DCE. The sample results for these COCs were compared with the following three tiers of evaluation criteria.

- **Short-Term Exposure:** The federal Agency for Toxic Substances and Disease Registry (ATSDR) developed acute (14-day) and intermediate (15- to 365-day) minimal risk levels (MRLs) applicable to short or moderate exposure periods for certain chemicals. An acute or intermediate MRL is an estimate of the daily human exposure to a chemical likely to result in no appreciable risk of adverse non-carcinogenic health effects over a specified short-term duration of exposure. These chemical-specific estimates are intended to serve as screening levels and are used by ATSDR health assessors and other responders to identify chemicals and potential health effects that may be of concern at sites. MRLs are not intended to define cleanup or action levels for ATSDR or other agencies. Measured concentrations in the air can be compared to MRLs to assess short-term potential risks.
- **Long-Term Exposure:** The long-term exposure goals are based on the indoor air cleanup levels for long-term exposure per EPA's 2010 VI ROD Amendment. For a commercial scenario, the cleanup levels are based on a long-term exposure duration of 25 years, 250 days per year, and 10 hours per day. If workers are present in the building less often, risk would be lower. For example, if a worker works only 5 hours per day instead of 10 hours, the reduced exposure time provides a safety factor of 2 (estimated risks would be half as much). The same is also true if the exposure concentration, the exposure duration, or exposure frequency is less than the exposure assumptions used to determine the 5 (micrograms per cubic meter) $\mu\text{g}/\text{m}^3$ action level for TCE.
- **Outdoor:** Outdoor samples are compared to the indoor samples to evaluate the impact of the outdoor air on the indoor air quality. According to EPA's 2010 VI ROD Amendment, outdoor concentrations of TCE typically range from below the detection limit to 0.4

µg/m³. The outdoor air samples can also help assess whether indoor VOC sources or vapor intrusion pathways are present. The VI ROD Amendment states that indoor air concentrations higher than outdoor air concentrations may be indicative of indoor sources and/or vapor intrusion.

2.4 Vapor Sampling Methodologies

Vapor samples were collected as per the work plan from all six (6) NASA Ames buildings, including the five proposed grab vapor sample locations. All samples were collected using 6-Liter, stainless steel SUMMA canisters fitted with flow control regulators and pressure gates. The SUMMA canisters were fitted with 24-hour flow regulators for the 24-hour sample collections, while the 5-minute grab samples were collected using SUMMAs fitted with 5-minute duration flow regulators. The samples were analyzed for all seven (7) COCs as listed in Section 1.1 using EPA Method TO-15 SIM by Columbia Analytical Services, a National Environmental Laboratory Accreditation Conference certified laboratory.

Five (5) 5-minute “pathway” grab samples were also collected during the HVAC-ON round on February 24, 2012 while the EPA was present. Co-located, duplicate samples were collected at a rate of 1 in 10 samples, for a total of 4 duplicate samples (see Table 1).

3 Air Sampling Results

ISSi sampled six NASA Ames buildings in February 2012. Sixteen (16) air samples were collected during HVAC-OFF conditions, while twenty (20) air samples were collected during the HVAC-ON conditions. The vapor sampling results are presented in *Table 2*. The four duplicate samples are shown in *italics*.

All HVAC-ON air sample analyses indicated vapor concentrations below the long-term cleanup levels established in EPA’s 2010 ROD Amendment for all seven COCs.

One sample collected under HVAC-OFF conditions in the *N144 FEMA* building indicated the presence of TCE slightly above the long-term cleanup level of 5 ug/m³, but well below the short-term action level of 540 ug/m³, while one HVAC-OFF air sample collected in the *N212 shop area* indicated the presence of PCE slightly above the long-term cleanup level of 2 ug/m³.

All air samples showed concentrations below long-term cleanup levels established in EPA’s 2012 ROD Amendment, and below short-term minimal risk levels.

The following subsections present the sampling results in each of the buildings samples. Sample locations with posted concentrations above action levels are shown in this report on *Figure 3* and *Figure 4*. Based on the very low to non-detect levels of COCs in all buildings but *Building N212* and the *FEMA N144* building, vapor results are shown only for TCE in Building N212 and for PCE in the FEMA N144 building, Figures 3 and 4, respectively. All selected sample locations are shown on *Figures 3 through 8* in *Appendix A*.

Two (2) outdoor, background air samples were collected, one each during the HVAC-OFF and HVAC-ON air sampling events. The outdoor air background samples were located to the

southwest of Building N258, on the west side of Wright Avenue at the intersection of Allen Avenue. This location is the same background location that was utilized for previous indoor air sampling events conducted by NASA.

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Table 1: Building Sampling List

Building No.	Building Usage	Sample No.	Sample Type	HVAC Status		No. of Samples	Notes
				ON	OFF		
N144	NASA Warehouse/FEMA	N144-1-01-ON	24-Hour	X		1	Room R141
		N144-1-01-OFF	24-Hour		X	1	
N212	Model Development	N212-1-01-ON	24-Hour	X		1	Room 104 (moved to Room 101A)
		N212-1-01-OFF	24-Hour		X	1	
N213	Research Support	N213-B-01-ON	24-Hour	X		2	Basement Room 022 (moved to Room 025 which is occupied office space)
		N213-B-01-OFF	24-Hour		X	2	
		N213-B-02-ON	24-Hour	X		2	Basement Room 003 (moved to Room 004 which is occupied office space)
		N213-B-02-OFF	24-Hour		X	1	
		N213-B-03-ON	24-Hour	X		1	Basement Room C004
		N213-B-03-OFF	24-Hour		X	1	
		N213-B-04-P	Grab	X		1	Basement Elevator vault
		N213-B-05-P	Grab	X		1	Basement Room N002
		N213-B-06-P	Grab	X		1	Basement Room N042
		N213-B-07-P	Grab	X		1	Basement Elevator vault
		N213-1-01-ON	24-Hour	X		1	1 st Floor Room 104F
		N213-1-01-OFF	24-Hour		X	1	
		N213-1-02-ON	24-Hour	X		1	1 st Floor Room 104
		N213-1-02-OFF	24-Hour		X	1	
		N213-1-03-ON	24-Hour	X		2	1 st Floor Room 103
		N213-1-03-OFF	24-Hour		X	1	
		N213-1-04-ON	24-Hour	X		1	1 st Floor Room C103
		N213-1-04-OFF	24-Hour		X	1	
N213-1-05-ON	24-Hour	X		1	1 st Floor outside of Room 146		
N213-1-05-OFF	24-Hour		X	1			
N240	Airborne Missions & Life Science Experiments	N240-1-01-ON	24-Hour	X		1	1 st Floor Room C101 (OFF not collected). Mission critical research. See text.
		N240-1-01-OFF	24-Hour		-	1	
		N240-1-02-ON	24-Hour	X		1	1 st Floor Room 113 (moved to Room 115A)
		N240-1-02-OFF	24-Hour		-	1	
		N240-1-03-ON	24-Hour	X		1	1 st Floor Room 144
		N240-1-03-OFF	24-Hour		X	1	
N240-1-04-P	Grab	X		1	1 st Floor Elevator shaft		
N245	Space Science Research	N245-1-01-ON	24-Hour	X		1	1 st Floor Room 147
		N245-1-01-OFF	24-Hour		X	1	
T20-G	Space Sciences & Environmental	T20G-1-01-ON	24-Hour	X		1	1 st Floor Room C101
		T20G-1-01-OFF	24-Hour		X	1	
		T20G-1-02-ON	24-Hour	X		1	1 st Floor Room C106
		T20G-1-02-OFF	24-Hour		X	1	

Quality Assurance/Quality Control (QA/QC) activities complied with the requirements as specified in the Site-wide Work Plan (Haley & Aldrich, 2011a) and as per ASTM Standard Test Method D 5466-01 (ASTM, 2007). There were no deviations or discrepancies identified in sampling protocols or field sampling techniques. Four duplicate samples were collected as part of this task. The laboratory followed media preparation procedures for the sample canisters and analyses. Project analytical and QA/QC data underwent a Tier IV evaluation for correctness, completeness and accuracy, and are included in *Attachment D*.

Table 2: Building Vapor Results

Sample ID	Date	HVAC System	VC	TCE	PCE	trans-1,2-DCE	cis-1,2-DCE	1,1-DCE	1,1-DCA
N144-1-01-OFF	02/19/12	OFF	<.0063	7.00	1.80	0.26	0.18	<.014	<.0052
N144-1-01-ON	02/23/12	ON	<.0063	3.40	1.40	0.20	0.19	ND	<.0052
N212-1-01-OFF	02/19/12	OFF	<.0063	0.03	3.00	<.0059	0.011	ND	<.0052
N212-1-01-ON	02/23/12	ON	<.0063	0.07	0.28	<.0059	0.018	ND	<.0052
N213-B-01-OFF	02/19/12	OFF	<.0063	0.036	0.039	<.0059	0.012	ND	<.0052
<i>N213-B-08-OFF</i>	02/19/12	OFF	<.0063	0.045	0.077	<.0059	0.015	ND	<.0052
N213-B-01-ON	02/23/12	ON	Sample failed lab leak test. No analysis completed. See Duplicate results below = <i>-B-08-ON</i> .						
<i>N213-B-08-ON</i>	02/23/12	ON	<.0063	0.041	0.110	<.0059	0.028	ND	<.0052
N213-B-02-OFF	02/19/12	OFF	<.0063	0.075	0.600	<.0059	0.048	ND	0.011
N213-B-02-ON	02/23/12	ON	<.0063	0.084	0.300	<.0059	0.087	ND	0.0085
<i>N213-B-09-ON</i>	02/23/12	ON	<.0063	0.080	0.300	0.0073	0.088	ND	0.0080
N213-B-03-OFF	02/19/12	OFF	<.0063	0.086	0.074	<.0059	0.120	ND	0.0061
N213-B-03-ON	02/23/12	ON	<.0063	0.059	0.180	<.0059	0.082	ND	<.0052
N213-B-04-P(ON)	02/22/12	ON	0.260	3.100	0.250	0.110	12.00	0.250	0.220
N213-B-05-P(ON)	02/22/12	ON	0.018	0.320	0.057	<.0059	0.91	0.019	<.0052
N213-B-06-P(ON)	02/22/12	ON	<.0063	0.036	0.040	<.0059	0.02	<.014	<.0052
N213-B-07-P(ON)	02/22/12	ON	<.0063	0.064	0.120	<.0059	0.074	<.014	<.0052
N213-1-01-OFF	02/19/12	OFF	<.0063	0.040	0.051	<.0059	<.0069	<.014	<.0052
N213-1-01-ON	02/23/12	ON	<.0063	0.063	0.140	<.0059	0.030	<.014	<.0052
N213-1-02-OFF	02/19/12	OFF	<.0063	0.058	0.240	<.0059	0.036	<.014	<.0052
N213-1-02-ON	02/23/12	ON	<.0063	0.067	0.190	<.0059	0.069	<.014	<.0052
N213-1-03-OFF	02/19/12	OFF	<.0063	0.120	0.220	0.010	0.076	<.014	0.0074
N213-1-03-ON	02/23/12	ON	<.0063	0.077	0.110	<.0059	0.047	<.014	<.0052
<i>N213-1-10-ON</i>	02/23/12	ON	<.0063	0.076	0.190	<.0059	0.048	<.014	<.0052
N213-1-04-OFF	02/19/12	OFF	<.0063	0.095	0.044	0.0096	0.11	<.014	0.0065
N213-1-04-ON	02/23/12	ON	<.0063	0.050	0.240	<.0059	0.049	<.014	<.0052
N213-1-05-OFF	02/19/12	OFF	<.0063	0.059	0.033	<.0059	0.057	<.014	<.0052
N213-1-05-ON	02/23/12	ON	<.0063	0.054	0.190	0.024	0.054	<.014	<.0052
N240-1-01-ON	02/23/12	ON	<.0063	0.780	0.740	0.033	0.110	<.014	<.0052
N240-1-02-ON	02/23/12	ON	<.0063	0.750	0.590	<.0059	0.080	<.014	<.0052
N240-1-03-OFF	02/19/12	OFF	<.0063	0.290	0.036	<.0059	0.021	<.014	0.006
N240-1-03-ON	02/23/12	ON	<.0063	0.090	0.330	<.0059	0.013	<.014	<.0052
N240-1-04-P(ON)	02/22/12	ON	<.0063	1.700	0.093	<.0059	0.035	<.014	<.0052
N245-1-01-OFF	02/19/12	OFF	<.0063	0.110	0.100	<.0059	0.031	<.014	<.0052
N245-1-01-ON	02/23/12	ON	<.0063	0.034	0.150	<.0059	<.0069	<.014	<.0052
T20G-1-01-OFF	02/19/12	OFF	<.0063	0.034	0.031	0.017	0.0092	<.014	<.0052
T20G-1-01-ON	02/23/12	ON	<.0063	0.033	0.540	0.032	0.015	<.014	<.0052
T20G-1-02-OFF	02/19/12	OFF	<.0063	0.040	0.130	0.018	0.013	<.014	<.0052
T20G-1-02-ON	02/23/12	ON	<.0063	0.024	1.700	0.015	0.0075	<.014	<.0052
N258-1-01-OFF	02/19/12	Bckgnd	<.0063	0.023	0.140	0.0097	<.0069	<.014	<.0052
N258-1-01-ON	02/23/12	Bckgnd	<.0063	0.050	1.300	<.0059	0.033	<.014	<.0052
Short-Term Action Level									
Intermediate (15-365 days)			80	540	NA	800	NA	80	NA
Long-Term Cleanup Level									
Commercial			2	5	2	210	210	700	6

Note 1: All analytical concentration units are reported as ug/m³.

Note 2: Data with the less-than designator “<” indicates the Method Reporting Limit (MDL).

Note 3: *Sample IDs in italics* are duplicates of the preceding sample ID.

3.1 Building N144 – FEMA Warehouse Office Area

Building Description: Building N144 is an approximately 160,000 square-foot single story building consisting of a raised concrete warehouse floor with wood siding and asphalt roofing. Internal floor to ceiling height is approximately 40 feet. The building was historically utilized as a supply depot by the Navy during the time when Moffett Federal Airfield was an active Navy base. Post departure of the Navy in 1994, the warehouse has been utilized primarily as a FEMA storage and transfer facility where goods and supplies are stored and processed for use in case of a declared emergency.

The interior consists of large storage open storage areas with racked storage shelves plus stacked palletized supplies. Forklifts are the only regular vehicle used within the building interior. There is interior office space located in the northern, central and southern portions of the building. The southern offices are unoccupied and are currently only used for document storage. The northern and central office space currently houses FEMA staff, normally Monday through Friday from 8 A.M. to 5 P.M.

The N144 FEMA warehouse portion of the building does not have a central HVAC system. There is, however, an individual, wall mounted cooling/air conditioning unit plus separate ceiling mounted heater for the occupied Room 141 office area. The air conditioner draws air from the open warehouse area, while the heater pulls air from the interior of the Room 141 office area. These heating and cooling systems are operational during normal office hours, each individually controlled by a local thermostat. It is noted here that neither unit was on during sample canister deployment or retrieval events, plus weather during the sampling events was moderate.

There are no known floor drains nor openly stored paints, lacquers or thinners noted in Room 141 during the walkthroughs or sampling events.

Number of Discrete Samples Analyzed: Two (2) air samples were collected from Room 141, which is located in the central portion of the warehouse building, and is approximately 500 square-feet in area. Both 24-hour HVAC-OFF and HVAC-ON vapor samples were collected from Room 141.

Sample Locations: Indoor air samples were collected from an area located on the western side of Room 141 (see Figure 4 in Attachment A). The sample canister was placed on a desk top for the collection of both N144-1-01-OFF and N144-1-01- ON sampling events. Photographs taken during sampling activities are provided in Attachment B.

Sample Duration: 24-hour duration air samples were collected for both the N144 HVAC-OFF and N144 HVAC-ON sample collection events.

Tables and Figures: The results for the building N144 air samples are shown in Table 2 and on Figure 3. The laboratory reports are included in *Appendix D*.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa

canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: The HVAC-ON air sample, N144-1-01-ON, indicated the presence of TCE at 3.4 ug/m^3 and PCE at 1.4 , both concentrations below the long-term cleanup levels of 5 ug/m^3 and 2 ug/m^3 , respectively. The HVAC-OFF air sample, N144-1-01-OFF, revealed a TCE concentration at 7 ug/m^3 , which is slightly above the long-term cleanup level of 5 ug/m^3 for TCE, but well below the short-term action level of 540 ug/m^3 . PCE was also present at 1.8 ug/m^3 , but was also below the PCE long-term cleanup level of 2 ug/m^3 . Trans-1,2-DCE, and cis-1,2-DCE were also detected in indoor air samples, however, at concentrations below the long-term cleanup level. TCE sample results for Room 141 are shown on Figure 3.

Evaluation of Analytical Results: Four (4) of the seven (7) COCs were detected in the indoor air samples in Room 141. All four detections were well below the short-term action levels, with only one (1) of the four (TCE) slightly above the long-term cleanup level for TCE.

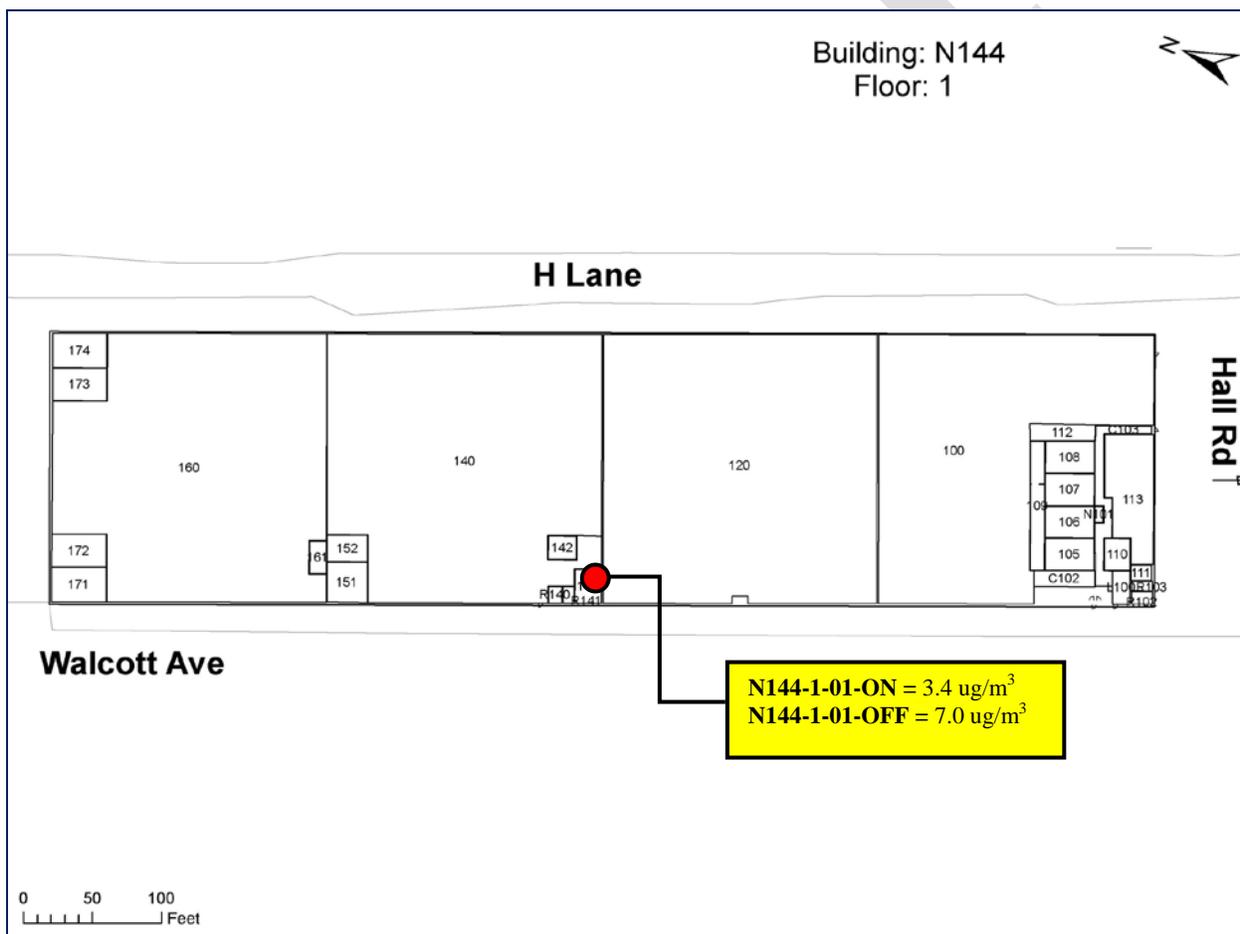


Figure 3: Building N144 Vapor Sample Location & TCE Results

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential for short-term exposure risk due to the N144 HVAC-ON operational mode during normal business hours; however, there appears to be a potential for an exposure risk for TCE under the *long-term cleanup level criteria during HVAC-OFF events*. Additional air sampling may be necessary in the N144, Room 141 office area.

3.2 Building N212 – Model Development Building

Building Description: Building N212 is a 12,000 square foot, concrete building with a large open workshop with offices, a small workshop and storage located along the east side of the building. The building is utilized exclusively for the fabrication of metal and other components used for aerodynamic research.

Number of Discrete Samples Collected: Two (2) air samples were collected from Room 101A, which is located in the east-central portion of the building, approximately 1,200 square-foot in area. One each 24-hour HVAC-OFF and HVAC-ON vapor samples were collected from the Room 101A area.

Sample Locations: Indoor air samples were collected from an area located on the western side of Room 101A (see Figure 4). This sample location is the one selected by the EPA during the original sample location walkthrough. The sample canister was placed on a bench top for the collection of both N212-1-01-OFF and N212-1-01- ON. Photographs taken during sampling activities are provided in Attachment B.

Sample Duration: 24-hour duration air samples were collected for both the N212 HVAC-OFF and N212 HVAC-ON sample collection events.

Tables and Figures: The results for the building N212 air samples are shown in Table 2 and on Figure 4. The laboratory reports are included in Appendix D.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: The only COC detected above the EPAs indoor air cleanup levels for long-term exposure goals was PCE at 3.0 ug/m³ in N212-1-01-OFF, which is slightly above the PCE action level of 2 ug/m³. TCE and cis-1,2-DCE were also detected in indoor air samples, however, at concentrations well below the long-term cleanup levels and the ATSDR's short-term action levels. All remaining COCs were non-detect. PCE sample results are presented in Table 2 and on Figure 4 above.

Evaluation of Analytical Results: Only one (1) of the seven (7) COCs was detected in the indoor air samples in Room 101A above the EPA long term action level. This sample, N212-1-01-OFF, indicated the presence of PCE slightly above the long-term action level of 2 ug/m³.

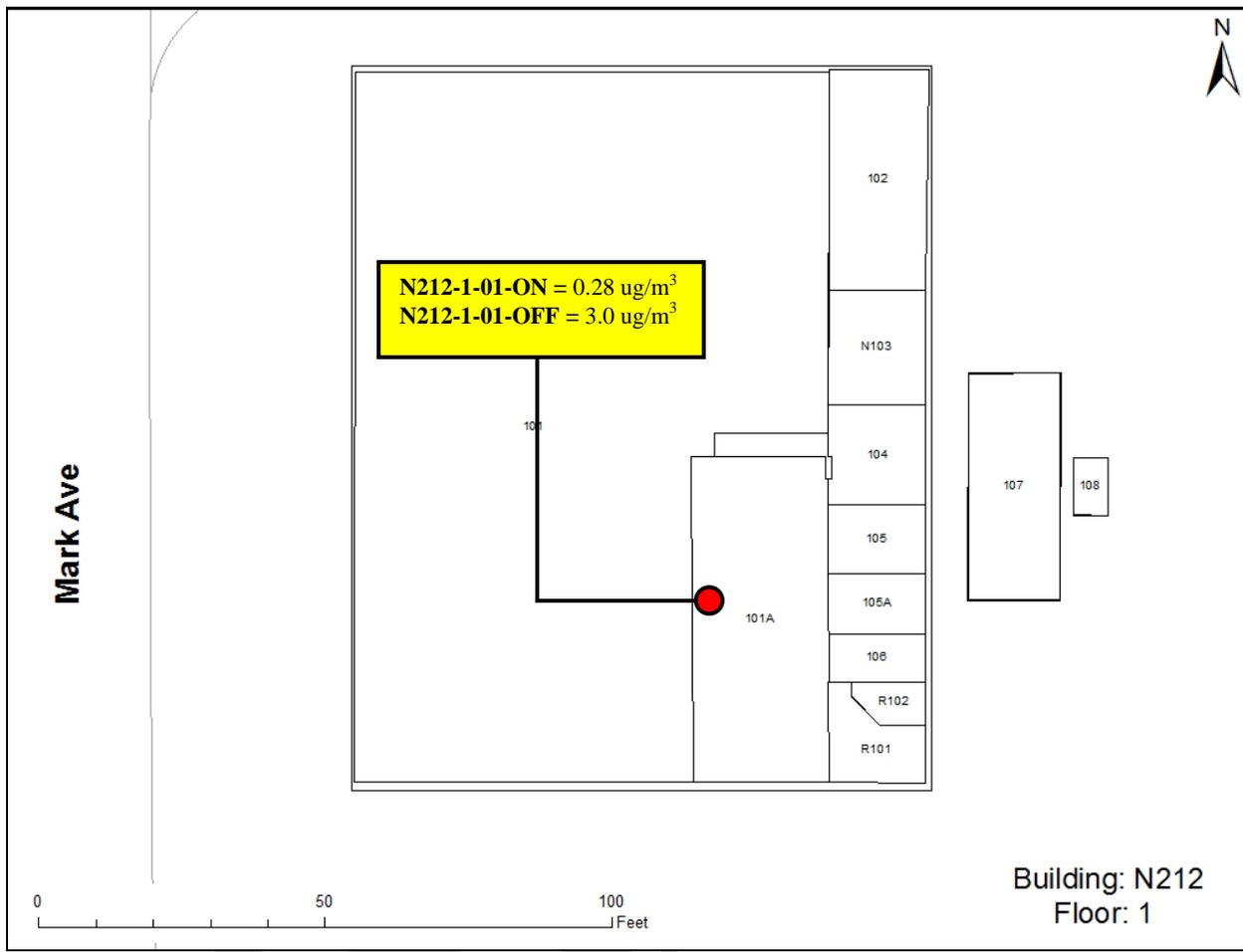


Figure 4: Building N212 Vapor Sample Location and PCE Results

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential for short-term exposure risk with the HVAC-ON operational mode during normal business hours; however, there appears to be a potential of an exposure risk to PCE under the long-term cleanup level criteria during HVAC-OFF events. Additional air sampling may be necessary in the N212, Room 101A area.

3.3 Building 213 – Facilities Engineering

Building Description: Building N213 is approximately 12,000 square feet of floor space, and consists of a two story concrete building plus a full basement. The building is occupied by the Ames Engineering and Facilities Divisions, and consists of general office and conference room space, the facility GIS division, the Ames engineering document control center and general storage space. There is also two (2) mechanical equipment rooms located in the basement which primarily contain compressors and boilers.

Number of Discrete Samples Collected: Indoor air samples were collected at a number of locations spaced throughout the basement and 1st floor areas (see Figures 4 and 5 in Attachment A). Nine (9) HVAC-OFF air samples were collected from the basement and 1st floor portions of the building, while 11 HVAC-ON air samples were collected from the basement and 1st floor portions. Four (4) 5-minute grab samples were also collected from the basement portion of the building.

Sample Locations: Of the nine (9) HVAC-OFF air samples collected in Building N213, three (3) plus one (1) duplicate were collected in the basement portion, and five (5) were collected from the 1st floor portion.

The three samples collected in the basement during HVAC-OFF were collected from Rooms 004 and 025, and from the hallway area C004 (see Figure 4 in Attachment A). The sample collected in Room 004 was originally proposed to be collected from the Room 003 area; however, the 003 area is a closed, secured computer server area, whereas the adjacent Room 004 area is an occupied office area. Similarly, the sample collected in Room 025 was originally proposed to be collected in the Room 022 area; however, the 022 area was an open storage area as opposed to the Room 025 area which is an occupied office located across the hallway from the open 022 storage area. A duplicate air sample was also collected from the 025 office area.

The five (5) HVAC-OFF air samples collected from the 1st floor areas were collected from all proposed areas (Rooms 103, 104, 104F, and hallways outside Rooms 132 and 146)(see Figure 5 in Attachment A). The hallway area sample containers were placed on the floor with sample tubing taped to the adjacent wall with the upper end near the breathing zone.

Of the 11 HVAC-ON air samples collected in building N213, three (3) plus two (2) duplicates were collected in the basement portion and five (5) plus one (1) duplicate were collected from the 1st floor portion (see Figures 4 and 5 in Attachment A).

The three (3) HVAC-ON air samples collected in the basement were collected in the same areas as the HVAC-OFF (Rooms 004, 025 and C004), including one (1) duplicate in each of Rooms 004 and 025.

The five (5) HVAC-ON air samples collected on the 1st floor were collected in the same areas as the HVAC-OFF air samples, including one (1) duplicate sample from the Room 103 area.

Four (4) 5-minute grab samples were also collected during HVAC-ON from the basement portion of the building, two (2) from the mechanical Rooms N002 and N042, and two (2) from the elevator under-vault areas V001 and V002 (see Figure 4 in Attachment A).

Sample Duration: 24-hour duration air samples were collected for both the N213 HVAC-OFF and N213 HVAC-ON sample collection events.

Tables and Figures: The results for the building N213 air samples are shown in Table 2. Air analytical results are, however, not posted on a figure due to the very low to non-detect levels of

COCs in all building N213 vapor results. A map showing the N213 sample locations is included in Attachment A. The laboratory reports are included in Attachment D.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: All COCs detected during both HVAC-OFF and HVAC-ON sampling events were well below both the long-term cleanup levels and the ATSDR's short-term action levels. Vinyl chloride was also not detected in any air sample. Sample results are presented in Table 2.

All seven (7) COCs were detected in the four (4) 5-minute grab samples; however, all concentrations were below both the long-term cleanup levels and the ATSDR's short-term action levels.

Evaluation of Analytical Results: There were no detections in the Building N213 air samples of the seven (7) COCs above current action levels, during either the HVAC-OFF or HVAC-ON sampling events. Only one of the 5-minute grab air samples indicated a potential pathway. This sample, N213-B-04-P (HVAC-ON), which was collected from the sample location V001 elevator under-vault area, revealed the presence of TCE at 3.10 ug/m^3 ; however, this concentration is below the long-term cleanup level plus well below the short-term action levels.

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential expose risk under either the long-term cleanup levels or the ATSDR's short-term action levels. Therefore, additional air sampling is not required in Building N213.

3.4 Building N240 – Airborne Missions & Applied Life Sciences Experiments

Building N240 is a 22,000 square foot, concrete building which contains a mixture of office and cubical space plus several areas with NASA mission critical research. The building is used primarily for airspace and spacecraft research, development, and life science research experiments. The building has a central section where the facility research is conducted, with both western and eastern portions that contain the office spaces.

Both 24-hour HVAC-OFF and HVAC-ON vapor samples were collected from the Room 144 area, which is located in the eastern offices portion of the building (see Figure 6 in Attachment A). 24-hour HVAC-ON vapor samples were collected from the central and western portions of the building (Room 115A and hallway area C101); however, 24-hour HVAC-OFF air samples could not be collected in the central and western portions of the building due to the presence of both spacecraft and related mission critical research that required the HVAC system to remain on 24/7. An air sample was collected from Room 115A, a transition room used to enter the “positive pressure” “clean room” Room 113 area which currently contains the mission critical research.

Number of Discrete Samples Collected: Two (2) air samples were collected from the east-central portion of the building, one (1) from the central portion of the building, and one (1) from the western portion of the building, for a total of four (4). One (1) 5-minute grab sample was collected from the E102 elevator vault area also located in the central portion of Building N240. Photographs taken during sampling activities are provided in Attachment B.

Sample Locations: Two (2) air samples were collected from Room 144 area, which is located in the east-central portion of the building. One (1) sample was collected from the Room 115A area and one (1) from the C101 hallway area (see Figure 6 in Attachment A). Both 24-hour HVAC-OFF and HVAC-ON vapor samples were collected from the Room144 area, while only HVAC-ON air samples were collected, one each from the Room 115A and C101 hallway areas. Photographs taken during sampling activities are provided in Attachment B.

Both N240-1-03-OFF and N240-1-03-ON air samples were collected from an area located in the central portion of the Room 144 area. The sample canisters were placed on a desk top for the collection of both N240-3-01-OFF and N240-3-01- ON air samples.

The HVAC-ON sample N240-1-01 collected from the C101 hallway area was placed on the floor with sample tubing taped to the adjacent wall with the upper end near the breathing zone. The N240-1-02-ON sample collected from Room 115A was placed on a shelf at breathing level.

One (1) 5-minute grab air sample was also collected as proposed from the 1st floor elevator vault at E102 (see Figure 6 in Attachment A).

Sample Duration: 24-hour duration air samples were collected for both the N240 HVAC-OFF and N240 HVAC-ON sample collection events.

Tables and Figures: The results for the building N240 air samples are shown in Table 2. Air analytical results are, however, not posted on a figure due to the very low to non-detect levels of COCs in all building N240 vapor results. A map showing the N240 sample locations is included in Attachment A. The laboratory reports are included in Appendix D.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: All COCs detected during both HVAC-OFF and HVAC-ON sampling events were well below both the long-term cleanup levels and the ATSDR's short-term action levels. Vinyl chloride was also not detected in any air sample. Sample results are presented in Table 2.

Evaluation of Analytical Results: There were no detections in the Building N240 air samples of the seven (7) COCs above current action levels, during either the HVAC-OFF or HVAC-ON

sampling events. The one (1) 5-minute grab air sample collected from the elevator under-vault at location E102, N240-1-04-P, indicated a potential pathway with TCE at 1.70 ug/m³; however, this concentration is below both the long-term cleanup level plus well below the short-term action levels.

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential for short-term exposure risk due in either the HVAC-OFF or HVAC-ON operational modes for the Room 144 area, plus for the HVAC-ON operation mode for the central and western portion of Building N240. However, due to the presence of mission critical operations, HVAC-OFF indoor air status of the central and western portions of the building could not be determined due to the requirement for 24/7 HVAC-ON. Additional air sampling may, therefore, be necessary in N240.

3.5 Building N245 – Space Science Research Laboratory

Building N245 is a two story concrete building plus basement that is approximately 70,000 square feet which contains a mixture of office, research, fabrication shop and theatre space. The building is used primarily for research related to existence of life in “foreign” or non-earth atmospheres. Earth science research is also conducted in this building.

Both 24-hour HVAC-OFF and HVAC-ON vapor samples were collected from the Room 147 area, which is located in the south central portion of the building (see Figure 7 in Attachment A). Room 147 is primarily occupied office cubicle area.

Number of Discrete Samples Collected: Two (2) air samples were collected from Room 147, which is located in the east-central portion of the building, and is approximately 1,200 square-feet in area.

Sample Locations: Indoor air samples were collected from an area located on the eastern portion of Room 147. The sample canister was placed on a desk top for the collection of both N245-1-01-OFF and N245-1-01- ON air samples. Sample location photographs taken during sampling activities are provided in Appendix B.

Sample Duration: 24-hour duration air samples were collected for both the N245 HVAC-OFF and N245 HVAC-ON sample collection events.

Tables and Figures: The results for the building N245 air samples are shown in Table 2. Air analytical results are, however, not posted on a figure due to the very low to non-detect levels of COCs in all building N245 vapor results. A map showing the N245 sample locations is included in Attachment A. The laboratory reports are included in Appendix D.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: Three (3) of the seven (7) COCs were detected. All remaining COCs were non-detect. Sample results are presented in Table 2.

Evaluation of Analytical Results: The three (3) COC detected were TCE, PCE and cis-1,2-DCE, all well below the long-term cleanup levels and the ATSDR's short-term action levels.

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential expose risk under either the long-term cleanup levels or the ATSDR's short-term action levels. Therefore, additional air sampling is not required in Building N245.

3.6 Building T20G – Modular Office Units

Building T20G is a 15,000 square foot, one (1) story modular office building with offices, conference rooms, and a small “wet lab” space used exclusively for environmental sample and equipment storage. The building is utilized to house primarily environmental and mission support staff.

Number of Discrete Samples Collected: Four (4) indoor air samples were collected from the T20G office complex. Both 24-hour HVAC-OFF and 24-hour HVAC-ON vapor samples were collected from the originally proposed sample locations (see Figure 8 in Attachment A).

Sample Locations: Indoor air samples were collected from the hallway areas adjacent to the Room 102 and Room 189 areas, which are office areas located on the western and south central portions of the building. Samples T20G-1-01-OFF/ON were collected in the hallway adjacent to Room 102, while T20G-1-02-OFF/ON air samples were collected in the hallway adjacent to Room 189. Hallway area air sample containers were placed on the floor with sample tubing taped to the adjacent wall with the upper end near the breathing zone.

Sample Duration: 24-hour duration air samples were collected for both the T20G HVAC-OFF and T20G HVAC-ON sample collection events.

Tables and Figures: The results for the building T20G air samples are shown in Table 2. Air analytical results are, however, not posted on a figure due to the very low to non-detect levels of COCs in all building T20G vapor results. A map showing the T20G sample locations is included in Attachment A. The laboratory reports are included in Appendix D.

Quality Assurance/Quality Control: To ensure the integrity of air sample collections, a canister specific tag, which included the sample location ID, was attached to each Summa canister. The tag label included sample ID, sample start and finish times/dates, sample collector plus canister pre- and post- sample collection pressures. A picture of the staged Summa canister was also taken and is included in Appendix B.

Air Sampling Results: All COCs detected during both HVAC-OFF and HVAC-ON sampling events were below both the long-term cleanup levels and the ATSDR's short-term action levels. Vinyl chloride was also not detected in any air sample. Sample results are presented in Table 2.

Evaluation of Analytical Results: PCE was detected in one (1) sample, T20G-1-02-ON, at 1.7 ug/m³. This concentration is close to the PCE concentration detected in the background sample (N258-1-01-ON) collected at the same time, which was 1.3 ug/m³. All remaining COCs were either non-detect or at significantly lower levels.

Recommendations and Follow-up Actions: Based on these data, there appears to be no potential expose risk under either the long-term cleanup levels or the ATSDR's short-term action levels. Therefore, additional air sampling is not required in Building T20G.

4 Findings and Conclusions

NASA collected forty-one vapor (41) samples to evaluate the vapor intrusion pathway in six occupied buildings on the NASA Ames campus.

Two (2) of the six buildings sampled under HVAC-OFF conditions revealed the presence of two of the seven COCs above the EPA long-term cleanup level but below the ATSDR's short-term action levels. The vapor sampling results are presented in **Table 2**, and the results and conclusions are detailed in *Sections 3.1 through 3.6*. TCE and PCE results are also presented for the six buildings, along with the background results, in the following **Figures 5** through **8**.

The **N144 FEMA warehouse Room 141** area results indicated the presence of TCE at 7 ug/m³, which is slightly above the long-term cleanup level of 5 ug/m³ for TCE, but well below the short-term action level of 540 ug/m³. PCE was also present at 1.8 ug/m³, but was also below the PCE long-term cleanup level of 2 ug/m³.

Based on these results, *additional vapor sampling and analysis is recommended for this office area.*

The **N212 building Room 101A** area results indicated the presence of PCE at 3.0 ug/, which is slightly above the PCE action level of 2 ug/m³. TCE and cis-1,2-DCE were also detected in indoor air samples, however, at concentrations well below the long-term cleanup levels and the ATSDR's short-term action levels.

Based on these results, *additional vapor sampling and analysis is recommended for the Room 101A shop area.*

As shown in **Table 2**, analytical results for the five (5) "grab" samples indicated that the COCs present were all below both the EPA long-term cleanup levels and the ATSDR's short-term action levels. There is, therefore, *no further action recommended for the "grab" sample areas.*

Figure 5: TCE Air Concentrations

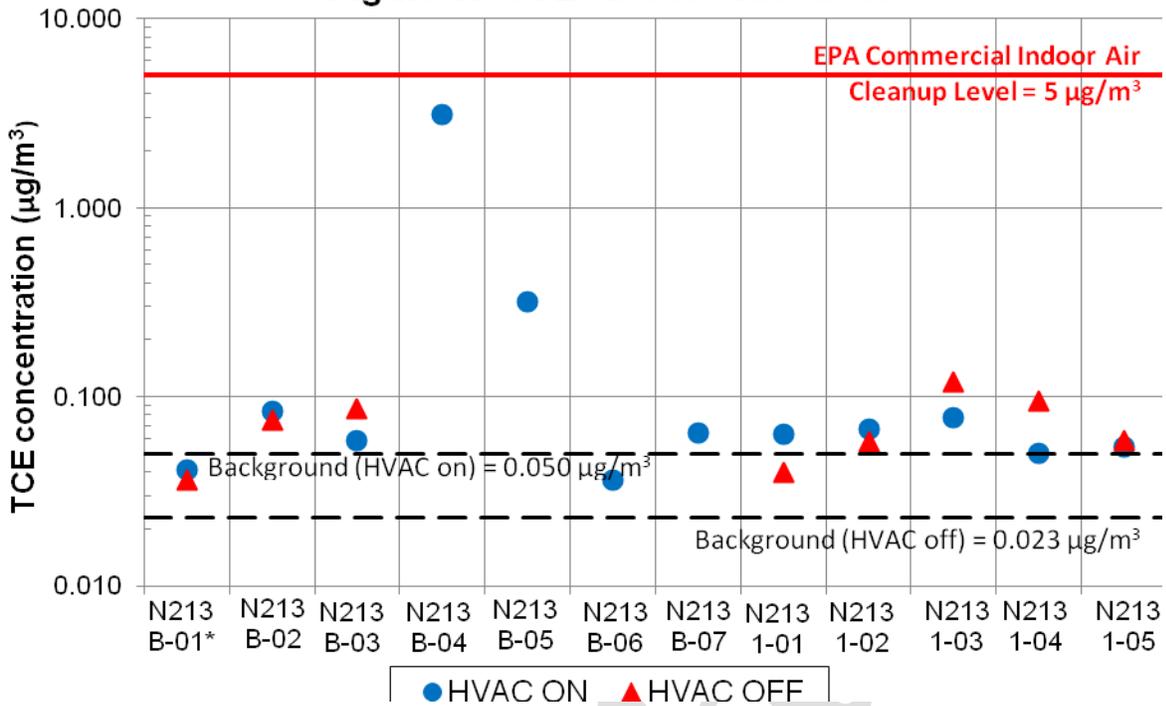


Figure 6: TCE Air Concentrations

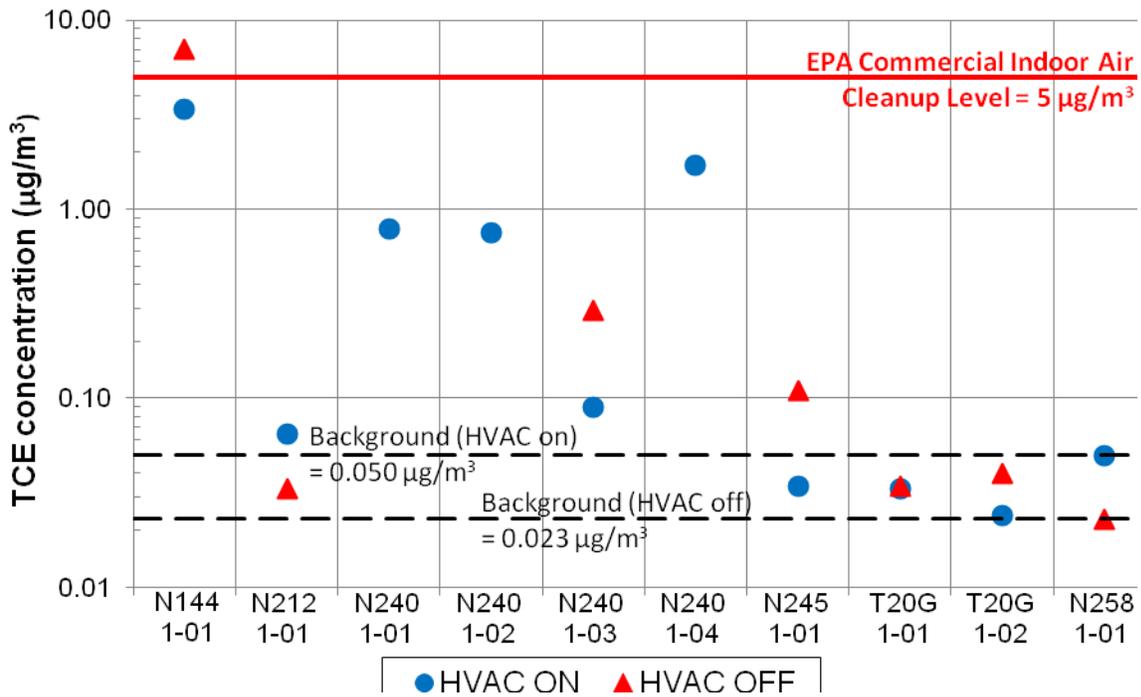


Figure 7: PCE Air Concentrations

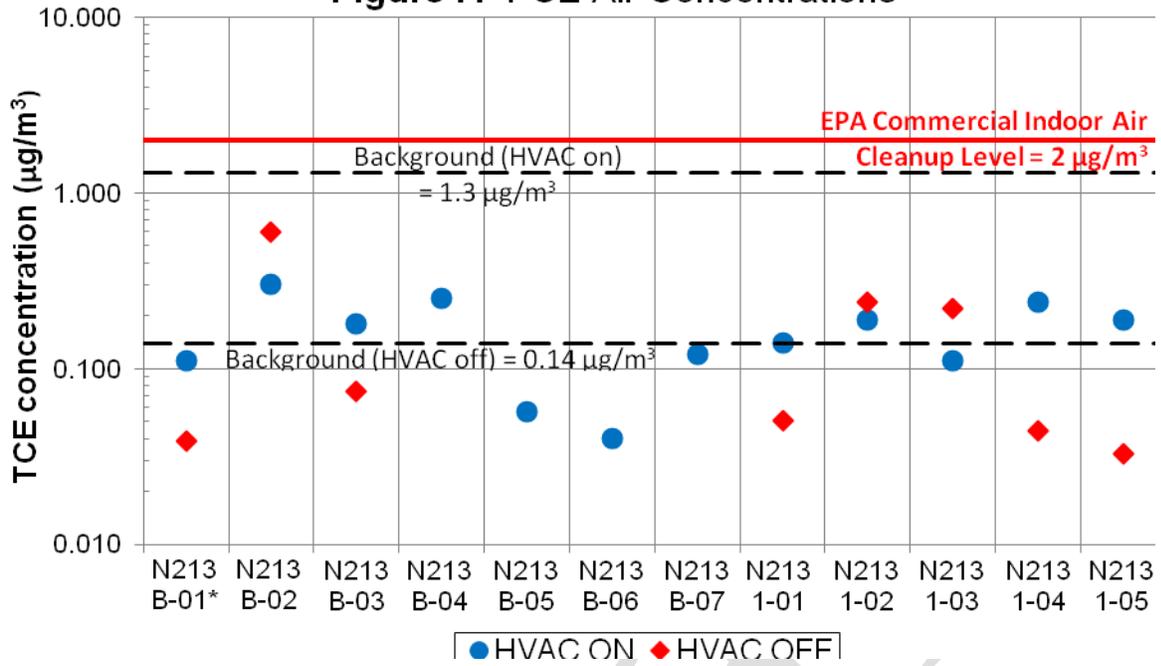
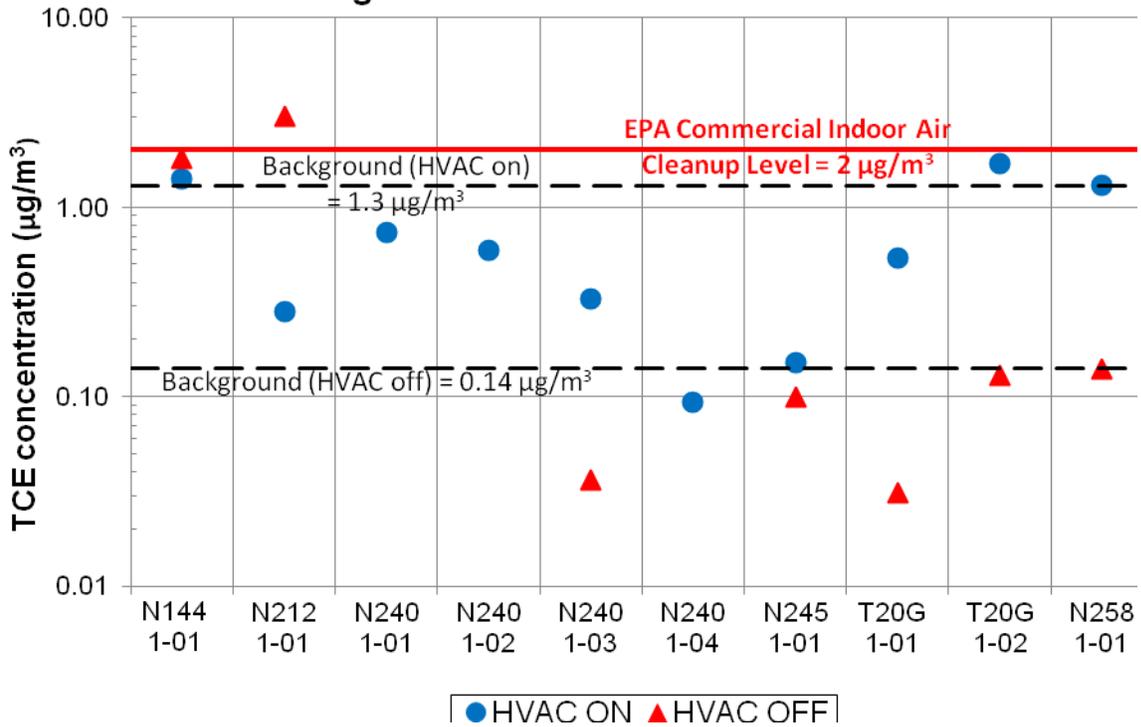


Figure 8: PCE Air Concentrations



5 References

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Draft

Attachment A

Building Vapor Sample Location Maps

Draft

Attachment B

Vapor Sampling Location Photographs

Draft

Attachment C

Building Questionnaire Forms

Draft

Attachment D

Laboratory Reports
(Including QA/QC)

Draft