FINAL

Remedial Investigation Work Plan
AOU-1: East Side Springs
700 South 1600 East PCE Plume
Salt Lake City, Utah

BPA No. VA259-14-A-0021
TO No. VA259-14-J-4311

July 17, 2015

Prepared for: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

APPENDIX C

FINAL

Health & Safety Plan
Remedial Investigation Workplan
700 South 1600 East Street PCE Plume
U.S. Department of Veteran's Affairs
Salt Lake City, Utah

BPA No. VA259-14-A-0021
TO No. VA259-14-J-1384

July 17, 2015

Prepared for: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

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Site Emergency Contacts

Medical Emergency – 911 University of Utah Health Care 50 N Medical Drive, Salt Lake City, UT 84132	**Utilities Emergency Phone Numbers – 911** Water: 911 Gas: 911 Electric: 911
Fire/Spill Emergency – 911 Facility Fire Response: 911 Local Fire Dept.: 911	**Federal Express Dangerous Goods Shipping** Phone: 800-238-5355
Security & Police – 911 Local Police: 911	**CHEMTEL (hazardous material spills)** **Phone: 800-255-3924**

Site Emergency Information

Facility Alarms: None

Evacuation Assembly Area(s): Due to the wide geographic dispersion of investigation activities, appropriate assembly areas will be identified as part of the daily safety meetings.

Facility/Site Evacuation Route(s): To be provided at daily safety meetings

Directions to Local Hospitals

Local Hospital: University of Utah Health Care
50 N Medical Drive, Salt Lake City, UT 84132

Site Location: The work site location comprises the Plume located generally within the area bounded by 500 South and Michigan Avenue and between Guardsman Way and 1100 East, Salt Lake City, Salt Lake County, Utah. The George E. Wahlen Department of Veterans Affairs Medical Center (VA Medical Center) is located at 500 Foothill Drive, Salt Lake City, UT 84148.

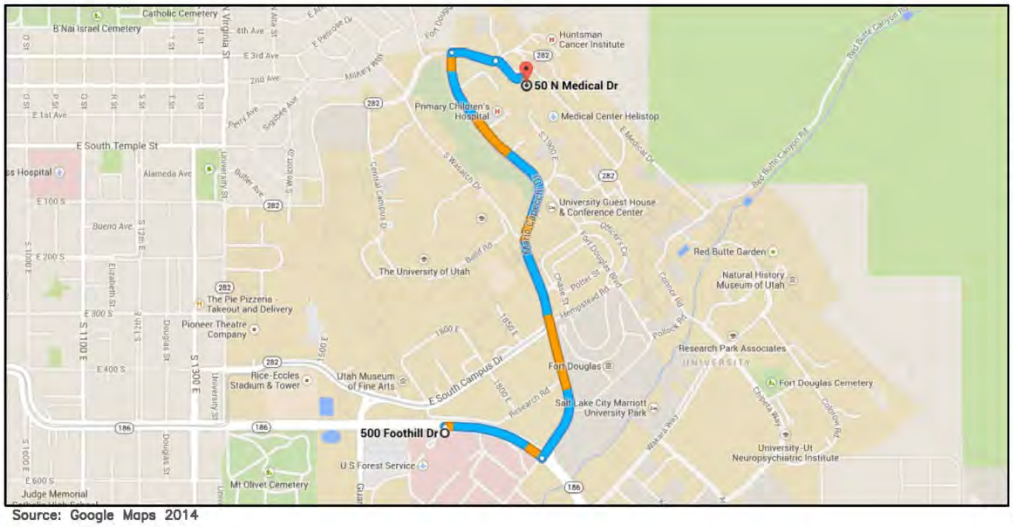
Directions to the local hospital (starting from the VA Medical Center) are presented below and shown in Figure 1:

1. Head **east** on **Foothill Drive** toward **Mario Capecchi Drive**
2. Turn left onto **Mario Capecchi Drive**
3. Turn right onto **N Medical Drive**
4. Slight right to stay on **N Medical Drive**

Destination will be on the right

FINAL

Directions from **500 Foothill Dr** to **50 N Medical Dr**



Source: Google Maps 2014

500 Foothill Dr

Salt Lake City, UT 84148

1. Head **east** on **Foothill Dr** toward **Mario Capecchi Dr**

   0.3 mi

2. Turn **left** onto **Mario Capecchi Dr**

   1.2 mi

3. Turn **right** onto **N Medical Dr**

   0.1 mi

4. Slight **right**

   Destination will be on the right

   463 ft

50 N Medical Dr

Salt Lake City, UT 84132

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Map data ©2014 Google

VA HOSPITAL

SALT LAKE CITY UTAH

ROUTE TO HOSPITAL

FIGURE 1

SW NM

AS SHOWN

4/11/2014 4/11/2014

FIRST ENVIRONMENT

BOONTON NEW JERSEY

File: I:\DEPVA030\CAD\VA-Hospital.dwg

Team Emergency Contacts	
First Environment, Inc.	**CH2M Hill**
24-hour Injury and Illness Reporting Contact – 732-887-4375 **Responsible Health & Safety Manager** **Devin DeMarco, CHMM, CPEA**	
Project Responsible Health & Safety Manager Devin DeMarco, CHMM, CPEA 732-887-4375 (cell) or 973-334-0003 (office)	**Director – Health, Safety, Security & Environment** Andy Strickland/DEN 720-480-0685 (cell) or 720-286-2393 (office)
	Health and Safety Manager Josh Painter 303-993-9274
Human Resources Department Scott Kymer 973-632-6741 (cell) or 973-334-0003 (office)	**Human Resources Department** Phone: Employee Connect toll-free number 1-877-586-4411 (U.S. and Canada)
Worker's Compensation: Scott Kymer 973-632-6741 (cell) or 973-334-0003 (office)	**Worker's Compensation:** Contact Market HR dept. to have form completed or contact Jennifer Rindahl after hours: 720-891-5382
Media Inquiries Corporate Strategic Communications Kristy Cerullo 908-625-6031 (cell) or 973-334-0003 (office)	**Media Inquiries Corporate Strategic Communications** John Corsi 720 286-2087
Automobile Accidents Scott Kymer 973-632-6741 (cell) or 973-334-0003 (office)	**Automobile Accidents** Rental: Jennifer Rindahl/DEN 720-286-2449 CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057
Project Manager Ed Reid, P.G. 678-787-2295 (cell) or 770-424-3344 (office)	**Project Manager** Name: David Waite Phone: 801-350-5272 801-560-8307 (cell)
Site Safety Coordinator (SC) Ed Reid, P.G. 678-787-2295 (cell) or 770-424-3344 (office)	**Safety Coordinator (SC)** Name: George Tangalos Phone: 801-350-5224 971-506-0917 (cell)
	Project Environmental Manager Name: Nancy Ballantyne Phone: 720-286-5561 303-885-9954 (cell)
Medical Consultant Jeffrey S. Liva, M.D., M.P.H., M.S Preventive Plus One West Ridgewood Ave, G1 Paramus, NJ 07652 201-444-3060	**Medical Consultant** WorkCare Dr. Peter Greaney, M.D. 300 S. Harbor Blvd, Suite 600 Anaheim, CA 92805 800-455-6155/866-893-2514 714-978-7488

Additional subcontractors will provide their relevant information as engaged in the Project.

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ATTACHMENT 3 – Hazardous Control Procedures
ATTACHMENT 4 – MSDS Sheets

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LIST OF ACRONYMS

1,2-DCE	cis-1,2-dichloroethylene
AHA	activity hazard analysis
AOU	accelerated operable unit
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COC	contaminants of concern
DPT	direct push technology
HASP	health and safety plan
HAS	hollow stem auger
IDW	investigation derived waste
OU	operable unit
PCE	tetrachloroethylene
Ppb	part per billion
PPE	personal protective equipment
PTSP	Pre-Task Safety Plans
RHSM	Responsible Health & Safety Manager
RIWP	remedial investigation work plan
SDS	Safety Data Sheet
SC	Site Safety Coordinator
TCE	trichloroethylene
VA	U.S. Department of Veterans Affairs

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1.0 Introduction

This health and safety plan (the HASP or Plan) supports the remedial investigation work plan (RIWP) developed for the U.S. Department of Veterans Affairs' (VA) Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Environmental Cleanup (Project) for the 700 South 1600 East Street Tetrachloroethylene (PCE) Plume (Plume) located in Salt Lake City, Utah (Site). The HASP accounts for currently known or suspected health and safety hazards and risks associated with those field activities to be executed under the RIWP. The HASP identifies appropriate controls to minimize the risks associated with each of the identified hazards. All field operations performed to implement the RIWP will be conducted in accordance with this HASP and relevant health and safety regulatory requirements.

The HASP has been developed by First Environment, Inc. (First Environment) in conjunction with its principal subcontractor CH2M Hill (the First Environment Team or Team). First Environment's Responsible Health & Safety Manager (RHSM) is the lead authority responsible for the accuracy and comprehensiveness of the HASP and maintains overall responsibility for Site health and safety. Team subcontractors may implement additional field health and safety requirements only if those requirements provide the same or greater level of protection as the safety measures stipulated in this HASP.

This HASP is designed to be updated as new Site information and hazards are identified, field commitments change, and to account for any necessary corrective actions (lessons learned). This Plan will be reviewed, and as necessary, updated by the RHSM in accordance with the revision schedule and prior to the initiation of any field tasks not specifically referenced herein.

2.0 Approval

This Plan has been written for use by the First Environment Team performing work at the Site. The Team claims no responsibility for its use by others unless that use has been specified and defined in Project or contract documents. The HASP is written as an oversight document to execute those field activities needed to implement the Project's RIWP and work tasks described herein and must be amended to account for any field efforts not previously referenced in the Plan.

By approving this HASP, the RHSM certifies that the selected health and safety controls are based on a Project-specific Activity Hazard Analysis (AHA).

Original Plan:

Plan Prepared by:		First Environment, Inc.		Date:	
Plan Reviewed/Approved by:		Devin DeMarco, CHMM, CPEA – Responsible Health and Safety Manager		Date:	
Project Manager Review:		Ed Reid, P.G.		Date:	
Site Safety Coordinator Review:		Ed Reid, P.G.		Date:	

Revision Section[1]:

Description of Revisions to Plan:

Revision Prepared by:		First Environment, Inc.		Date:	
Revision Reviewed/Approved by:		Devin DeMarco, CHMM, CPEA – Responsible Health and Safety Manager		Date:	
Project Manager Review:		Ed Reid, P.G.		Date:	
Site Safety Coordinator Review:		Ed Reid, P.G.		Date:	

[1] As necessary, additional revision sections are added to the Plan and the document footer is revised to reflect the current effective date.

3.0 Applicability

This HASP applies to:

- all First Environment Team staff, including subcontractors and tiered subcontractors, working at the Site;
- all visitors to the Site in the custody of the First Environment Team (including visitors from the VA, other government officials, and general public).

Subcontractors and tiered subcontractors shall also follow any of their company-specific health and safety programs and site-specific HASP requirements. However, these shall be no less stringent than the contents of this Plan. Such programs shall be submitted to First Environment in advance of any work occurring at the Site with any conflicts resolved by the RHSM.

This HASP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of the First Environment Team.

This HASP defines the health and safety hazards identified for the Site and the procedures and requirements for the mitigation of such hazards associated with the site investigation activities identified in the RIWP. The Site includes the complete Project area, as defined by the RIWP, including any Project offices, trailers, and facilities thereon.

This HASP will be available at the Site during field activities and will be reviewed in accordance with the revision schedule. The HASP adopts, by reference, First Environment Enterprise-Wide Operational Control Procedures, as appropriate. In the event of a contradiction between this HASP and any governing regulation, the more stringent and protective requirement shall apply.

All First Environment Team members will sign the employee sign-off form (attached to this HASP) to acknowledge their review of this document. Copies of the signature page will be maintained at the Site by the Site Safety Coordinator (SC).

4.0 General Project Information

4.1 Project Information and Background

First Environment Project Number: DEPVA030	**Project/Site Name:**	700 South 1600 East Street PCE Plume
Client: U.S. Department of Veterans Affairs George E. Wahlen VA Medical Center	**Client Address:**	500 Foothill Drive Salt Lake City, Utah 84148

4.2 Site Background and Setting

The George E. Wahlen VA Medical Center (Facility) is located in a mixed residential and commercial area near the University of Utah in Salt Lake City, Utah (City). The Facility operated a part-time dry-cleaning service utilizing tetrachloroethylene (PCE) from approximately 1976 through 1984. As a result of these activities, PCE was discharged to the environment and a PCE plume has been detected in the neighborhood of 700 South 1600 East Street within an area of approximately 300 acres. PCE has been detected at part per billion (ppb) levels in one of Salt Lake City's secondary drinking water supply wells (closed in 2004). PCE has also been detected at ppb levels in shallow and deep groundwater, surface water springs, and in soil gas. Figure 2 presents a Site location map.

4.3 Description of Tasks

Field work tasks covered by this HASP include multi-media field sampling and well drilling and installation. Work will take place in streets and residential settings to support the RIWP for AOU1 (East Side Springs) and OU2 (source area), as shown in Figure 3. Low-level PCE groundwater contamination (up to 300 ppb) within the Plume is known with selected detections of TCE at lower concentrations.

Below is a description of the tasks covered by this Plan. Any additions or changes in scope will require a revision to this HASP in accordance with the Change Management provisions of the document (see Section 4.4).

The Site activities covered by the Plan include:

AOU-1

- surface water sampling;
- installation of shallow temporary groundwater sample points,
    - groundwater sampling;
- installation of vadose zone soil vapor sampling points,
    - soil gas sampling;
- installation of monitoring wells,
    - groundwater sampling;
- indoor air sampling.

OU-2

- installation of monitoring wells,
    - soil sampling,
    - groundwater sampling.

Site activities accounted for in the Plan also include mobilization/demobilization, utility location, traffic control, and the management of Investigation Derived Waste (IDW). Well drilling and installation referenced above includes roto-sonic, hollow stem auger, and direct push technology drilling.

4.4 Change Management

Changes to this HASP will be documented and approved by the First Environment RHSM. At a minimum, the Plan will be reviewed every four months with documentation of the review made. The need for a revision to the HASP may be identified by the SC or other First Environment Team members who will communicate this need to the RHSM. The following are examples of changes that may require a revision to the Plan:

- change in First Environment Team staff;
- new subcontractor to perform work;
- new chemicals, materials, tools, or equipment brought to Site for use;
- change in scope or addition of new tasks;
- change in contaminants of concern (COCs) or change in concentrations of COCs; and
- new hazards or hazards not previously addressed in the Plan.

Changes to the HASP will be documented in the Revision Section of the Plan and accepted by the RHSM. The SC may make revisions to the HASP in the field in ink and initial them when approved by the RHSM so long as a formal amendment to the Plan accounting for the revision is completed within five business days. HASP revisions are not required for safety-related changes that the SC or RHSM would normally make in the field in accordance with the Plan's parameters, such as upgrading or downgrading personal protective equipment (PPE) in accordance with pre-established action levels, expansion or reduction of work control zones based on monitoring results, and similar changes made within the operating parameters of the HASP. The field copy of the HASP shall be kept up-to-date in accordance with the Revision Schedule.

4.5 Subcontractor Health & Safety Initial Meeting

An initial subcontractor health and safety meeting will be held with Team subcontractors performing field work on the Project. The purpose of the meeting shall be to discuss and agree on key health and safety requirements for individual subcontracted tasks and to emphasize and reinforce the Team's expectations for subcontractor safety performance. The target audience includes Team Project staff having health and safety responsibilities (e.g., RHSM, SC) and key subcontractor staff (e.g., project manager, foreman, designated field health and safety lead). The meeting will emphasize that any subcontractors who do not understand any of these provisions should contact the RHSM for clarification. For small-scale projects (e.g., small drill

crew and limited Team staff), all subcontractor crew members shall attend, if available. The meeting shall be held prior to or at the completion of mobilization, with enough time to ensure that identified health and safety concerns can be addressed prior to the start of work. The meeting may be held over the phone or in person depending on Project needs. Sign-in sheets acknowledging the HASP are provided as Attachment 1.

4.6 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings shall be held with all Team personnel to review the hazards, controls, and required procedures that apply to each day's activities and to review any relevant environmental issues, requirements, and/or best management practices. All participants shall sign a sign-in form to confirm their attendance at the meeting. The Project's daily safety meeting sign-in sheet is included as Attachment 2.

Individual Pre-Task Safety Plans (PTSP) may serve as daily safety meetings to account for multiple, independent site investigation activities that are dispersed throughout the Site and occurring simultaneously. The PTSPs shall be completed by individual crews on an as-needed basis to focus on those hazards posed by their specific work. For this scenario, each crew shall complete a safety meeting sign-in sheet to establish a record of the meeting.

5.0 Project Organization and Responsibilities

5.1 Client

Client Name:	U.S. Department of Veterans Affairs George E. Wahlen VA Medical Center
Phone:	801-582-1565
Facility Contact Name:	D. Lynne Welsh, Remedial Manager/CERCLA RPM
Phone:	801-582-1565, x2021

5.2 First Environment

Project Manager:	
PM Name:	Ed Reid, P.G.
Office:	GA
Telephone number:	770-424-3344
Cellular Number:	678-787-2295

Environmental Manager:	
EM Name:	Ed Reid, P.G.
Office:	GA
Telephone number:	770-424-3344
Cellular Number:	678-787-2295

Responsible Health and Safety Manager:	
RHSM Name:	Devin DeMarco, CHMM CPEA
Office:	NJ
Telephone number:	973-334-0003
Cellular Number:	732-887-4375

Site Safety Coordinator:	
SC Name:	Ed Reid, P.G.
Office:	ATL
Telephone: number:	770-424-3344
Cellular: Number:	678-787-2295

5.3 CH2M Hill

Project Manager:	
PM Name:	David Waite
Office:	SLC
Telephone number:	801-350-5272
Cellular Number:	801-560-8307

Environmental Manager:	
EM Name:	Nancy Ballantyne
Office:	DEN
Telephone number:	720-286-5561
Cellular Number:	303-885-9954

Health and Safety Manager:	
RHSM Name:	Josh Painter
Office:	DEN
Telephone number:	303-993-9274
Cellular Number:	303-993-9274

Safety Coordinator:	
SC Name:	George Tangalos
Office:	SLC
Telephone: number:	801-350-5224
Cellular: Number:	971-506-0917

5.4 First Environment Team Subcontractors

Subcontractor: TBD	
Contact Name:	
Telephone number:	
Cellular Number:	

Subcontractor: TBD	
Contact Name:	
Telephone number:	
Cellular Number:	

6.0 Standards of Conduct

All individuals associated with this Project must work injury-free and drug-free and must comply with all requirements of this HASP. Subcontractors must also comply with the safety requirements of the subcontractors' HASP so long as those requirements provide the same or greater level of protection as the safety measures stipulated in this HASP.

7.0 Activities Hazard Analysis

Table 1 below presents the results of the First Environment Team's Activity Hazard Analysis (AHA) for the Site investigation activities identified in Section 4.3 (Description of Tasks). Specific investigation activities are listed in the table with relevant hazards identified for each activity. Risks associated with each hazard have been evaluated for scale and appropriate controls, with the results presented in the table. The presented controls account for First Environment's corporate procedures that address engineering, project administration, and the assignment and use of PPE. Hazard control procedures are presented as Attachment 3.

The AHA table includes the following for each planned Site activity:

- identification of hazards;
- assessment of risk associated with each identified hazard; and
- identification of controls that minimize or eliminate the risk.

Supplemental Project-specific safety control measures developed by the RHSM for each high-risk rating or risk not fully defined are presented in Section 7.1. A summary of the PPE requirements for the Site developed through the completion of the AHA are presented in Section 11.

Team subcontractors are required to provide completed hazard analysis specific to their scope-of-work on the Project for acceptance by the Team prior to the start of field activities. The completed analysis shall be accompanied by the subcontractor's project-specific safety plan, and any safety procedures deemed necessary by the RHSM.

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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Physical Hazards								
Bloodborne Pathogens	Body Fluid Residue Or Waste From Worker Injury	L	L	L	L	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64K Emergency Response Plans; Procedure 11.5 – Sample Handling and Waste Disposal; Procedure 4.4.64J – Site Control; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
L – Hazard exposure presents low risk (injury unlikely)
U – Hazard exposure not fully defined (incomplete information)

FINAL

TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	**Hazard Association**	**Site Activities**						**Controls**
		AOU 1				**OU-2**		
		Soil Gas Sampling	**Groundwater Sampling**	**Surface Water Sampling**	**Indoor Air Sampling**	**Groundwater Well Drilling and Installation and Soil Sampling**	**Groundwater Monitoring Well Sampling**	
Chemicals and Wastes	Sampling, Decontamination, Well Development and Purge water, Spent PPE, Drill Cuttings; Concrete Work, Spills	L	M	L	L	M	M	Procedure 11.13 – Respiratory Protection; Procedure 4.4.64N – Hazard Communication; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 11.5 – Sample Handling and Waste Disposal; Procedure 4.4.64J – Site Control Procedure 4.4.64K; Emergency Response Plans; Mandatory OSHA Training
Compressed Gases	Natural Gas, Propane, Hydrogen, Oxygen, Acetylene	L	L	L	L	M	L	Procedure 4.4.6.4I – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Confined Space	Excavations and Pits, Storage Tanks, Stacks, Non-Building Structures	N/A	N/A	N/A	N/A	N/A	N/A	Procedure 11.14 – Respiratory Protection; Procedure 4.4.64P - Permit-Required Confined Space Program; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64K Emergency Response Plans; Mandatory OSHA Training
Conveyors	Compression, Crushing, Amputation	N/A	N/A	N/A	N/A	N/A	N/A	Procedure 4.4.6.4I – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Driving	Operating Motor Vehicles	L	L	L	L	L	L	Procedure 4.4.6.4I – Site Health and Safety; Mandatory OSHA Training; Driver's License

N/A – Hazard not associated with activity.
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Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Electric Shock	Generators, Welding Machines, Electrical Service Installation. Extension Cords, Electric Powered Equipment	L	L	L	L	L	L	Procedure 4.4.64O - Lockout/Tagout; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.6.4I – Site Health and Safety; Procedure 4.4.64 K – Emergency Response Plans; Mandatory OSHA Training
Ergonomics	Repetitive Motion	M	M	M	M	M	M	Procedure 4.4.6.4.I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Explosion	Explosive Material and Chemicals, Batteries	L	L	L	L	L	L	Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64K Emergency Response Plans; Mandatory OSHA Training

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		AOU 1				**OU-2**		
		Soil Gas Sampling	**Groundwater Sampling**	**Surface Water Sampling**	**Indoor Air Sampling**	**Groundwater Well Drilling and Installation and Soil Sampling**	**Groundwater Monitoring Well Sampling**	
Exposure To Elements	Extreme Heat, Sunburn, Heat Exhaustion, Extreme Cold, Frostbite	M	M	M	L	M	M	Procedure 4.4.6.4I – Site Health and Safety; Mandatory OSHA Training
Falling Material	Cranes, Rigging, Drlling Rigs	L	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Fire	Batteries, Facility Fire	L	L	L	L	L	L	Procedure 4.4.64K – Emergency response Plans; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Fumes	Sampling, Fossil Fueled Equipment Operation	L	L	L	L	L	L	Procedure 11.14 – Respiratory Protection; Procedure 4.4.64N – Hazard Communication; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Hand Tools	Knives, Hammers, Screw Drivers, Wrenches, Shovels, Pick Axes	M	M	M	L	M	M	Procedure 4.4.64I – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Hazardous Energy (Lock Out Tag Out)	Drilling Rigs, Generators, Direct Push Probes	L	N/A	N/A	N/A	L	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64O - Lockout/Tagout; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64K Emergency Response Plans; Mandatory OSHA Training
High Temperature And Flame	Welding	N/A	N/A	N/A	N/A	L	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.6.4I – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
L – Hazard exposure presents low risk (injury unlikely)
U – Hazard exposure not fully defined (incomplete information)

TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
High Velocity Flying Material	Drilling, Cutting, Sawing,	L	N/A	N/A	N/A	M	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Material Handling	Drilling, Manual Lifting	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Moving Equipment	Forklifts, Construction Equipment	L	N/A	N/A	N/A	L	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Moving Machinery/Hydraulic Parts	Drilling Rigs, Direct Push Probes	M	N/A	N/A	N/A	M	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Moving Vehicles	Motor Vehicles, Drilling Rigs, Trucks	H	L	L	L	H	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training; See Section 7.1 of Plan
Noise	Equipment, Vehicles, Drilling Rig, Direct Push Probe, Generator Operation	H	L	L	L	H	L	Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training; See Section 7.1 of Plan
Obstructed Vision	Night Work	L	L	L	L	L	L	Procedure 4.4.6I; Site Health and Safety; Mandatory OSHA Training
Particulate/Dust	Road Dust, Excavation	L	L	L	L	M	L	Procedure 11.14 – Respiratory Protection; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Pinch Points	Drilling Rigs, Sampling Equipment, Direct push Probe	H	L	L	L	H	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training; See Section 7.1 of Plan
Power Tools	Drills, Saws, Corers	H	L	L	L	H	L	Procedure 4.4.64I – Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training; See Section 7.1 of Plan
Pressurized Fluids	Hydraulic Hoses	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Protruding Metal	Drilling Rigs, Direct Push Probe	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Radioactive Material	Analytical Equipment, Site Contamination	L	L	L	L	L	L	Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Sharp Objects/Edges	Knives, Saws, Drill Bits, Scissors, Chisels	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Slippery Surfaces	Drilling Rigs, Truck Beds, Uneven Terrain, Wet Terrain; Scaffolds and Platforms	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64J – Site Control: Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
L – Hazard exposure presents low risk (injury unlikely)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Stairways And Ladders	Drilling Rigs, Facilities At Site, Trucks	N/A	N/A	N/A	L	N/A	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Procedure 4.4.64J – Site Control; Mandatory OSHA Training
Substance Abuse	Alcohol, Drugs	L	L	L	L	L	L	Procedure 11.10 – Corporate Health and Safety Overview, Medical Surveillance Program; Employee Emergency Intervention and Health Insurance;
Swinging Suspended Material	Hoists, Rigging	L	N/A	N/A	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Truck Loading And Unloading	Dump Trucks, Flatbed Trucks, Tractor Trailers	M	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Utilities (Overhead)	Electric Power Lines	M	L	L	N/A	M	L	Procedure 11.3 – Intrusive and Remedial Field Activities; Mandatory OSHA Training
Utilities (Underground)	Electric Power Lines, Natural Gas Lines, Sewer Lines, Water Lines, Chemical And Petroleum Pipelines	M	L	N/A	N/A	H	N/A	Procedure 11.3 – Intrusive and Remedial Field Activities; Mandatory OSHA Training; See Section 7.1 of Plan

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	Hazard Association	Site Activities						Controls
		AOU 1				OU-2		
		Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Walking/Working Surfaces	Drilling Platforms	L	L	L	L	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training
Welder's Burn	Acetylene Torch Work	L	N/A	N/A	N/A	M	N/A	Procedure 4.4.64L – Personnel Protective Equipment;
Working Around Material Handling Equipment	Dump Trucks, Conveyors, Backhoes, Excavators	L	N/A	N/A	N/A	M	L	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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TABLE 1: Activities Hazard Analysis Results								
Hazard Identification	**Hazard Association**	**Site Activities**						**Controls**
		AOU 1				**OU-2**		
		Soil Gas Sampling	**Groundwater Sampling**	**Surface Water Sampling**	**Indoor Air Sampling**	**Groundwater Well Drilling and Installation and Soil Sampling**	**Groundwater Monitoring Well Sampling**	
Working Near Water	Surface Water Sampling	N/A	L	N/A	N/A	N/A	N/A	Procedure 4.4.6I; Site Health and Safety; Procedure 4.4.64L – Personnel Protective Equipment;
Workplace Violence	Internal And External Threats	L	L	L	L	L	L	Procedure 11.10 – Corporate Health and Safety Overview Procedure 4.4.46J – Site Control

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
M – Hazard exposure presents moderate risk (injury unlikely or any injury minor with no lost time)
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TABLE 1: Activities Hazard Analysis Results							
Hazard Identification	Site Activities						Controls
	AOU 1				OU-2		
	Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Biological Hazards							
Insect Stings	L	L	L	L	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Feral Dog Attacks	M	L	L	M	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Hantavirus Exposure	L	L	L	M	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Mosquito Bites	L	L	L	L	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Poison Ivy, Oak, and Sumac Exposure	M	M	M	N/A	M	M	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Snake Bites	L	L	L	N/A	L	L	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Spider (poisonous) Bites	L	L	L	M	L	M	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Tick Bites	M	M	M	N/A	M	M	Procedure 4.4.6.4i – Site Health and Safety; Procedure
Household Pets (dogs, cats etc.) Attacks	L	L	L	H	L	L	See Section 7.1 of Plan

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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TABLE 1: Activities Hazard Analysis Results							
Hazard Identifications	**Site Activities**						**Controls**
	AOU-1				**OU-2**		
	Soil Gas Sampling	**Groundwater Sampling**	**Surface Water Sampling**	**Indoor Air Sampling**	**Groundwater Well Drilling and Installation and Soil Sampling**	**Groundwater Monitoring Well Sampling**	
Chemical Hazards							
Non-chlorinated VOCs (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chlorinated VOC: Tetrachloroethylene (PCE)	U	U	U	U	U	U	Procedure 11.14 – Respiratory Protection; Procedure 4.4.64N – Hazard Communication; Procedure 4.4.64L – Personnel Protective Equipment; Mandatory OSHA Training; See Section 7.1 of Plan
Chlorinated VOC: Trichloroethylene (TCE)	U	U	U	U	U	U	
Chlorinated VOC: Cis-1,2-dichloroethylene (1,2-DCE)	U	U	U	U	U	U	
Chlorinated VOC: Vinyl chloride	U	U	U	U	U	U	
Chlorinated VOC: 1,4-dioxane	U	U	U	U	U	U	
Semi-Volatile Organics (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Petroleum Products (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metals (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PCBs (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coal/MGP Tar (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pesticides (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A – Hazard not associated with activity.
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TABLE 1: Activities Hazard Analysis Results							
Hazard Identifications	Site Activities						Controls
	AOU-1				OU-2		
	Soil Gas Sampling	Groundwater Sampling	Surface Water Sampling	Indoor Air Sampling	Groundwater Well Drilling and Installation and Soil Sampling	Groundwater Monitoring Well Sampling	
Asbestos (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiberglass	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other (specify)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A – Hazard not associated with activity.
H – Hazard exposure presents high risk (injury possible resulting in reportable incident.)
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7.1 Additional Project-Specific Hazard Controls

7.1.1 Chlorinated VOCs

See Section 10.0 for Site monitoring requirements and response actions.

7.1.2 Household Pet (dogs, cats, etc.) Attacks

When work in residences is scheduled, the scheduler shall ask if pets are in the home. At the time of work, the resident shall be asked to secure or isolate the pet such that Team personnel are not at risk. Upon the arrival at a residence, personnel shall verify that the pet has been secured before starting work.

7.1.3 Moving Vehicles

If lane closures, traffic re-direction, or flaggers are needed, arrangements shall be made prior to field work with the necessary City personnel to ensure a safe work environment.

7.1.4 Noise

Ensure conformance with the PPE provisions presented in Section 11.0.

7.1.5 Pinch Points

Ensure conformance with the PPE provisions presented in Section 11.0

7.1.6 Power Tools

All Team personnel using power tools shall be trained in the safe handling and use of hand-held power tools.

7.1.7 Underground Utilities

All well installation and drilling activities shall be preceded by a fully-completed mark out by local utility authorities.

8.0 Hazard Communication

The SC or qualified designee will perform the following hazard communication duties for the RIWP scope-of-work:

- maintain a complete inventory of chemicals brought to the Site by the Team as an attachment to the HASP;
- before or as the chemicals arrive at the Site, obtain a Material Safety Data Sheet (MSDS) and add the document as an attachment to the HASP; and
- provide employees hazard-specific HazCom training using the MSDSs included in the HASP.

The inventory of chemicals and MSDSs related to Site work are included as Attachment 4 of the Plan.

9.0 Contaminants of Concern

The potential contaminants of concern (COC) and their occupational exposure limit and signs and symptoms of exposure are presented in Table 2 below. The maximum concentration of each COC and the associated location and media that was sampled (groundwater, soil boring, surface soil) is also provided. These concentrations were used to determine engineering, administrative, and PPE controls described in the Plan's AHA as well as Site monitoring requirements.

TABLE 2: Contaminants of Concern

Contaminant	Location and Maximum[a] Concentration	Exposure Limits[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Tetrachloroethylene (PCE)	GW: 320 ug/l	25 ppm	150 Ca	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
Trichloroethylene (TCE)	UK	2 mg/m^3	1,000 ppm	Burning sensation, cough, wheezing, laryngitis, shortness of breath, headache, nausea, vomiting, gastrointestinal disturbance,	9.45
Cis-1,2-dichloroethylene (1,2-DCE)	UK	10 ppm	1000 ppm	Difficulty breathing, headache, dizziness. Prolonged or repeated contact with skin may cause defatting or dermatitis. Contact with eyes can cause redness, blurred vision and provokes tears.	9.65
Vinyl Chloride	UK	1 ppm		Irritation, nausea, difficulty breathing, irregular heartbeat, headache, drowsiness, disorientation, joint pain, loss of coordination, hearing loss, lung congestion.	10.0
1,4-dioxane	UK	25 ppm	500 ppm	Nausea, vomiting, weakness, dizziness, vertigo, headache, sweating, loss of appetite, kidney injury may occur. Liver damage may occur.	9.4

Footnotes:
[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of permissible exposure limit (PEL), recommended exposure limit (REL), or threshold limit value (TLV) listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.
eV = electron volt
mg/kg = milligram per kilogram
mg/m^3 = milligrams per cubic meter
ug/m^3 = micrograms per cubic meter

Potential Routes of Exposure		
Dermal: Contact with contaminated media. This route of exposure is minimized through use of engineering controls, administrative controls, and proper use of PPE.	**Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through use of engineering controls, administrative controls, and proper use of respiratory protection when other forms of control do not reduce the potential for exposure.	**Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

10.0 Site Monitoring

Monitoring is performed as provided in the Table 3 below. The readings, calibration, and actions taken in response to readings are recorded in the field log books.

Exposure records (breathing zone and personal air sampling) are preserved for the duration of employment plus 30 years. Copies of all Project exposure records (e.g., copies field logbook pages where breathing zone readings are recorded along with associated calibration) will be sent to the RHSM for retention and also maintained in the Project files.

Subcontractors are responsible for monitoring and performing integrated personal sampling for their employees as documented in their HASP, or if permitted, according to the table below.

TABLE 3: Direct Reading Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level Reached	Frequency[b]	Calibration
HASPSITE GC/MS FID: OVA model 128 or equivalent PID	All Tasks	<10 ppm >10 ppm	Level D, continue work Stop work and contact RHSM to discuss engineering controls and potential PPE upgrade	Initially and periodically during tasks	Daily
Heat Stress Monitor	All Tasks	In accordance with SC work-load assessment	Monitor employees, ensure hydration, and implement breaks	At the discretion of the SC	As required by heat stress monitor manufacturer

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.

Note:
Noise monitoring shall also be initiated if the SC or designee believes that short or long-term exposure levels may be exceeded during field work activities.

11.0 Personal Protective Equipment

11.1 Required Personal Protective Equipment

A PPE assessment was completed as part of the Project AHA. The conclusions of the assessment are presented in Table 4 below. The PPE has been selected to ensure the control of hazards beyond that which engineering controls and administrative practices could provide.

TABLE 4: Project-Specific Personal Protective Equipment Requirements

Task	Level	Body	Head	Respirator[a]
General field work outside within the work site location; Mobilization/ Demobilization	D	☒ Work clothes (sleeved shirt, long pants) ☒ Safety-toed boots ☒ Gloves (leather)[d] ☒ ANSI/ISEA 107-2010 high visibility vest	☐ANSI Z89.1 Hardhat[b] ☒ANSI Z87.1 Safety glasses ☐Hearing protection[c]	None required
IDW Management; VI Investigation; Groundwater Well Drilling and Installation; Soil Boring and Sampling; Groundwater Monitoring Well Sampling	Modified D	☒ Work clothes ☒ ANSI/ISEA 107-2010 high visibility vest ☒ Safety-toed boots ☒ Inner surgical-style nitrile ☒ Gloves (leather)[d]	☒ANSI Z89.1 Hardhat[b] ☒ANSI Z87.1 Safety glasses ☐Hearing protection[c]	None required
Equipment decontamination if using pressure washer	Modified D with splash protection	☒ Polycoated Tyvek or Rain Suit ☒ Safety-toed boots ☒ Outer boot covers ☒ Inner surgical-style nitrile ☒ Gloves (leather)[d]	☒ANSI Z89.1 Hardhat[b] ☒ANSI Z87.1 Safety glasses ☐Hearing protection[c] ☒ Face shield	None required.

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)

Upgrade[e]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels in the “Site Monitoring” section exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] No facial hair that would interfere with respirator fit is permitted.
[b] The use of a hardhat with a splash-shield is to be determined by the SC. Of the work tasks described, the use of hard hats is required only during well drilling, soil boring activity, loading and unloading drums, and during any other tasks where the SC deems their use necessary.
[c] Ear protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting or as directed by the SC’s noise assessment.
[d] Outer leather gloves shall be worn whenever there is a scratch or cut potential based on the materials being handled.
[e] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC or designee is present.

12.0 Worker Training and Qualification

12.1 Worker Training

Table 5 below summarizes the training requirements for Team personnel working at the Site. Copies of training will either be available at the Site or available from the RHSM.

TABLE 5: Worker Training Requirements	
Required Worker Training	**Task or Equipment-Specific Training (if performing task)**
☒ 40-hour HAZWOPER Training	☐ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Confined Space Entry Training
☒ 8-hour HAZWOPER Supervisor	☐ Excavation Competent Person
☒ HASP Training	☐ Fall Protection (site-specific)
☒ First Aid/CPR/BBP – at least 2 people	☐ Forklift Operator
	☒ Hazard Communication
	☐ Soil and Groundwater Sampler
	☐ NFPA 70E Training (energized electrical safety training)
	☐ Qualified Earthmoving Equipment Operator
	☐ Scaffold Training
Project-Specific Required Training	
☒ Drum Handling Training	☒ Manual Lifting Training
☒ Hand Safety Training	☒ Traffic Safety Training

12.2 Subcontractor Worker Training

Table 6 below summarizes the training requirements for subcontractor personnel working at the Site. Copies of training will be available at the Site.

TABLE 6: Subcontract Training Requirements	
Required Subcontractor Worker Training	**Subcontractor Task or Equipment-Specific Training (required if performing this work)**
☒ 40-hour HAZWOPER Training	☐ Aerial Lift Operator Training
☒ 8-hour HAZWOPER Refresher	☐ Asbestos Competent Person
☒ 8-hour HAZWOPER Supervisor	☐ Asbestos Training (Supervisor, Worker)
☒ 3-day HAZWOPER OJT	☐ Confined Space Entry Training
☒ HASP Training	☐ Certified Crane Operator
☒ Subcontractor HASP Training	☐ Crane Assembly/Disassembly Competent Person
	☒ Fall Protection (site-specific)
	☒ Forklift Operator (Certified)
	☒ Hazard Communication
	☒ Qualified Drill Rig Operator

12.3 HAZWOPER-Exempted Tasks

The following tasks are not within the scope of the HAZWOPER standard, so HAZWOPER training is not required for workers performing these tasks: Mobilization/Demobilization

13.0 Medical Surveillance and Qualification

Medical surveillance required for Team members and subcontractor personnel working at the Site is summarized in Table 7 below. Copies of physician's medical opinion will either be available from First Environment for First Environment personnel or from the subcontractor's human resources representative.

TABLE 7: Medical Surveillance Requirements	
General Required Medical Surveillance	**Job or Activity-Specific Medical Surveillance (required if performing this work)**
☒ HAZWOPER Medical Clearance	☐ Noise
☒ Respirator Medical Clearance	☐ Baseline Blood Lead
	☐ Asbestos Medical Clearance
	☐ Other (specify):
Personnel or Tasks Not Requiring Medical Surveillance	
Mobilization/ Demobilization	

14.0 Site Control Plan

Site control is established to prevent the spread of contamination throughout the Site location, protect field personnel, and to ensure that only authorized individuals are permitted into potentially hazardous areas. Task-specific control measures are presented in Table 8 below and will be implemented at the discretion of the SC. Any uncertainly regarding the needs for one or more control measures will be discussed with the RHSM. Use of the buddy system will be implemented in all instances unless written authorization is provided by the SC or RHSM.

TABLE 8: Site Control for General Work Area(s)			
☒ Perimeter fencing	When access to the work zone can endanger the public	☒ Barricades	In accordance with traffic management plan
☒ Signage	When it is necessary to raise the visibility of work areas to minimize public interference; In accordance with traffic management plan	☒ Other: Caution tape	When access to the work zone can endanger the public
☒ Traffic control devices	At the discretion of the SC or designee	☐ Other: TBD	In accordance with traffic management plan

15.0 Decontamination

Extensive decontamination efforts are not expected due to the minimal COCs and low-level concentrations of the constituents. Any necessary decontamination activities should consider adjacent or nearby projects and personnel. No eating, drinking, or smoking is permitted in contaminated areas and in decontamination zones. Site decontamination requirements are summarized in Table 9 below.

All contaminated material generated through the personnel and equipment decontamination processes will be properly containerized and labeled, stored at a secure location, and disposed in accordance with Project plans and applicable regulations.

TABLE 9: Decontamination Requirements

Type of Decon	Activity	Equipment	Process/Protocol
Personnel Dry Decon	Section 4.3 Activities	☒ Solids disposal bag or drum (used PPE)	☒ PPE disposal (no decon) ☒ PPE waste area identified ☐ Other: _____
Equipment Dry Decon	Section 4.3 Activities	☒ Table for equipment decon/staging ☒ PPE used during decon ☒ Decon supplies (brushes, brooms) ☒ Containers/method to capture decon waste	☒ Equipment wiped/cleaned before leaving the Site ☐ Other: _____
Equipment Wet Decon	Section 4.3 Activities	☒ Table for equipment decon/staging ☒ Pressure Washer ☒ PPE used during decon ☒ Decon supplies (brushes, brooms) ☒ Containers/method to capture decon water and or sludge	☒ Equipment wiped/cleaned before leaving the Site ☐ Other: _____

15.1 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency life-saving first aid and/or medical treatment, normal decontamination procedures may be abbreviated or omitted. In this situation, Site personnel will accompany contaminated victims to advise emergency response personnel of potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing shall be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces will be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

16.0 Communications

A primary and backup means of communication for field crews have been established as described in Table 10 below:

TABLE 10: Means of Communication		
Type of Communication	**Primary Means**	**Backup Means**
Communication between field crew	☒ Voice ☐ Radio ☐ Phone	☐ Voice ☐ Radio ☒ Phone
Communication with office crew	☐ Radio ☒ Phone	☐ Radio ☒ Phone
Communication with fire and emergency services	☐ Radio ☒ Phone	☐ Radio ☒ Phone

17.0 Required Facilities and Equipment

The facilities and equipment summarized in Table 11 below are required and used for safe completion of the RI scope-of-work:

TABLE 11: Required Facilities and Equipment		
Facility	**Type**	**Location**
☐ Worker Showers/Lockers		
☐ Restrooms		
☐ Supplementary Illumination (during hours of low-visibility)		
☒ Emergency Eyewash	Portable	Vehicle
☐ Emergency Shower		
☒ First Aid Kit/Supplies	Portable	Vehicle
☒ Fire Extinguishers	20 lb. ABC	Drill rig
☒ Spill Kit(s)	Petroleum kit	Drill rig
☒ Potable Water	Bottled water	Vehicle
☒ Insect Repellent	Can	Vehicle
☐ Heated Rest Area		
☐ Other_____		

18.0 Emergency Response Plan

Personnel responsible for coordinating emergency situations during Site activity are identified in Table 12 below. The Emergency Contacts Page is at the front of this Plan.

TABLE 12: Emergency Personnel		
Responsibility	**Name**	**Phone Number(s)**
Responsible Health & Safety Manager	Devin DeMarco	973-334-0003; 732-887-4375 (cell)
Site Safety Coordinator	Edward Reid	770-424-3344; 678-773-1454 (cell)

If an emergency situation develops which requires evacuation of the work area, the following steps will be implemented.

Evacuation Step	Methods and Comments:
Notify affected workers	Field Supervisor to notify effected workers
Evacuate to safe location	Depending on emergency, Field Supervisor to determine rally points during daily safety meetings
Assemble and account for workers	Field Supervisor to use daily safety briefing sign-in sheet
Notify supervisor/Manager	Field Supervisor notifies SC using cell phone
Notify VA Remedial Manager	SC notifies VA Remedial Manager using cell phone
Complete incident report	Contact First Environment human resources representative

Potential emergency situations and response actions are identified below. Regardless of the incident type, the SC, RHSM, Project Manager, and VA Remedial Manager shall be informed of the event once the emergency condition or event has concluded.

In Case Of:	Response Actions:
Injury or illness	Contact field supervisor and RHSM if non-emergency. Call 911 for emergency.
Chemical exposure	Contact field supervisor and RHSM if non-emergency. Call 911 for emergency.
Fire or explosion	Call 911 for emergencies and move to a safe evacuation zone. Contact field supervisor and RHSM.
Adverse weather	Contact field supervisor and RHSM if non-emergency. Call 911 for emergency.
Heat stroke	Call 911, have a designee give location and directions to ambulance if medical attention is needed.
Material spill or release	Contact field supervisor and RHSM if non-emergency. Call 911 for emergency.

In the event of a large quantity spill of hazardous materials or uncharacterized waste, personnel discovering the spill will (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC will be notified immediately.
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes).
- Clear personnel from the spill location and barricade the area.
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread.
- Use sorbent materials to control the spill at the source.
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill.
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified.
- Contact the RHSM and Project Manager in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required.
- Assess possible hazards to human health or the environment as a result of the release, fire, or explosion.
- Follow incident notification, reporting, and investigation section of this plan.

19.0 Incident Notification, Reporting, and Investigation

19.1 Incident Notification

All employees and subcontractors' employees will immediately report any incident (including near misses) in which they are involved or witness to their field supervisor. The Team or Subcontractor field supervisor, upon receiving an incident report, will inform his/her immediate superior and the SC.

The SC will immediately report the following information to the RHSM, PM, and VA Remedial Manager by phone and e-mail:

- Project name and Site manager;
- date and time of incident;
- description of incident;
- extent of known injuries or damage;
- level of medical attention; and
- preliminary root cause/corrective actions.

19.2 Serious Incident Reporting Requirements

Serious incidents include the following:

- event that involves a fire, explosion, or property damage that requires a site evacuation;
- spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community, or the environment;
- work related death or life threatening injury or illness of an employee, subcontractor, or member of the public;
- kidnap or missing person; and
- acts or threats of terrorism

If an incident meets any of the "Serious Incident" criteria, the SC is to immediately contact the RHSM, PM, and First Environment's Human Resources Representative, then follow the standard incident reporting procedures, including notification to the VA Remedial Manager.

19.3 Safe Behavior Observations

The SC or designee will perform at least one safe behavior observation each week for any field work performed by subcontractors or when there are at least two Team personnel performing field work. The observations will focus on field personnel's conformance to the provisions of this Plan. A summary of the observations will be submitted to the RHSM by the conclusion of each work week.

20.0 Records and Reports

Table 13 below provides examples of records that must be maintained as the RIWP scope of work progresses:

TABLE 13: Record Retention Requirements	
• Exposure records includes monitoring data (including calibration records), MSDSs, exposure modeling results	• Equipment maintenance
• Training records	• Emergency equipment inspection records
• Incident reports, investigations and associated back-up information	• Self-assessment checklists
• Federal or state agency inspection records	• Daily Safety Meeting Sign-In forms/PTSPs
• HSE audits and assessments	• Waste analytical data
• Equipment inspections	• Reports and certifications

FINAL

ATTACHMENT 1
HASP Employee Sign-Off Form

FINAL

Attachment 1: HASP Employee Signoff Form

EMPLOYEE SIGNOFF FORM
Health and Safety Plan

First Environment Team employees and subcontractors listed below have been provided with a copy of this HASP, have read and understood it, and agree to abide by its provisions.

Project Name: **Project Number:**

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

FINAL

ATTACHMENT 2
HASP Daily Safety Meeting Form

FINAL

Attachment 2: HASP Daily Safety Meeting Form

Daily Safety Meeting
Health and Safety Plan

First Environment Team employees and subcontractors listed below have attended the daily safety meeting.

Project Name: **Project Number:** **Date:**

EMPLOYEE NAME (Please print)	**COMPANY**	**EMPLOYEE IINITIALS**

FINAL

ATTACHMENT 3
Hazardous Control Procedures

Environmental Management System Procedures
Title: Intrusive and Remedial Field Activities

1.0 Purpose and Scope:

To identify and establish appropriate environmental, health and safety, and quality field procedures consistent with the project, customer, and regulatory agency requirements. This procedure applies to each event of intrusive or remedial fieldwork and supplements the Project Management procedure. An event may occur over several days.

2.0 Responsible Parties:

- Project Manager
- Senior Personnel
- Field Team Leader
- Field Health and Safety Officer
- Field Team - Members of the Project Team who are performing work in the field.
- Subcontractors

3.0 Procedure:

3.1 Pre-Field Work Event

3.1.1 The **Project Manager** identifies the applicable federal, state, and local regulations, standards, and permitting requirements for the fieldwork.

3.1.2 The **Project Manager** ensures the development of the Work Plan. The Work Plan always includes the following:

- Approved Site-Specific Health, Safety & Emergency Response Plan (HASP)
- Utility mark-out requirements; utilizing State/City operated one-call systems, utility systems and private utility markout firms, as appropriate.

The Work Plan ***may*** also include, as appropriate:

- Sampling Plan
- Quality Assurance/Quality Control Plan.
- Equipment requirements and associated calibration requirements
- Contractor requirements
- Sampling and investigative procedures and protocols to be used,
- Data requirements including types and quantities of data needed, minimum detection limits required, quality assurance/quality control

samples (i.e., duplicates, field blanks, trip blanks) and chain-of-custody responsibilities,
- Notification to regulatory agency,
- Waste generation, classification, handling, and disposal requirements,
- Laboratory and analytical requirements
- Permit requirements,

Alternatively, the Work Plan may rely on standard protocols and procedures for field work as laid out in technical regulations, customer requirements, or other accepted sources.

3.1.3 The **Project Manager** reviews the Work Plan with the Project Team, designating the Field Team Leader. Unless specified otherwise by the Project Manager, the Field Team Leader serves as the Field Health and Safety Officer.

3.1.4 The **Project Manager** ensures the field activities schedule is coordinated with the client and the site contact, if any.

3.1.5 The **Project Manager** ensures that the Field Team reviews the:

- Work Plan including the HASP
- appropriate elements of the Corporate Health and Safety Plan,
- site operator's health and safety and other requirements, and
- any other pertinent issues regarding the field activities
- Subcontractor (if there is a subcontractor) site specific Health and Safety Plan

3.1.6 The **Project Manager** also ensures methods of communication are established.

3.1.7 The **Field Team Leader** ensures the equipment and supplies specified in the work plan are delivered to the site at the start of field work.

3.1.8 If subcontractors are to perform services as part of the work effort, they are engaged and contracted as outlined in ***11.4 Management of Subcontractors and Vendors.***

3.2 Initial On-site Activities

3.2.1 Prior to the initiation of a field work event, the **Field Team Leader** or his/her designee meets with the site contact if available, and reviews any facility Health and Safety requirements. If there are conflicts between the facility Health and Safety requirements and the HASP, the Project Manager resolves the conflicts with the site contact.

3.2.2 Prior to initiation of field work, the **Field Health and Safety Officer** confirms that any subcontractors to First Environment have their organization's site-specific Health and Safety Plan on-site, have reviewed

it and the ***Guide for Our Subcontractors and Vendors*** with their personnel and that their personnel have signed the Guide to Our Subcontractors and Vendors – Read and Acknowledge Form. Should the subcontractor change employees during the field work event, the Field Health and Safety Officer ensures the subcontractor complies with the requirements, above.

3.2.3 The **Field Team Leader** confirms utilities have been marked out.

3.3 Daily On-site Activities

3.3.1 Each day prior to the commencement of daily field work activities, the **Field Team Leader** reviews the work planned at the site with the Field Team and any subcontractors, ensuring that responsibilities for tasks onsite including QA/QC responsibilities are clearly defined.

- The **Field Health and Safety Officer** reviews the HASP, appropriate elements of the Corporate Health and Safety Plan, and any other pertinent issues regarding the field activities with the Field Team and any subcontractors prior to commencement of the daily field work activities at the project site. All **Field Team** members sign the HASP to confirm understanding and intent to comply with the requirements of the HASP. Subcontractors do not sign First Environment's HASP.

3.3.2 The **Field Team** performs the work following the requirements stipulated in the Work Plan.

3.3.3 **Field Team** members record field work in a bound engineering field book, which is dedicated to the specific project, or on the appropriate First Environment field forms as directed by the Project Manager. First Environment field forms must be filled out completely.

3.3.4 The **Field Team** Leader ensures that products or services provided are consistent with the terms of the contract and meet project specifications.

3.3.5 If an unexpected field situation is encountered, the **Field Team Leader** or designee immediately notifies the Project Manager or other appropriate Senior Personnel and may stop work, if deemed necessary.

- If any **Field Team** member encounters unsafe working conditions, that individual immediately halts all work including subcontractor work at the site until the unsafe working conditions are addressed.

- First Environment does not direct how subcontractors perform their work. However, if any member of the Field Team identifies that the subcontractor is creating unsafe working conditions, this would be in conflict with the subcontractor's site specific Health and safety Plan. In such situations, the **Field Team** Member immediately stops work

and notify the Field Team Leader. The **Field Team Leader** notifies the Project Manager or other Senior personnel. Work does not recommence until the subcontractor is able to work in conformance with their site specific Health and Safety Plan or until the Plan is modified so that work can be performed safely.

- In the situation where First Environment does not have oversight over other contractors at the site and unsafe working conditions are encountered, the **Field Team** ceases work and moves from the area where unsafe conditions are encountered. The **Field Team Leader** notifies the site contact, senior onsite personnel for the contractor, and the Project Manager of the situation. Field Team Leader (or Field Health and Safety Officer) notes that notification of the unsafe condition was communicated to the site contact and senior onsite personnel for the contractor in the bound engineering field book. The **Field Team Leader** does not allow the Field Team to recommence work until the unsafe working conditions are addressed.

- In the event of unsafe conditions or changes in site conditions the **Field Health and Safety Officer** in consultation with the **Project Manager** may make modifications to the HASP on site and initials the changes. The **Field Health and Safety Officer** ensures these changes are communicated to the Field Team. Field Health and Safety Officer also communicates the changes to any subcontractors for their consideration with regard to their Health and Safety plan.

3.4 Post Site Activities

3.4.1 **Field Team** members may identify new potential environmental aspects and impacts associated with field activities. If new potential aspects and impacts are identified, these are communicated to the Project Manager who forwards the information to the Steering Committee for review.

3.4.2 The **Project Manager** or designee reviews the field work with the Field Team to review successes and challenges encountered. As appropriate, information regarding the site activities is disseminated to other members of the firm using one of the internal communication methods. Information may also be recorded in the Proposal-Project Database and the Subcontractor Database.

3.4.3 The **Project Manager** ensures PCANs are prepared as appropriate. PCANs must be filed for any incidents where work is interrupted due to unsafe conditions and the HASP, if to be used again, modified accordingly.

3.4.4 The **Field Team Leader** ensures signed and dated records of field activities are transferred to the receptionist for filing as appropriate, including the Guide for Our Subcontractors, HASP, field sampling forms, and copies of the completed chain of custody.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures/Documents

- Identification of Environmental Aspects & Impacts
- Corporate Health & Safety Plan
- Project Management
- Management of Subcontractors and Vendors
- Internal Communication

4.3 Forms/tools

- HASP Form
- PCAN Database
- Field Forms
- First Environment Chain of Custody (COC)
- Guide for Our Subcontractors and Vendors
- Guide for Our Subcontractors and Vendors – Read and Acknowledgement Form
- Field Equipment Checklist

4.4 Records:

- PCANs
- Work Plans including HASPS
- Guide for Our Subcontractors and Vendors – Read and Acknowledgement Forms
- Field Forms
- Engineering Field Books

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Field Work Decontamination

1.0 Purpose and Scope:

To ensure that personnel and equipment used in field work are properly decontaminated, so as to protect the safety and health of personnel and to prevent the accidental spread of contaminants.

2.0 Responsible Parties:

- Project Manager
- Field Team Leader – serves as field health and safety officer and may as appropriate delegate activities to other members of the Field Team
- Field Team

3.0 Procedure:

3.1 Generally, the Field Team Leader directs work so as to ensure sampling is initiated in the areas where the least amount of contamination is expected to areas of greater contamination.

3.2 Field Team members decontaminate personnel and equipment as appropriate prior to leaving a work area.

3.3 Field Team Leader ensures that the decontamination processes are completed as required and contacts the Project Manager if any issues or questions are encountered.

3.4 Employees decontaminate as follows:

Light Equipment Decontamination	
1	Wash with Alconox and tap water
2	Thoroughly rinse with tap water
3	Thoroughly rinse with deionized water
4	If items still visibly dirty or contaminated, repeat steps 1-3
5	Air Dry

Heavy Equipment Decontamination	
1	Position equipment over site decon pad
2	Remove gross contamination (e.g., soil, mud)
3	Spray down equipment with pressure washer or steam
4	If items still visibly dirty or contaminated, repeat steps 1-3
5	Air dry

Personnel Decontamination	
1	Remove boot covers (as appropriate)
2	Remove tape and outer gloves (as appropriate)
3	Remove outer garment (as appropriate)
4	Remove respirator (do not touch head straps) (as appropriate)
5	Remove inner gloves (as appropriate)
6	Wash hands, forearms, and face with soap and water
7	Clean with towel or air dry

3.5 Materials or waste generated from decontamination are managed as specified in the HASP.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures and Documents

- Intrusive and Remedial Field Activities
- Site Specific Health and Safety Plan

FIRST ENVIRONMENT

11.3.3 Environmental Management System Procedures
Title: Control of Hazardous Energy (Lockout/Tagout)

1.0 Purpose and Scope:

To protect First Environment personnel from serious injuries or accidents resulting from the unexpected energization or startup of equipment. This applies to equipment using any form of energy including mechanical, electrical, hydraulic, pneumatic, chemical and thermal energy, and to maintenance and servicing activities such as constructing, installing, setting up, adjusting, inspecting, modifying, lubricating, cleaning, unjamming, making adjustments or tool changes. It does not apply to single plug-controlled equipment when the plug is in sight and under the exclusive control of the authorized employee.

2.0 Responsibilities:

Health and Safety Committee
Health and Safety
Project Managers
Authorized Employees
Affected Employees

3.0 Procedure:

3.1 No employee, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance, shall attempt to start, energize or use that machine or equipment.

3.2 For any project that includes servicing or maintaining equipment, Project Managers ensure that the Health and Safety Manager is notified.

3.3 The Health and Safety Manager or his/her designee completes the “Control of Hazardous Energy – Equipment-Specific Assessment” and trains the employee planning to do the work (the “Authorized Employee”) and any employee(s) who will be in the vicinity of the equipment while it is being serviced or maintained (“Affected Employees”), on the completed Assessment.

3.4 The Authorized Employee uses the “Control of Hazardous Energy – Lockout/Tagout” Checklist to document that the steps outlined in the “Control of Hazardous Energy -

Equipment-Specific Assessment" form have been followed. Once completed, the form is retained as a record with the project files.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures/Documents
- Health and Safety Training Module

4.3 Forms/tools
- Control of Hazardous Energy – Equipment-Specific Assessment
- Control of Hazardous Energy – Lockout/Tagout Form

4.4 Records:
- Work Plans including HASPs

FIRST ENVIRONMENT
CONTROL OF HAZARDOUS ENERGY/LOCKOUT TAGOUT
EQUIPMENT-SPECIFIC ASSESSMENT

Equipment Name, ID and Serial #:		Location:
Date Assessed:	Related Operating Procedures Reviewed: ☐ Yes ☐ No	Related Maintenance Procedures Reviewed: ☐ Yes ☐ No

LOCK OUT TAG OUT ASSESSMENT CHECKLIST

1. Is there a potential for stored, residual, or reaccumulation of energy after shutdown?	☐ Yes	☐ No
2. Does the unit have multiple energy sources that cannot be readily identified and isolated?	☐ Yes	☐ No
3. Have accidents involving unexpected activation/reenergization occurred during servicing?	☐ Yes	☐ No
Written procedures must be developed if any "Yes" answers have been given! ←		

1. ASSESSED ENERGY SOURCES: (indicate specific sources with initials)

	Initials	Energy Source	Magnitude and Unit of Measure	Method to Dissipate or Restrain
a.		Chemical:		
b.		Hydraulic:		
c.		Pneumatic:		
d.		Mechanical:		
e.		Electrical:		
f.		Thermal:		
g.		Radioactive:		
h.		Other:		
i.		Other:		

2. TYPES AND LOCATIONS OF OPERATING CONTROLS: * Further Detailed on Attachment: Yes ☐ No☐

Types of Operating Controls	Location on Unit
2a.	
2b.	
2c.	
2d.	

3. TYPES AND LOCATIONS OF ENERGY ISOLATING DEVICE(S): * Further Detailed on Attachment: Yes ☐ No☐

Types of Energy Isolating Devices	Location(s)
3a.	
3b.	
3c.	
3d.	

4. METHODS TO VERIFY ISOLATION OF THE UNIT: * Further Detailed on Attachment: Yes ☐ No☐

Verification Method	Location(s)
4a.	
4b.	
4c.	
4d.	

5. DIAGRAM OR PHOTOS OF UNIT: Schematic/Blueprint Attached? ☐ Yes ☐ No

6. WRITTEN PROCEDURES (by):	Developed (date)	To be Implemented by (date)

7. ADDITIONAL STEP BY STEP INSTRUCTIONS

How to Shut Down This Equipment::

How to Isolate This Equipment:
How to Block This Equipment:
How to Secure This Equipment:
Where to Place Locks and Tags on This Equipment:
How to Remove Locks and Tags on This Equipment:
How to Transfer Locks and Tags from This Equipment:
Person Responsible for Lockout and Tagout Devices for This Equipment:
Other Comments:

☐ Approved <u>AUTHORIZATION</u>

I certify that I have conducted a Lockout Tagout Assessment of the equipment or machine named above and have detailed the findings of the assessment on this form. * Further detailed on attachment: ☐ Yes ☐ No

Name:	Signature:	
Title:	Date:	Time:
Permanent Retention File:	Location:	
Date Filed:	Filed By:	

FIRST ENVIRONMENT
CONTROL OF HAZARDOUS ENERGY/LOCKOUT TAGOUT
CHECKLIST

Equipment Name, ID and Serial #:	Location:

Date Assessed:	Related Operating Procedures Reviewed: ☐ Yes ☐ No	Related Maintenance Procedures Reviewed: ☐ Yes ☐ No

REVIEW WITH EMPLOYEE(S) PERFORMING SERVICE OR MAINTENANCE ON THE FOLLOWING:

1. HAVE YOU HAD LOCKOUT/TAGOUT TRAINING?	☐ Yes	☐ No
2. DO YOU HAVE A SAFETY LOCK?	☐ Yes	☐ No
3. ARE LOCKOUT PROCEDURES FOR THIS MACHINE AVAILABLE AND/OR POSTED?	☐ Yes	☐ No
4. DO YOU KNOW YOUR RESPONSIBILITIES FOR HAZARDOUS ENERGY CONTROL?	☐ Yes	☐ No

OBSERVE WORK PRACTICES

A. WERE ENERGY CONTROL PROCEDURES CORRECTLY FOLLOWED?	☐ Yes	☐ No

IF NO, DESCRIBE DEFICIENCIES BELOW:

☐ I certify that I have conducted a Lockout Tagout Inspection at the equipment or machine named above and have detailed the findings of the inspection on this form. * Further detailed on attachment: ☐ Yes ☐ No		
Name: Title: Permanent Retention File: Date Filed:	Signature: Date: Location: Filed By:	Filed By: Time:

FIRST ENVIRONMENT

Corporate Health & Safety Plan

Title: *Permit-Required Confined Space Program*

Approved by: DD
Date: 5/14/14
Revision #: 2

I. Purpose

The purpose of this written program is to ensure First Environment employees are familiar with entry methods that are utilized prior to and during all work activities in permit-required confined spaces. First Environment employees do not enter confined spaces, but may supervise contractors who are performing confined space entry. This program is designed to identify requirements to prevent personal injuries and illnesses that may be prevalent in confined spaces and for compliance with OSHA Standard 1910.146.The elements contained in this program must be followed in all situations where entry into a permit required confined space is necessary.

II. Hazard Evaluation of Permit Spaces

This procedure, shall be applied to any "confined space" including but not limited to:

- Storage tanks
- Service tunnels
- Open top spaces more than 4 feet in depth such as pits, vaults, and vessels

III. Safe Permit Space Entry Operations- Means, Procedures and Practices

Acceptable entry conditions are those in which:

- All hazards in a permit-required confined space that can be eliminated have been eliminated via engineering controls, ventilation, or some other means:
- Authorized entrants are protected by use of PPE against any remaining or potential hazards: and
- All procedures of this program are being followed.

IV. Equipment Provision

The employer will provide at no cost to the employee all appropriate, adequate, and necessary personal protective equipment (PPE), testing and monitoring equipment, ventilation equipment, communications equipment (PPE), testing and monitoring equipment, ventilation equipment, communications equipment, lighting equipment, barriers and shields, ladders or other entrance/exit equipment, rescue and emergency equipment and any other equipment necessary for safe entry into and rescue from a permit-required confined space. Supervisors of the permit-required confined space entry procedures will be responsible for ensuring use of the appropriate equipment by all entrants to the confined space.

V. Permit Space Condition Evaluation

5.1 Conditions in the permit space shall be tested to determine if acceptable entry conditions exist before entry is authorized to begin. If isolation of the space is infeasible because the space is large or is part of a continuous system (such as a sewer), pre-entry testing shall be performed to the extend feasible before entry is authorized and, if entry is authorized, entry conditions shall be continuously monitored in the areas where authorized entrants are working;

5.2 The permit space shall be tested or monitored as necessary to determine if acceptable entry conditions are being maintained during the course of entry operations; and

5.3 When testing for atmospheric hazards, the company shall test first for oxygen, then for combustible gases and vapors, and then for toxic gases and vapors.

5.4 A qualified person shall monitor health and safety criteria and enter the readings into the field log prior to each initial confined space entry and no less than once each hour thereafter as long as a worker is in the confined space, and until the "permitted" work is completed and the personnel have exited the confined space. If the work being performed within the confined space is suspected to have a deteriorating impact on the atmosphere within the space, the qualified person shall evaluate the quality of the atmosphere as frequently as necessary to ensure that the acceptable atmospheric conditions are maintained.

VI. Permit Space Attendant Procedures

At least one attendant outside the permit space into which entry is authorized for the duration of entry operations shall be provided.

VII. Active Role Designations, Duties, and Training

6.1 The employer shall provide training so that all employees designed for involvement in confined space entry acquire the understanding, knowledge, and skills necessary for the safe performance of the duties assigned to them in permit-required confined

space entry procedures. This training is provided annually and at the following times:

- When changes in permit-required space hazards occur on which the employee has not been trained.
- Before changing the employee's duty assignment.
- Before assignment to duties.
- When the employer has reason to believe that the employee has deviated from a trained-upon procedure or that knowledge is inadequate.

6.2 The following categories of employees are designated employees, whose duties are listed below:

- Authorized Entrants,
- Attendants,
- Entry Supervisors,
- Rescue and Emergency Service Employees.

6.3 Any employee who has successfully met the 40-hour training requirements and initial 3-days of on-site training as required by OSHA 29CFR1910.120(e) shall be considered as meeting the requirements for "qualified person" for the purpose of Class C confined space entry work.

6.4 However, the qualified person shall also have up-to-date training CPR and first aid, or shall be assisted on-site by a person who holds up-to-date certifications in CPR and first aid.

6.5 Records to support conformance with these requirements should be available.

VIII. Authorized Entrants

Authorized entrants of a permit-required confined space are trained to the extent that they know the hazards they may face, are able to recognize signs or symptoms of exposure, and understand the consequences of exposure to hazards. Entrants know how to use any needed equipment, communicate with attendants as necessary, alert attendants to the warning signs or the existence of a hazardous condition, and exit as quickly as possible whenever ordered or alerted (by alarm, warning sign, or prohibited condition) to do so.

VIII. Attendants

Attendants to a confined space know the hazards of confined spaces, are aware of behavioral effects of potential exposures, maintain continuous count and identification of authorized entrants, and remain outside the space until relieved, and communicate with entrants as necessary to monitor entrant status. Attendants also monitor activities inside and outside the permit space and order exist if required, summon rescuers if necessary, prevent unauthorized

entry into the confined space, and perform non-entry rescues if required. They do not perform other duties that interfere with their primary duty to monitor and protect the safety of authorized entrants at the time of the permit-required confined space entry.

X. Entry Supervisors

Entry supervisors with responsibility for issuing confined space permits know the hazards of confined spaces, verify that all tests have been conducted and all procedures and equipment are in place before endorsing a permit, terminate entry if necessary, cancel permits, and verify that rescue services are available and the means for summoning them are operable. Supervisors are to remove unauthorized individuals who enter the confined space. They also determine, at least when shifts and entry supervisors change, the acceptable conditions, as specified in the permit continue.

XI. Rescue and Emergency Service Employees

9.1 Rescue services are provided by on-site employees or an off-site service if on-site assistance is unavailable. The on-site teams are properly equipped and receive the same training as authorized entrants, plus training in the use of personal protective and rescue equipment and in first aid, including CPR. They practice simulated rescues at least once every 12 months.

9.2 Outside rescue services are made aware of the hazards of the confined spaces, have access to comparable permit spaces to develop rescue plans, and practice rescues.

9.3 Hospitals or treatment facilities are provided with any material safety data sheets (MSDSs) or other information in a permit space hazard exposure situation that may aid in treatment of rescued employees.

XII. Rescue and Emergency Services Procedures

12.1 Rescue and emergency services shall be contacted by phone or walkie-talkie and shall be within three minutes response time for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees, and for preventing unauthorized personnel from attempting a rescue.

12.2 No worker shall, under any circumstance, enter a confined space in order to rescue a worker who cannot exit a confined space due to unconsciousness, illness or injury. This action shall only be taken by an emergency response team that is trained and equipped for such a removal.

XIII. Entry Permit System

13.1 Before entry is authorized, the employer shall document the completion of required pre-entry measures by preparing an entry permit.

13.2 Before entry begins, the entry supervisor identified on the permit shall sign the entry permit to authorize entry.

13.3 The completed permit is made available at the time of entry to all authorized entrants, by posting it as the entry portal or by any other equally effective means, so that the entrants can confirm that pre-entry preparations have been completed.

13.4 The duration of the permit does not exceed the time required to complete the assigned task or job identified on the permit.

13.5 The entry supervisor shall terminate entry and cancel the entry permit when:

- The entry operations covered by the entry permit have been completed; or
- A condition that is not allowed under the entry permit arises in or near the permit space.

13.6 The employer shall retain each canceled entry permit for at least 1 year to facilitate that required annual review of the permit-required confined space program. Any problems encountered during an entry operation shall be noted on the pertinent permit so that appropriate revisions to the permit space program can be made.

13.7 A copy of the permit shall be posted at the applicable confined space and shall be removed at the end of the permitted work period or when the defined work is completed, whichever occurs first.

13.8 An entry permit that authorizes entry to a permit space must include:

- Identification of the space;
- Purpose of the entry;
- Date and duration of the permit;
- A list of authorized entrants, by name;
- Names of current attendants and entry supervisor;
- A list of hazards in the permit space;
- A list of measures to isolate the permit space and eliminate or control the hazards;
- The acceptable entry conditions;
- The results of tests initialed by the person(s) performing the tests;
- The rescue and emergency services available and the means to summon them;
- Communication procedures for attendants and entrants;
- Any required equipment (such as respirators, communication, alarms, etc.);
- Any other necessary information; and

- Any additional permits (such as for hot work).

XIV. Multiple Employer Entry Procedures

If more than one employer's employees will be entering a permit-required confined space at the same time, then a pre-entrance meeting will be held with the entry supervisors of all involved employers. In this meeting, all entry procedures and issues will be agreed upon and written into the permit.

XV. Post-Operations Procedures

After entry operations have been completed.the space will be closed and the permit will be canceled.

XVI. Review Procedures

16.1 The company will review entry operations when they have reason to believe that the measures taken under the permit space program may not protect employees and will revise the program to correct deficiencies found to exist before subsequent entries are authorized.

16.2 Examples of circumstances requiring company review of the permit space program are:

- Any unauthorized entry of a permit space, the detection of a permit space hazard not covered by the permit
- The detection of a condition prohibited by the permit
- The occurrence of an injury or near-miss during entry
- A change in the use or configuration of a permit space
- And employee complaints about the effectiveness of the program

16.3 The company will review the permit space program, using the retained canceled permits from the past 12 months with 1 year after each entry and revise the program as necessary, to ensure that employees participating in entry operations are protected from permit space hazards. . If no entry is performed during a 12-month period, no review will be performed.

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Sample Handling and Waste Disposal Procedure

1.0 Purpose and Scope:

To ensure that:

- Samples collected for in-house analysis are properly tracked and disposed
- All laboratory and field chemical disposal is conducted properly, and
- All waste generated during field work is properly disposed.

2.0 Responsible Parties:

- Project Manager
- Laboratory Manager
- Administrative Team
- Employees

3.0 Procedure:

3.1 Sample Analysis and Return to Job Site

3.1.1 Project Managers indicate at each week's meeting, the samples to be received for in house analysis the following week, if any.

3.1.2 Project Managers prepare a Sample Analysis Request and provide this to the Laboratory Manager.

3.1.3 When FE employees bring samples to the office (with accompanying chain-of-custody) for in-house analysis or archiving, the receptionist is notified. The receptionist notifies the Project Manager that the samples have arrived.

3.1.4 The Project Manager reviews and /or completes the chain-of-custody, providing the Receptionist with the pink and yellow copies and keeping the white copy with the samples, which are transported to the laboratory for storage.

3.1.5 The Receptionist creates a Sample Tracking File (STF) folder that contains the yellow chain-of-custody form and is maintained at the reception desk.

3.1.6 The Receptionist creates a sample analysis job file folder that contains the Sample Analysis Request and provides this to the Laboratory Manager. This

serves as notice to the Laboratory Manager that the samples have arrived on-site.

3.1.7 Upon arrival at the laboratory, the Laboratory Manager labels and stores the samples appropriately. The sample batch information is entered into the screening sample arrival log.

3.1.8 The Laboratory Manager or designee, places the job file folder into the internal laboratory files.

3.1.9 The Laboratory Manager or designee, checks for sample completeness, completes the white chain-of-custody form, and performs the requested analysis.

3.1.10 After analysis, the properly labeled samples are temporarily stored in the storage area by the Laboratory Manager until they can be returned to the job site.

3.1.11 The Laboratory Manager prepares a summary of the results. The results are filed in the job file folder and a copy is forwarded to the Project Manager. The Laboratory Manager prepares and provides a Sample Return Notice with the analysis results to the Project Manager.

3.1.12 The Project Manager completes the projected date of sample return section of the Sample Return Notice. A copy of the notice is forwarded to the Receptionist to be filed in the STF.

3.1.13 The Project Manager ensures the samples are returned to the job site on time. The Project Manager signs the yellow chain of custody in the STF after the samples have been returned. The Project Manager enters the actual sample return date with signature onto the Sample Return Notice and files the notice in the STF. The Laboratory Manager then files the sample tracking folder with the Job Tracking Folder in the internal laboratory files.

3.1.14 The Receptionist reviews the STF weekly to determine if proposed disposal dates have passed. The Project Manager is contacted for a revised proposed return date if this occurs.

3.1.15 The Laboratory Manager reviews the samples stored in the laboratory area every three months, checking for chains-of-custody to ensure all samples are being properly tracked.

3.2 Chemical Management and Disposal

3.2.1 The Laboratory Manager or designee, performs a check of the chemicals and standards used in the field equipment and in the laboratory to ensure chemicals are on the chemical inventory and are not expired.

3.2.2 If chemicals need to be disposed of, the Laboratory Manager ensures that

they are disposed of properly.

3.2.3 Any employee who determines that a chemical needs to be disposed of must notify the Laboratory Manager who will ensure that it is disposed of properly.

3.3 Waste Disposal for Field Generated Waste

3.3.1 Waste disposal practices consistent with regulatory requirements and best practices are specified in the Site Specific Health and Safety Plan (HASP)

4.0 References and Related Documentation

4.1 Policy
4.2 Site HASP

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Corporate Health and Safety Overview

1.0 Purpose and Scope:

To reduce or eliminate injuries and illnesses. It is the policy of First Environment to exercise precautions necessary to protect Employees.

This corporate safety philosophy provides a guiding vision and general policy by which we conduct business and safety together every day. This philosophy is a statement of the ideals the company would like to achieve in safety.

First Environment is committed to providing a safe and healthy workplace for all its Employees. First Environment complies with all applicable requirements issued by the federal Occupational Health and Safety Administration (OSHA) and the states in which business is conducted and implements a site-specific health and safety program when applicable. Management and all Employees working at First Environment share the responsibility for the success of the safety and health program.

2.0 Responsibilities:

Project Managers are responsible for ensuring that operations are performed with the utmost regard for the safety and health of the Employees involved, including themselves.

Employees are responsible for cooperating with all aspects of the health and safety program, including compliance with rules and regulations. Employees are encouraged to be alert to unsafe conditions and report them promptly to their manager, human resources, or a health and safety committee member. Employees also are responsible for continuously practicing safety while performing their job duties. Failure to comply with First Environment's safety and health policies can result in disciplinary action up to and including termination of employment.

3.0 Procedure:

3.1 Corporate Safety Philosophy

The safety of Employees is of utmost importance. The following principles support this philosophy:

3.1.1 Injuries and accidents are preventable through establishment and compliance with safe work procedures.

3.1.2 The prevention of bodily injury and safeguarding of health are the first considerations in all workplace actions and are the responsibility of every Employee at every level.

3.1.3 Written safety plans describing the safe work practices and procedures to be practiced in all workplace actions are an essential element of the overall workplace safety program. Employees at every level are responsible for knowing and following the safety practices described in the written safety plan.

3.2 Employer Responsibility to Provide a Safe Work Place

It is the policy of First Environment to provide a place of employment free from hazards, which may cause illness, injury, or death to associates. It is also First Environment's policy to establish an effective and continuous safety program incorporating educational and monitoring procedures maintained to teach safety, correct deficiencies, and provide a safe, clean working environment.

Staff members are trained in appropriate safety procedures, including chemical-specific training as required. Individual safety files are maintained in Personnel for all associates.

3.3 Employee Responsibility to Follow Safety Rules and Work Safely at all Times:

Employees have a responsibility to themselves and to First Environment for their safety and the safety of the co-workers. Employees are required to:

3.3.1 Comply with all federal, state, and local rules and regulations relevant to their work including, but not limited to OSHA and the Environmental Protection Agency (EPA)

3.3.2 Observe all company rules and regulations related to the efficient and safe performance of their work.

3.3.3 Integrate safety into each job function and live by this philosophy in the performance of job duties.

3.3.4 Maintain equipment and property in a safe, hazard-free condition

3.3.5 Report or correct unsafe equipment and practices.

3.3.6 Report any accidents that occur while on the job immediately and complete the necessary forms.

3.4 Medical Monitoring

For Employees who conduct field operations on sites containing hazardous materials, medical examinations are a required component of the Health and Safety Program. Examinations and clinical laboratory tests are conducted to provide a baseline level for later comparison. The baseline medical examination and clinical profile determines the entrance state of health. In accordance with 29CFR 1910.120, a physician's written opinion is obtained as to whether the Employee has any detected medical conditions which would place the Employee at increased risk of material impairment of the Employee's health from work in hazardous waste operations or from respirator use. Medical exams and certifications are conducted at least annually, or whenever the need is indicated through industrial hygiene monitoring, the nature, and duration of the job.

3.5 Occupational Safety

Another element of the health and safety program is maintaining a workplace protected from safety hazards. Wherever possible, unsafe conditions are eliminated or minimized. Personnel are trained to exercise caution where unsafe conditions exist and to avoid unsafe acts. Potential unsafe conditions at specific sites are defined insofar as possible in the site-specific health and safety plan and described to personnel prior to assigning them to the site. Newly occurred on-site hazards are discussed with personnel prior to beginning each day's work.

3.6 Training

First Environment field personnel receive extensive training in health and safety. Employees are trained according to applicable OSHA standards including OSHA regulation, Title 29, Code of Federal Regulations (CFR), Part 1910.1200, Hazard Communication, and Part 1910.38 Employee Emergency Plans. OSHA regulation 29CFR1910.120 requires extensive personnel training for hazardous waste workers. As part of this training, personnel learn the use, maintenance, and limitations of PPE. Other topics covered during the training include labels and the types of hazards that hazardous waste workers may encounter, noise and hearing protection, respiratory protective devices, safety, eye protection, decontamination, levels of protection, and site control. The 40-hour training is supplemented with 8 hours of annual refresher training and, 8 hours of supervisor training, as appropriate.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures

Health and Safety Procedures

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Respiratory Protection

1.0 Purpose and Scope:

This procedure fulfills the requirements of the OSHA's Respiratory Protection Standard (29 CFR1910.134) and establishes the process by which respirators will be used by First Environment employees.

2.0 Responsible Parties:

- Project Manager
- Human Resource Manager
- Health and Safety Team
- Hazardous Operations Team
- Employees

3.0 Procedures:

3.1 General

3.1.1 In those instances where feasible engineering or administrative controls do not adequately protect employees, appropriate respirators are required to be worn.

3.1.2 In addition to these general procedures, site-specific respirator procedures are developed for those job sites requiring respirator protection.

3.1.3 Respirators/cartridges are selected based on the expected hazards and conditions of the job site, taking into account workplace factors that affect respirator performance and reliability. Only respirators approved by the National Institute of Occupational Safety and Health (NIOSH) are used. The following is considered:

- Chemical characteristics of the contaminant (concentration)
- Physical characteristics of the contaminant (gaseous or particulate)
- Oxygen levels at least 19.5 %
- Expected duration of the exposure

3.1.3 When the action levels indicated in the Site Specific Health and Safety Plan, which will be established below the IDLH levels, are reached, the Project Team stops all project activities and immediately notifies the Project Manager. The Project Manager notifies Senior Management, who decides how to proceed. First Environment employees do not enter any area that requires Level A personal protective equipment. Areas that require Level B personal protective equipment are evaluated on a case-by-case basis by the Hazardous Operations Team and Senior Management.

3.1.4 A written respiratory protection program will be prepared for any workplace where respirators are necessary to protect the health of the employees or whenever respirators are required by First Environment. The program shall be updated as necessary to reflect any changes in the workplace conditions that affect respiratory use. The program shall be prepared in accordance with 29 CFR 1910.134.

3.2 Medical Evaluation:

3.2.1 A medical evaluation is completed annually for each employee expected to wear a respirator. The evaluation determines the employee's ability to use a respirator and is performed prior to any fit testing or required use of a respirator.

3.2.2 The medical evaluation is completed by a physician or other licensed health care professional and takes into consideration the physical demands associated with respirator use. The OSHA medical questionnaire is used for screening purposes.

3.2.3 The Human Resource Manager should ensure that the annual Medical Evaluation records are kept in personnel files.

3.3 Training and Fit Testing:

3.3.1 Training and fit testing is conducted for all employees expected to be able to wear negative or positive pressure tight-fitting respirators in performance of their job duties.

3.3.2 A fit test must be performed before the respirator is used in the workplace and annually thereafter. The fit test protocol is selected based on the type of respirator to be worn.

3.3.3 Employees are instructed on respiratory hazards, respirator selection fit testing, use and limitations of the respirator, proper use, donning and removing respirators, and cleaning and storage procedures.

3.3.4 Training is conducted initially, prior to use of respirators and annually thereafter unless the conditions of the job site or respirator program change, in which case additional training is provided prior to the expected respirator use.

3.3.5 Human Resources ensues that the trainings and fit testing are kept in personnel files.

3.4 Use of Respirators

3.4.1 Employees that use respirators must comply with all aspects of the respirator procedure and the OSHA Respiratory Protection Standard.

3.4.2 Employees that are required to wear respirators will take precautions to prevent

conditions that will cause face piece leakage, such as facial hair, wearing of jewelry or glasses.

3.4.3 All employees should perform a user seal check each time they put on a tight fitting respirator. User seal checks will be discussed during the initial and annual training programs.

3.4.3 Employees shall not remove their respirators while in a hazardous environment.

3.5 Cleaning, Storing and Disinfecting Respirators

3.5.1 Respirators are issued for the exclusive use of one worker. Employees are responsible for the cleaning, inspection, and storage of their respirators

3.5.2 The use, cleaning, inspection, and storage shall be document on the Respiratory Cleaning and Inspection Log Sheet included with the written Respiratory Protection Program.

3.5.3 Repairs of to worn or defective respirators or respirator parts shall be made only by persons appropriately trained to perform such activities. All repairs should be made according to manufacture's recommendations and NIOSH-approved parts.

3.6 Program Evaluation

3.6.1 A periodic inspection and evaluation of the respirator protection program to determine its continued effectiveness is conducted by the Health & Safety Team and Hazardous Operations Team in conjunction with the Steering Committee's annual review of EMS Procedures.

4.0 References and Related Documentation

4.1 Policy

4.2 Procedures – Health and Safety Procedures

4.3 Records

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Personal Protective Equipment

1.0 Purpose and Scope:

To ensure that First Environment employees are protected from site hazards, based on an evaluation of hazard levels, work area conditions, and specific tasks, by defining, requiring the use of, and maintaining the appropriate level of personal protective equipment. For the purpose of this procedure, PPE includes safety equipment for head, eyes, face, ears, body, hands and feet.

2.0 Responsibilities:

Human Resources Manager
Health and Safety Manager
Project Managers
Site Safety Officer
Field Manager
Employees

3.0 Procedure:

3.1 Before beginning field work, the Project Manager ensure work conditions and specific jobs to be performed are assessed to determine if hazards exist, or are likely to exist, which would require personal protective equipment. The assessment is recorded on the site specific Health and Safety Plan (HASP)

3.1.1 If any of the hazards are present, or likely to be present, and cannot be adequately controlled through elimination, substitution, or engineering or administrative control, then, the Project Manager selects the types of PPE that will protect the project team.

3.1.2 When employees work on a host employer's site, the project manager requests information of the client about hazards, controls, safety and health rules and emergency procedures, so that appropriate personal protective equipment can be selected. This is documented in the HASP.

3.2 PPE is supplied by First Environment.

3.3 Employees are responsible for keeping their assigned PPE properly cleaned and maintained.

3.4 The Field Manager is responsible for maintaining an adequate supply of expendable PPE and decontamination equipment.

3.5 Contaminated PPE which cannot be decontaminated is disposed of properly.

3.6 Employee Training and Information

3.6.1 The Health and Safety Manager and Human Resources Manager ensure new employees are trained in proper PPE use (what, when, limitations, care) as part of the Health and Safety Training module and 40-hour OSHA Training.

3.6.2 The annual eight-hour refresher training provided to all field employees includes hazard assessment and the use of PPE.

3.7 Informing Other Employers/Contractors

3.7.1 Prior to initiating work on a multiemployer work site, the Project Manager informs other employers and contractors about hazards that First Environment has identified. This is done by sending clients and subcontractors a copy of First Environment's completed Site-Specific Health and Safety Plan for their information.

3.7.2 If the hazards of First Environment's work require it, the Project Manager will also inform other employers of necessary precautionary measures to protect their employees (e.g., vacating the premises for the duration of the work).

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures/Documents

- Intrusive and Remedial Field Activities
- Health and Safety Training Module

4.3 Forms/tools

- Field notebook
- Site-Specific Health and Safety Plan

Environmental Management System Procedures
Title: Emergency Preparedness and Response

1.0 Purpose and Scope:

To establish and maintain a process to identify the potential for and respond to incidents and emergency situations both in the office and in the field. The process is driven by the requirements of First Environment's Corporate Health and Safety Procedures, and RCRA, and OSHA requirements.

2.0 Responsible Parties:

- Employees

3.0 Procedure:

3.1 Emergency Preparedness and Response and Drills

Emergency Preparedness and Response including drill requirements and documented response requirments for different types of work or activities are set forth in the following table:

Area of Work	Requirements	Drill Requirements
Non-Intrusive Field Work – Active Site	Active facility emergency response requirements	Determined by site operator
Non-Intrusive Field Work - Un-manned or Inactive Site	Employees establishes appropriate emergency response considering Emergency Action and Fire Prevention procedure	Verbal review

Intrusive or Remedial Field Work - Active Site	Site Specific HASP and guidance, as required by 11.3 Intrusive and Remedial Field Activities – incorporating facility requirements	Paper review at morning meeting
Intrusive or Remedial Field Work – Unmanned or Inactive Site	Site Specific HASP and guidance, as required by 11.3 Intrusive and Remedial Field Activities	Paper review at morning meeting
Office	Emergency Action and Fire Prevention Procedure	Drills as specified in Procedure

3.2 Results of drills and emergencies are evaluated by the Health and Safety Committee to determine if a PCAN should be filed and appropriate revisions need to be made to the EMS.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures

- Intrusive and Remedial Field Activities
- Emergency Action and Fire Prevention

4.3 Records

- Site HASPs

4.4 References

- Regulations

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Field Work Emergency Response Procedure

1.0 Purpose and Scope:

To ensure the safety of First Environment personnel and the public in the event of an emergency situation that occurs at a site where field work is being conducted.

2.0 Responsible Parties:

- Senior Management
- Project Managers
- Field Team Leader
- Employees

3.0 Procedure:

3.1 At no time will any Employee place themselves, or allow themselves to be placed, in a life-threatening situation. Employees are expected to act only in accordance with their training. Life safety takes precedence over other considerations.

3.2 ***Evacuation***

3.2.1 Evacuation routes and muster points are outlined in the site specific HASP.

3.2.2 The Field Team Leader notifies the site contact or sounds the appropriate alarm and notifies the Project Manager.

3.2.3 The Field Team Leader ensures that all First Environment employees are accounted for at the muster point and notifies the Project Manager that an evacuation has occurred.

3.3 ***Fire***

3.3.1 The Field Health and Safety Officer is responsible for conducting daily inspections of portable fire extinguishers in the field to ensure that fire extinguishers are in place, charged, and ready for use in the event of a fire.

3.3.2 In the event of a fire:

- call the Fire Department using 9-1-1
- If safe to do so, use the fire extinguisher located in the field or personal vehicle to extinguish the fire.

3.3.3 The Field Team Leader oversees the evacuation of First Environment personnel as described above.

3.4 Medical

3.4.1 Employees trained in First Aid and/or CPR may render immediate medical assistance to the extent that they are qualified by their training. If necessary, the injured person will be decontaminated prior to being given First Aid or CPR.

3.4.2 No employee is to be moved if anything other than a minor ambulatory injury is suspected or has occurred. The only exception is if leaving the employee in the location could put the employee at risk of immediate greater injury. Professional emergency services should be contacted using 9-1-1 or the number on the site specific HASP.

3.4.3 Professional emergency services responding in an emergency will direct all rescue and medical duty assignments upon their arrival.

3.5 Weather Related

3.5.1 In the event of a weather related emergency such as a thunderstorm, tornado, hurricane, or earthquake, Employees shall follow the facility response plan. If no facility response plan exists, employees shall:

- Move to the lowest level and seek shelter in an interior room or hallway away from windows.
- Stand or crouch in a strongly supported doorway.
- Stay away from windows
- If outside and unable to get inside, lie flat in a ditch or depression

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures

- Emergency Preparedness and Response
- Site Specific Health and Safety Plans
- Intrusive and Remedial Field Activities

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Field Work Spill Response Procedure

1.0 Purpose and Scope:

To identify the process to be used to respond to spills of hazardous materials while in the field. Trained First Environment personnel recognize and respond directly only to incidental spills. If the spill is beyond what can be considered incidental, and is an emergency release, i.e., of a large quantity or if the personnel at the site are not trained in spill response, are not familiar with the material spilled, or cannot safely respond to the spill, a spill response contractor should be contacted.

2.0 Responsible Parties:

- Senior Personnel
- Project Managers
- Health and Safety Mamger
- Field Team Leader – serves as field health and safety officer and may as appropriate delegate activities to other members of the Field Team
- Field Team

CAUTION

First Environment Employees are authorized to control incidental spills. They are not authorized to respond to emergency releases. For emergency releases, employees, in consultation with the Project Manager or other Senior Personnel, summon emergency responders for assistance.

3.0 Procedure:

3.1 Field Team members trained in spill response may respond to incidental spills that occur under their control. First Environment personnel do not respond to spills under other organizations' (client, subcontractors) control. However, they may provide First Environment spill containment equipment to other organizations.

3.2 When First Environment field team members respond to the incidental spill, the following steps should be taken wearing the appropriate personal protective gear as outlined in the HASP and in conformance with the MSDS:

3.2.1 If safely possible, stop the source of the spill by picking up the leaking container, closing the valve, etc.

3.2.2 Notify the Field Team Leader of the spill.

3.2.3 Obtain the spill containment kit from the field truck or personal vehicle and deploy appropriate containment devices to prevent further migration of the release.

3.2.4 If the spill becomes unmanageable or if the situation becomes unsafe, stop spill response actions immediately and notify the Field Team Leader who will ensure that an emergency response contractor is obtained.

3.2.5 Containerize Drum the cleanup material and label containers appropriately when response is complete.

3.3 The Field Team Leader contacts the Project Manager and advises them of the spill. If the Project Manager is not available contact the Health and Safety Director or other Senior Personnel.

3.4 The Field Team Leader advises the site contact of the spill and response.

3.5 The Health and Safety Director, Project Manager, or Senior Management will then oversee full cleanup of the spill and determine if additional spill response and notification activities are necessary.

3.6 The Project Manager ensures the proper disposal of spill response material.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures and documents

- Emergency Preparedness and Response Procedure
- Site Specific Health and Safety Plan

FIRST ENVIRONMENT

Environmental Management System Procedures
Title: Field Work Air Monitoring Procedure

1.0 Purpose and Scope:

To ensure the safety of First Environment personnel and the public during site investigation and remediation work.

2.0 Responsible Parties:

- Project Managers
- Field Team Leader
- Employees

3.0 Procedure:

3.1 When indicated in the site-specific health and safety plan (HASP), employees use instruments to monitor levels of air contaminants and other physical and chemical hazards during fieldwork, in order to determine the need for taking action such as modifying required levels of personal protection and the need to initiate additional hazard control measures.

3.2 The types of instruments needed on the site, when measurements are to be taken, at which locations, and the actions to be taken if action levels are detected are specified in the HASP.

3.3 The Field Team Leader ensures that monitoring is conducted in accordance with the site-specific HASP and that equipment is verified or calibrated as necessary and records of such are kept in the field files.

3.4 The Field Team Leader ensures that the appropriate action is taken if action levels are triggered and ensures the Project Manager is notified.

4.0 References and Related Documentation:

4.1 Policy

4.2 Procedures
- Emergency Preparedness and Response
- HASP

4.3 Records

- Calibration/verification
- Maintenance

FINAL

ATTACHMENT 4
MSDS Sheets

Material Safety Data Sheet

Version 4.2
Revision Date 12/13/2012
Print Date 06/13/2014

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Tetrachloroethylene
Product Number	:	371696
Brand	:	Sigma-Aldrich
Supplier	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052
Emergency Phone # (For both supplier and manufacturer)	:	(314) 776-6555
Preparation Information	:	Sigma-Aldrich Corporation Product Safety - Americas Region 1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Carcinogen, Corrosive

Target Organs

Heart, Central nervous system, Liver, Kidney

GHS Classification
Acute toxicity, Oral (Category 5)
Eye irritation (Category 2B)
Carcinogenicity (Category 2)
Acute aquatic toxicity (Category 2)

GHS Label elements, including precautionary statements

Pictogram

Signal word Warning

Hazard statement(s)

H303	May be harmful if swallowed.
H320	Causes eye irritation.
H351	Suspected of causing cancer.
H401	Toxic to aquatic life.

Precautionary statement(s)

P281	Use personal protective equipment as required.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

HMIS Classification

Health hazard:	1
Chronic Health Hazard:	*
Flammability:	0

Physical hazards: 0

NFPA Rating

Health hazard: 1
Fire: 0
Reactivity Hazard: 0

Potential Health Effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.
Ingestion	May be harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Perchloroethylene
PCE

Formula : C_2Cl_4
Molecular Weight : 165.83 g/mol

Component		Concentration
Tetrachloroethylene		
CAS-No.	127-18-4	-
EC-No.	204-825-9	
Index-No.	602-028-00-4	

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Hydrogen chloride gas

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

Methods and materials for containment and cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Basis
Tetrachloroethylene	127-18-4	TWA	25 ppm	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Central Nervous System impairment Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Confirmed animal carcinogen with unknown relevance to humans			
		STEL	100 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Central Nervous System impairment Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Confirmed animal carcinogen with unknown relevance to humans			
		TWA	25 ppm 170 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	100 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
		CEIL	200 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
		Peak	300 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Potential Occupational Carcinogen Minimize workplace exposure concentrations. See Appendix A			

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

Splash protection

Material: Nitrile rubber
Minimum layer thickness: 0.2 mm
Break through time: 49 min
Material tested:Dermatril® P (KCL 743 / Aldrich Z677388, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	liquid, clear
Colour	colourless

Safety data

pH	no data available
Melting point/freezing point	Melting point/range: -22 °C (-8 °F) - lit.
Boiling point	121 °C (250 °F) - lit.
Flash point	no data available
Ignition temperature	no data available
Auto-ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	25.3 hPa (19.0 mmHg) at 25.0 °C (77.0 °F) 17.3 hPa (13.0 mmHg) at 20.0 °C (68.0 °F)
Density	1.623 g/cm3 at 25 °C (77 °F)
Water solubility	no data available
Partition coefficient: n-octanol/water	log Pow: 3.40
Relative vapor density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
Strong oxidizing agents, Strong bases

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Hydrogen chloride gas
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
LD50 Oral - rat - 2,629 mg/kg

Inhalation LC50
LC50 Inhalation - rat - 8 h - 34,200 mg/m3

Dermal LD50
LD50 Dermal - rabbit - 5,000 mg/kg

Other information on acute toxicity
no data available

Skin corrosion/irritation
Skin - rabbit - Severe skin irritation - 24 h

Serious eye damage/eye irritation
Eyes - rabbit - Mild eye irritation - 24 h

Respiratory or skin sensitization
no data available

Germ cell mutagenicity

no data available

Carcinogenicity

Limited evidence of carcinogenicity in animal studies

IARC:	2A - Group 2A: Probably carcinogenic to humans (Tetrachloroethylene)
NTP:	Reasonably anticipated to be a human carcinogen (Tetrachloroethylene)
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion	May be harmful if swallowed.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.

Signs and Symptoms of Exposure
narcosis, Liver injury may occur., Kidney injury may occur.

Synergistic effects
no data available

Additional Information
RTECS: KX3850000

12. ECOLOGICAL INFORMATION

Toxicity

Toxicity to fish	LC50 - Cyprinodon variegatus (sheepshead minnow) - 9.8 mg/l - 96.0 h
	LC50 - Lepomis macrochirus (Bluegill) - 13 mg/l - 96.0 h
	LC50 - Oncorhynchus mykiss (rainbow trout) - 4.9 mg/l - 96.0 h
	NOEC - Oryzias latipes - 17 mg/l - 10.0 d
	NOEC - Cyprinodon variegatus (sheepshead minnow) - 29 mg/l - 96.0 h

no data available

Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 7.50 mg/l - 48 h

Persistence and degradability

Bioaccumulative potential

Bioaccumulation	Lepomis macrochirus (Bluegill) - 21 d Bioconcentration factor (BCF): 49

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1897 Class: 6.1 Packing group: III
Proper shipping name: Tetrachloroethylene
Reportable Quantity (RQ): 100 lbs
Marine Pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1897 Class: 6.1 Packing group: III EMS-No: F-A, S-A
Proper shipping name: TETRACHLOROETHYLENE
Marine Pollutant: Marine pollutant

IATA
UN number: 1897 Class: 6.1 Packing group: III
Proper shipping name: Tetrachloroethylene

15. REGULATORY INFORMATION

OSHA Hazards
Carcinogen, Corrosive

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Tetrachloroethylene	127-18-4	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Tetrachloroethylene	127-18-4	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Tetrachloroethylene	127-18-4	2007-07-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. Tetrachloroethylene	127-18-4	2007-09-28

16. OTHER INFORMATION

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Material Safety Data Sheet

Version 4.2
Revision Date 10/30/2012
Print Date 06/13/2014

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Trichloroethylene
Product Number	:	251402
Brand	:	Sigma-Aldrich
Supplier	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052
Emergency Phone # (For both supplier and manufacturer)	:	(314) 776-6555
Preparation Information	:	Sigma-Aldrich Corporation Product Safety - Americas Region 1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Carcinogen, Irritant, Mutagen

Target Organs

Liver, Central nervous system, Heart, Lungs

GHS Classification
Acute toxicity, Oral (Category 5)
Skin irritation (Category 2)
Eye irritation (Category 2A)
Germ cell mutagenicity (Category 2)
Carcinogenicity (Category 1B)
Specific target organ toxicity - single exposure (Category 2)
Acute aquatic toxicity (Category 3)
Chronic aquatic toxicity (Category 3)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H303	May be harmful if swallowed.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H341	Suspected of causing genetic defects.
H350	May cause cancer.
H371	May cause damage to organs.
H412	Harmful to aquatic life with long lasting effects.

Precautionary statement(s)

P201	Obtain special instructions before use.

P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P273	Avoid release to the environment.
P281	Use personal protective equipment as required.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.

HMIS Classification

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	0
Physical hazards:	0

NFPA Rating

Health hazard:	2
Fire:	0
Reactivity Hazard:	0

Potential Health Effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes eye irritation.
Ingestion	May be harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms	:	TCE Trichloroethene
Formula	:	C_2HCl_3
Molecular Weight	:	131.39 g/mol

Component		Concentration
Trichloroethylene		
CAS-No.	79-01-6	-
EC-No.	201-167-4	
Index-No.	602-027-00-9	

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Hydrogen chloride gas

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

Methods and materials for containment and cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Light sensitive. Handle and store under inert gas.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Basis
Trichloroethylene	79-01-6	TWA	50 ppm 270 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
Remarks	Skin notation			
		STEL	200 ppm 1,080 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
	Skin notation			
		TWA	100 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.19-1967			
		CEIL	200 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.19-1967			
		Peak	300 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.19-1967			
		TWA	10 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Central Nervous System impairment cognitive decrement Renal toxicity Suspected human carcinogen			
		STEL	25 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Central Nervous System impairment cognitive decrement Renal toxicity Suspected human carcinogen			

	Potential Occupational Carcinogen See Appendix C See Appendix A

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Immersion protection
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: > 480 min
Material tested:Vitoject® (Aldrich Z677698, Size M)

Splash protection
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: > 30 min
Material tested:Vitoject® (Aldrich Z677698, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 873000, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	liquid, clear
Colour	colourless

Safety data

pH	no data available
Melting point/freezing point	Melting point/range: -84.8 °C (-120.6 °F) - lit.
Boiling point	86.7 °C (188.1 °F) - lit.
Flash point	no data available
Ignition temperature	410 °C (770 °F)
Autoignition	410.0 °C (770.0 °F)

temperature	
Lower explosion limit	8 %(V)
Upper explosion limit	10.5 %(V)
Vapour pressure	81.3 hPa (61.0 mmHg) at 20.0 °C (68.0 °F)
Density	1.463 g/mL at 25 °C (77 °F)
Water solubility	no data available
Partition coefficient: n-octanol/water	log Pow: 2.29
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
Oxidizing agents, Strong bases, Magnesium

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Hydrogen chloride gas
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
LD50 Oral - rat - 4,920 mg/kg

Inhalation LC50
LC50 Inhalation - mouse - 4 h - 8450 ppm

Dermal LD50
LD50 Dermal - rabbit - > 20,000 mg/kg

Other information on acute toxicity
no data available

Skin corrosion/irritation
Skin - rabbit - Severe skin irritation - 24 h

Serious eye damage/eye irritation
Eyes - rabbit - Eye irritation - 24 h

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
Laboratory experiments have shown mutagenic effects.
In vitro tests showed mutagenic effects

Carcinogenicity

This product is or contains a component that has been reported to be probably carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

Possible human carcinogen

IARC:	2A - Group 2A: Probably carcinogenic to humans (Trichloroethylene)
NTP:	Reasonably anticipated to be a human carcinogen (Trichloroethylene)
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
May cause damage to organs.

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Ingestion	May be harmful if swallowed.
Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes eye irritation.

Signs and Symptoms of Exposure
burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting, Exposure to and/or consumption of alcohol may increase toxic effects., Gastrointestinal disturbance, Kidney injury may occur., narcosis

Synergistic effects
no data available

Additional Information
RTECS: KX4550000

12. ECOLOGICAL INFORMATION

Toxicity

Toxicity to fish	LC50 - Pimephales promelas (fathead minnow) - 41 mg/l - 96.0 h
	LOEC - other fish - 11 mg/l - 10.0 d
	NOEC - Oryzias latipes - 40 mg/l - 10.0 d
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 18.00 mg/l - 48 h
Toxicity to algae	IC50 - Pseudokirchneriella subcapitata (green algae) - 175.00 mg/l - 96 h

Persistence and degradability

Bioaccumulative potential
Does not bioaccumulate.

Mobility in soil
no data available

PBT and vPvB assessment

no data available

Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Harmful to aquatic life with long lasting effects.

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1710 Class: 6.1 Packing group: III
Proper shipping name: Trichloroethylene
Reportable Quantity (RQ): 100 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1710 Class: 6.1 Packing group: III EMS-No: F-A, S-A
Proper shipping name: TRICHLOROETHYLENE
Marine pollutant: No

IATA
UN number: 1710 Class: 6.1 Packing group: III
Proper shipping name: Trichloroethylene

15. REGULATORY INFORMATION

OSHA Hazards
Carcinogen, Irritant, Mutagen

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Trichloroethylene	79-01-6	2007-07-01

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Trichloroethylene	79-01-6	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Trichloroethylene	79-01-6	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Trichloroethylene	79-01-6	2007-07-01

California Prop. 65 Components

WARNING! This product contains a chemical known to the State of California to cause cancer. Trichloroethylene	CAS-No. 79-01-6	Revision Date 2008-10-10

16. OTHER INFORMATION

Further information

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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

SAFETY DATA SHEET

Version 5.1
Revision Date 04/05/2014
Print Date 06/13/2014

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	*cis*-1,2-Dichloroethylene
Product Number	:	D62004
Brand	:	Aldrich
Index-No.	:	602-026-00-3
REACH No.	:	A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
CAS-No.	:	156-59-2

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Acute toxicity, Inhalation (Category 4), H332
Acute aquatic toxicity (Category 3), H402
Chronic aquatic toxicity (Category 3), H412

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H332	Harmful if inhaled.
H412	Harmful to aquatic life with long lasting effects.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.

P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P312	Call a POISON CENTER or doctor/ physician if you feel unwell.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P235	Store in a well-ventilated place. Keep cool.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms	:	cis-Acetylene dichloride
Formula	:	$C_2H_2Cl_2$
Molecular Weight	:	96.94 g/mol
CAS-No.	:	156-59-2
EC-No.	:	205-859-7
Index-No.	:	602-026-00-3

Hazardous components

Component	Classification	Concentration
cis-Dichloroethylene		
	Flam. Liq. 2; Acute Tox. 4; Aquatic Acute 3; Aquatic Chronic 3; H225, H332, H412	-

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides, Hydrogen chloride gas

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Handle and store under inert gas. Air and moisture sensitive. Light sensitive.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
cis-Dichloroethylene	156-59-2	TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Central Nervous System impairment Eye irritation		

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: light yellow
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: -80 °C (-112 °F) - lit.
f)	Initial boiling point and boiling range	60 °C (140 °F) - lit.
g)	Flash point	6.0 °C (42.8 °F) - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	no data available
k)	Vapour pressure	no data available
l)	Vapour density	no data available
m)	Relative density	1.284 g/cm3 at 25 °C (77 °F)
n)	Water solubility	no data available
o)	Partition coefficient: n-octanol/water	no data available

p)	Auto-ignition temperature	no data available
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information
no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials
Oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LC50 Inhalation - rat - 13700 ppm
Remarks: Behavioral:Somnolence (general depressed activity). Liver:Fatty liver degeneration.

Dermal: no data available

no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a

carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: KV9420000

narcosis, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Harmful to aquatic life.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1150 Class: 3 Packing group: II
Proper shipping name: 1,2-Dichloroethylene
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1150 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: 1,2-DICHLOROETHYLENE
Marine pollutant: No

IATA
UN number: 1150 Class: 3 Packing group: II
Proper shipping name: 1,2-Dichloroethylene

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Fire Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
cis-Dichloroethylene	156-59-2	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
cis-Dichloroethylene	156-59-2	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
cis-Dichloroethylene	156-59-2	1993-04-24

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Aquatic Acute	Acute aquatic toxicity
Aquatic Chronic	Chronic aquatic toxicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H332	Harmful if inhaled.
H402	Harmful to aquatic life.

HMIS Rating

Health hazard:	1
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	1

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling

or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.1 Revision Date: 04/05/2014 Print Date: 06/13/2014

SAFETY DATA SHEET

Version 3.7
Revision Date 04/05/2014
Print Date 06/13/2014

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	Vinyl chloride
Product Number	:	387622
Brand	:	Aldrich
Index-No.	:	602-023-00-7
REACH No.	:	A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
CAS-No.	:	75-01-4

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable gases (Category 1), H220
Gases under pressure (Liquefied gas), H280
Carcinogenicity (Category 1A), H350

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)

H220	Extremely flammable gas.
H280	Contains gas under pressure; may explode if heated.
H350	May cause cancer.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

P281	Use personal protective equipment as required.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	Eliminate all ignition sources if safe to do so.
P405	Store locked up.
P410 + P403	Protect from sunlight. Store in a well-ventilated place.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms	:	Chloroethylene
Formula	:	C_2H_3Cl
Molecular Weight	:	62.50 g/mol
CAS-No.	:	75-01-4
EC-No.	:	200-831-0
Index-No.	:	602-023-00-7

Hazardous components

Component	Classification	Concentration
Vinyl chloride		
	Flam. Gas 1; Press. Gas ; Carc. 1A; H220, H280, H350	-

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides, Hydrogen chloride gas

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Clean up promptly by sweeping or vacuum.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

Contents under pressure. Light sensitive.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Vinyl chloride	75-01-4	TWA	1 ppm	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	1 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Liver damage Lung cancer Confirmed human carcinogen		
		STEL	5 ppm	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	1 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		STEL	5 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		See 1910.1017		
		Potential Occupational Carcinogen See Appendix A		
Hydroquinone	123-31-9	TWA	1 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
		Eye irritation Eye damage		

		Confirmed animal carcinogen with unknown relevance to humans Sensitizer		
		TWA	2 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	2 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		C	2 mg/m3	USA. NIOSH Recommended Exposure Limits
		15 minute ceiling value		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Hydroquinone	123-31-9	Methemoglobin	1.5 %	In blood	ACGIH - Biological Exposure Indices (BEI)
	Remarks	During or end of shift			

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Splash contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 120 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: Liquefied gas
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: -153.8 °C (-244.8 °F) - lit.
f)	Initial boiling point and boiling range	-13.4 °C (7.9 °F) - lit.
g)	Flash point	-61.0 °C (-77.8 °F) - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 33 %(V) Lower explosion limit: 3.6 %(V)
k)	Vapour pressure	no data available
l)	Vapour density	no data available
m)	Relative density	0.911 g/cm3 at 25 °C (77 °F)
n)	Water solubility	no data available
o)	Partition coefficient: n-octanol/water	no data available
p)	Auto-ignition temperature	no data available
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information

no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity

no data available

10.2 Chemical stability

Stable under recommended storage conditions.
Contains the following stabiliser(s):
Hydroquinone (>=0 - <=0.0001 %)
Phenol (>=0 - <=0.01 %)

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials

Chemically active metals, Copper

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
no data available

LC50 Inhalation - rat - 0.3 h - 180000 ppm
Remarks: Behavioral:Tremor. Behavioral:Convulsions or effect on seizure threshold. Respiratory disorder

Dermal: no data available

no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

Human carcinogen.

IARC:	1 - Group 1: Carcinogenic to humans (Vinyl chloride)
NTP:	Known to be human carcinogen (Vinyl chloride)
OSHA:	OSHA specifically regulated carcinogen (Vinyl chloride)

Reproductive toxicity
no data available

Overexposure may cause reproductive disorder(s) based on tests with laboratory animals.

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: KU9625000

burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Central nervous system -
Stomach - Irregularities - Based on Human Evidence (Phenol)
Liver - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1086 Class: 2.1
Proper shipping name: Vinyl chloride, stabilized
Reportable Quantity (RQ): 1 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1086 Class: 2.1 EMS-No: F-D, S-U
Proper shipping name: VINYL CHLORIDE, STABILIZED
Marine pollutant: No

IATA
UN number: 1086 Class: 2.1
Proper shipping name: Vinyl chloride, stabilized
IATA Passenger: Not permitted for transport

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

SARA 302 Components
The following components are subject to reporting levels established by SARA Title III, Section 302:

	CAS-No.	Revision Date
Phenol	108-95-2	2007-07-01
Hydroquinone	123-31-9	2007-07-01

SARA 313 Components

The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Vinyl chloride	75-01-4	2007-07-01

SARA 311/312 Hazards
Fire Hazard, Sudden Release of Pressure Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Vinyl chloride	75-01-4	2007-07-01
Phenol	108-95-2	2007-07-01
Hydroquinone	123-31-9	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Vinyl chloride	75-01-4	2007-07-01
Phenol	108-95-2	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Vinyl chloride	75-01-4	2007-07-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. Vinyl chloride	75-01-4	2007-09-28

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Carc.	Carcinogenicity
Flam. Gas	Flammable gases
H220	Extremely flammable gas.
H280	Contains gas under pressure; may explode if heated.
H350	May cause cancer.
Press. Gas	Gases under pressure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	4
Physical Hazard	3

NFPA Rating

Health hazard:	2
Fire Hazard:	4
Reactivity Hazard:	0

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 3.7 Revision Date: 04/05/2014 Print Date: 06/13/2014

SAFETY DATA SHEET

Version 5.1
Revision Date 06/02/2014
Print Date 06/13/2014

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	1,4-Dioxane
Product Number	:	296309
Brand	:	Sigma-Aldrich
Index-No.	:	603-024-00-5
CAS-No.	:	123-91-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Eye irritation (Category 2A), H319
Carcinogenicity (Category 2), H351
Specific target organ toxicity - single exposure (Category 3), Respiratory system, H335

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.
H351	Suspected of causing cancer.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.

P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

May form explosive peroxides., Repeated exposure may cause skin dryness or cracking.
May form explosive peroxides.

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms	:	Dioxane Diethylene oxide
Formula	:	$C_4H_8O_2$
Molecular Weight	:	88.11 g/mol
CAS-No.	:	123-91-1
EC-No.	:	204-661-8
Index-No.	:	603-024-00-5

Hazardous components

Component	Classification	Concentration
1,4-Dioxane		
	Flam. Liq. 2; Eye Irrit. 2A; Carc. 2; STOT SE 3; H225, H319, H335, H351	-

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
1,4-Dioxane	123-91-1	TWA	20 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Liver damage Confirmed animal carcinogen with unknown relevance to humans Danger of cutaneous absorption		
		TWA	25 ppm 90 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		Skin notation		
		TWA	100 ppm 360 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		Skin designation The value in mg/m3 is approximate.		
		C	1 ppm 3.6 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential Occupational Carcinogen See Appendix A 30 minute ceiling value		

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: Chloroprene
Minimum layer thickness: 0.6 mm
Break through time: 35 min
Material tested:Camapren® (KCL 722 / Aldrich Z677493, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls.

If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: colourless
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	6.0 - 8 at 500 g/l at 20 °C (68 °F)
e)	Melting point/freezing point	Melting point/range: 10 - 12 °C (50 - 54 °F) - lit.
f)	Initial boiling point and boiling range	100 - 102 °C (212 - 216 °F) - lit.
g)	Flash point	12 °C (54 °F) - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 22 %(V) Lower explosion limit: 2 %(V)
k)	Vapour pressure	36 hPa (27 mmHg) at 20 °C (68 °F) 53 hPa (40 mmHg) at 25.20 °C (77.36 °F)
l)	Vapour density	3.04 - (Air = 1.0)
m)	Relative density	1.034 g/cm3 at 25 °C (77 °F)
n)	Water solubility	completely miscible
o)	Partition coefficient: n-octanol/water	log Pow: -0.27
p)	Auto-ignition temperature	no data available
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information

Surface tension	36.9 mN/m at 25 °C (77 °F)
Relative vapour density	3.04 - (Air = 1.0)

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.
Test for peroxide formation before distillation or evaporation. Test for peroxide formation or discard after 1 year.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials
Oxygen, Oxidizing agents, Halogens, Reducing agents, Perchlorates., Trimethylaluminum

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 4,200 mg/kg

LC50 Inhalation - rat - 2 h - 46,000 mg/m3
Remarks: Sense Organs and Special Senses (Nose, Eye, Ear, and Taste):Eye:Other.

LD50 Dermal - rabbit - 7,858 mg/kg

no data available

Skin corrosion/irritation
Skin - Human
Remarks: Chronic exposure causes drying effect on the skin and eczema.

Skin - rabbit
Result: No skin irritation

Serious eye damage/eye irritation
Eyes - rabbit
Result: Eye irritation - 24 h

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
Laboratory experiments have shown mutagenic effects.

Carcinogenicity

This product is or contains a component that has been reported to be possibly carcinogenic based on its IARC, ACGIH, NTP, or EPA classification.

Limited evidence of carcinogenicity in animal studies

IARC:	2B - Group 2B: Possibly carcinogenic to humans (1,4-Dioxane)
NTP:	Reasonably anticipated to be a human carcinogen (1,4-Dioxane)
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

no data available

Specific target organ toxicity - single exposure
May cause respiratory irritation.

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: JG8225000

Nausea, Vomiting, Weakness, Dizziness, Vertigo, Headache, Sweating, loss of appetite, Kidney injury may occur., Liver injury may occur.

Liver - Irregularities - Based on Human Evidence
Liver - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Pimephales promelas (fathead minnow) - 985 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 8,450 mg/l - 24 h
Toxicity to algae	EC50 - Desmodesmus subspicatus (green algae) - > 500 mg/l - 72 h

12.2 Persistence and degradability

Biodegradability	Result: < 5 % - Not readily biodegradable.

12.3 Bioaccumulative potential
Does not bioaccumulate.

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1165 Class: 3 Packing group: II
Proper shipping name: Dioxane
Reportable Quantity (RQ): 100 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1165 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: DIOXANE
Marine pollutant: No

IATA
UN number: 1165 Class: 3 Packing group: II

Proper shipping name: Dioxane

15. REGULATORY INFORMATION

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
1,4-Dioxane	123-91-1	2007-07-01

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
1,4-Dioxane	123-91-1	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
1,4-Dioxane	123-91-1	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
1,4-Dioxane	123-91-1	2007-07-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. 1,4-Dioxane	123-91-1	2007-09-28

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Carc.	Carcinogenicity
Eye Irrit.	Eye irritation
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.
H351	Suspected of causing cancer.
STOT SE	Specific target organ toxicity - single exposure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information
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APPENDIX D

FINAL

Preliminary Conceptual Site Model for the 700 South 1600 East Tetrachloroethylene (PCE) Plume Salt Lake City, Utah

PREPARED FOR:	D. Lynne Welsh/VA Salt Lake City Health Care System Rolf Lange/Avalon
DATE:	July 17, 2015
PREPARED BY:	Nazmi M. Talimcioglu of First Environment, Inc. and George Tangalos/Gary Colgan of CH2M HILL
CC:	Ed Reid of First Environment, Inc.; David Waite of CH2M HILL

Introduction

The 700 South 1600 East PCE plume is located in Salt Lake City, Utah (the Site) near the Wasatch Mountain front in the northeastern corner of the Salt Lake Valley (Figure 1). The Site was first identified in 1990 during sampling and analysis of the Mt. Olivet irrigation well. The concentration of PCE in groundwater from the Mt. Olivet well was 32 parts per billion (ppb) at that time. In 1997, PCE was initially detected at Salt Lake City Department of Public Utilities (SLCDPU) Drinking Water Well No. 18 (SLC-18) at a concentration of 0.6 ppb, and the PCE concentration in the Mt. Olivet irrigation well had risen to 184 ppb. In 1998, the United States Environmental Protection Agency (USEPA) conducted additional investigations of the area and installed seven monitoring wells (EPA-MW-01S, EPA-MW-01D, EPA-MW-02, EPA-MW-03, EPA-MW-04, EPA-MW-05, EPA-MW-06) east of the Mt. Olivet well (UDEQ, 2000) (Figure 2). During this investigation, source areas for the PCE contamination and the extent of the plume were not clearly identified. However, a sewer line originating from a former dry-cleaning facility in the Veterans Administration (VA) Medical Center was identified as a potential source (Bowen Collins, 2004) (Figure 2).

In 2010, in response to an oil pipeline break near Red Butte Creek, water samples were collected by the Salt Lake City Department of Public Utilities (SLCDPU) from Red Butte Creek and springs and seeps emanating along the Wasatch Fault scarp west of 1300 East Street. PCE was detected in several of these springs and seeps. Since 2010, additional investigations have been performed to investigate potential source areas and the nature and extent of PCE contamination (UDEQ, 2012; MWH, 2012). These investigations have resulted in the identification of several possible source areas, as discussed in this technical memorandum.

In September 2012, the USEPA released the hazard ranking for the Site (USEPA, 2009). In May 2013, the USEPA listed the Site on the National Priorities List (NPL), making the Site eligible for comprehensive assessment and cleanup through the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Superfund process (USEPA, 2014).

Purpose and Objective

The purpose of this Technical Memorandum is to explain and outline the preliminary Conceptual Site Model (CSM) as part of the Task Order TO 001, VA259-14-U-1364, CLIN 003. The CSM will be integral in developing the remedial investigation (RI) strategy for this Site. Additionally, the CSM will serve as the foundation for the development of a three-dimensional numerical groundwater flow and fate and transport model, using the Groundwater Modeling System (GMS) version 9.2 developed by Aquaveo.

The objective of the CSM is to evaluate and integrate information from previous source investigations, existing groundwater data and groundwater models, and available geological and hydrogeological data to identify data gaps for the Site. Identifying data gaps through the CSM process will directly inform the scoping process for the remedial investigation and feasibility study process.

Documents and Groundwater Models Reviewed

Document Review

Documents pertaining to the site history, previous investigations, and analytical data and modeling for the 700 South 1600 East PCE plume, as well as regional and site-specific geology and hydrogeology literature, were reviewed. The following sources were reviewed:

Anderson, P.B., *et al*, 1994. Hydrogeology of recharge areas and water quality of the principal aquifers along the Wasatch Front and adjacent areas, Utah. USGS Water Resources Investigations Report 93-4221.

Beacon, 2001. EMFLUX Passive Soil-Gas Survey; Building 515, University of Utah, Salt Lake City, Utah.

Bowen Collins, 2004. PCE Well Contamination Evaluation.

USEPA, 2012. Hazard Ranking System Documentation Record for 700 South 1600 East PCE Plume.

IHI Environmental, 2005. Soil Sampling Oversight Report, Sanitary Sewer Line, VASLCHCS Salt Lake City, Utah.

IHI Environmental, 2007. Soil Gas Investigation Report, Sanitary Sewer Lateral VASLCHCS Building 7 to Sunnyside Avenue, Salt Lake City, Utah.

MWH, 2012. Final Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection at Salt Lake City's Drinking Water Well No. 18 (also referred to as the 500 South Well).

Personius, S.F. and Scott, W.E., 2009. Surficial Geologic Map of the Salt Lake City Segment and Parts of Adjacent Segments of the Wasatch Fault Zone, Davis, Salt Lake, and Utah Counties, Utah (digitized from USGS Miscellaneous Investigations Series Map I-2106, 1992).

Thiros, S.A., 2010. Section 2. Conceptual understanding and groundwater quality of the basin-fill aquifer in Salt Lake Valley, Utah. U.S. Geological Survey Professional Paper 1781.

Thiros, S.A., 2003. Hydrogeology of Shallow Basin-Fill Deposits in Areas of Salt Lake Valley, Salt Lake County, Utah. USGS Water-Resources Investigations Report 03-4029.

Utah Department of Environmental Quality (UDEQ), 2000. Mount Olivet Cemetery Plume Analytical Results Report.

UDEQ, 2012. East Side Springs, Salt Lake County, Utah Site Investigation Analytical Results Report, UTN000802825.

UDEQ. 2010. Expanded Site Investigation (ESI) Work Plan, University of Utah Building 515, Salt Lake County, Utah, UT0001908821.

Utah Division of Water Rights (UDWRi), 2014. Searching Water Right Records; Map Search.

USGS, 2014. National Water Information System: Mapper.

Previous Groundwater Models

The groundwater associated with the plume has been modeled on two separate occasions (2004 and 2012) using limited hydraulic data obtained from pumping tests and sampling of the few monitoring wells and supply wells located in the area. The modeling efforts and results are summarized below.

Groundwater Model by Bowen Collins (2004)

Bowen Collins (2004) presented the results of a MODFLOW/MODPATH model depicting water levels, particle traces, and the capture zone for the SLC-18 well. The modeled groundwater extraction rate was based on actual pumping histories between 1999 and 2003. The five-year capture zone simulated by the model for this well was north of the VA Medical Center; however, the modeled horizontal hydraulic gradient differed from that inferred by the USEPA. Data obtained by the USEPA during the 1999-2000 Mount Olivet Cemetery Plume Investigation (UDEQ, 2000) indicated that the horizontal hydraulic gradient is toward the northwest, whereas the MODFLOW model results predicted a horizontal hydraulic gradient toward the west/southwest.

Groundwater Model by MWH (2012)

MWH (2012) developed a numerical groundwater model (MODFLOW/MT3D) for SLCDPU, based on long-term pumping tests at SLC-18 and in situ permeability (slug) tests at EPA-MW-01S and EPA-MW-01D, to evaluate the potential for PCE contamination to migrate to the northwest (toward SLC-18) from an assumed source near VA Medical Center Building 7. The modeling results indicated the potential to draw contamination into the well after pumping SLC-18 at 2,300 gallons per minute for a limited duration (less than 10 days).

MWH (2012) also commented on the Bowen Collins (2004) model, stating that the discrepancy between the USEPA groundwater hydraulic gradient and the MODFLOW groundwater hydraulic gradient is the result of “perched and localized mounding in the shallow portion of the shallow unconfined aquifer, and the regional groundwater flow direction is from the northeast to the southwest.”

Some uncertainties and data needs remain from the Bowen Collins (2004) and MWH (2012) studies. In reference to these studies, the uncertainties and data needs are discussed, by study, below:

Bowen Collins (2004)

Uncertainties and data needs associated with the Bowen Collins (2004) investigation include the following:

- The presence or absence of laterally extensive clay layers need further investigation based on the following:

> "The 5th South Well [SLC-18] and Mt. Olivet Cemetery Well [Mt. Olivet irrigation well] are both located in the primary recharge area (Anderson, *et al*, 1994). The 5th South Well log indicates clay and gravel are present to a depth of 266 feet but does not indicate there are significant clay layers in the area that would impede the downward migration of water or contamination to the aquifer. Based on the well log and water levels for the 5th South Well, the aquifer is under water table conditions [unconfined aquifer conditions] which is consistent with the USGS recharge zone findings. Based on EPA reports, the 5th South Well is reported to be completed in the same shallow aquifer as the contaminated Mt. Olivet Cemetery Well."

- Groundwater flow directions within specific hydrostratigraphic zones require further characterization based on this statement:

  > "There is a discrepancy between the EPA field data and MODFLOW model predictions for the groundwater flow direction in the vicinity of the 5th South well [SLC-18] … the data obtained by the EPA during field investigations in the Mt. Olivet Cemetery Plume [700 South 1600 East PCE plume] indicates that the groundwater flow direction is toward the northwest … the MODFLOW model predicted groundwater flow field for the 5th South Well toward the west/southwest. The EPA water levels indicated there is a localized recharge mound in the vicinity of Red Butte Creek that influences groundwater elevations and flow in the area."

- Groundwater discharge points potentially affected by PCE need further definition based on this statement:

  > "PCE contamination in the Mt. Olivet Cemetery Plume (700 South 1600 East PCE plume) will likely continue to spread to areas hydraulically downgradient (to the west) without cleanup effort. Given the relatively high levels of PCE in the plume (300+ parts per billion) in the area of the Mt. Olivet Cemetery Well [Mt. Olivet irrigation well], consideration should be given to the ultimate spread of the dilute plume."

- The possible influence on groundwater flow and contamination migration by other pumping wells in the area requires further consideration based on the following statement by Bowen Collins (2004):

  > "The data indicates there may be a correlation between prolonged pumping [of SLC-18] and PCE detections because prolonged pumping may pull the dilute portion of the PCE plume into the well. Based on these results it appears that PCE is not likely to reach the 5th South Well [SLC-18] unless the well is pumped continuously for over a month and with a total extracted volume of about 300 million gallons per year."

MWH (2012)

- The geometry of the Wasatch Fault and the effect the Wasatch Fault and fault spurs play on local and regional groundwater flow requires review based on the following:

"In addition to the complex depositional environment in the project area, the Wasatch Fault Line further complicates the hydrogeology. A mapped spur of the Wasatch Fault (a normal fault) intersects the location of Well #18 [SLC-18]."

"The measurements from the pumping tests at Well #18 (SLC-18) indicate the presence of one or more groundwater flow boundaries near this well. A boundary is hypothesized to be associated with the Wasatch Fault. The fault location in the immediate area of Well #18 is inconclusive … the fault was not modeled as a complete barrier-type boundary because pumping at Well #18 produced a strong response at EPA-MW-01D, indicating a hydraulic connection between these wells."

- The hydrostratigraphic zones below the Site require better definition so as to potentially identify marker beds that may allow hydrostratigraphic correlation of aquifers (perched and confined) and aquitards. This is based on the following statement:

  "An attempt to draw a potentiometric groundwater surface was performed using the data from area monitoring and extraction wells. However, because of perched aquifers present in the area, the varied screen intervals, and the wide lateral distribution of wells, it is believed that the result is erroneous. For example, the natural direction of groundwater flow is anticipated to roughly follow topography in the area (e.g., flow to the southwest). However, the derived potentiometric surface from the collected data results in a northwesterly flow direction. It is believed that numerous perched aquifers are present in the area and that the monitoring network is not consistent in relation to the aquifers penetrated."

- Based on the following statement, the history and source(s) of PCE contamination need to be further defined and identified:

  "For modeling purposes, a source was assumed to be upgradient of the known contamination and was therefore located near monitoring well EPA-MW-05 at the VA Hospital. This location encompasses the majority of the known area of contamination and may also encompass the potential for co-mingled plumes from the other source investigation areas (i.e., University of Utah Building 515; Utah Army National Guard vehicle maintenance facility)."

- The depth of PCE contamination needs to be confirmed based on the following:

  "It has been theorized that the contaminated zone is from 175-235 (feet below ground surface in the Mt. Olivet irrigation well), though this has not been confirmed."

  "The vertical distribution of contamination is evident at co-located wells, EPA-MW-01S and EPA-MW-01D, where contamination is orders of magnitude higher in the shallow interval."

  "Conclusions from the depth-specific sampling at Well #18 [SLC-18] confirmed that contamination is detectable at concentrations approaching 1 part per

billion from the upper intervals (e.g., 271-274 feet below ground surface); however, the results are inconclusive to determine if concentrations greater than trace amounts (0.02 part per billion) are evident in the deeper intervals."

- The nature and extent of the PCE plume requires better definition based on the following:

  "The US EPA installed seven monitoring wells in 1998 … because of the sparse vertical and horizontal density of the monitoring network, the true nature and extent of contamination has not been determined … The lateral extent of the plume is loosely defined by contamination levels in EPA-MW-04 (located toward the southern edge of the plume) … assumed that the lateral edge of the plume likely extends further south … between EPA-MW-04 and EPA-MW-06. The northern extent of the plume is loosely defined by historic concentrations at the abandoned EPA-MW-03 … the northern edge of the plume is a significant data gap."

Historical Site Investigations and Conditions

The following sections provide a brief description and summary of previous site investigations near the VAMC and provide an idea of the current site conditions relevant to the CSM.

Potential Source Areas

Several investigations have been performed in the past, including groundwater, soil, and soil-gas sampling, but a definitive source area has not been identified for the PCE plume. Based on historical records (USEPA, 2012), as well as data from previous investigations (Beacon, 2001; IHI Environmental, 2005, 2007; UDEQ, 2000, 2012), four potential source areas have been identified: the VA Medical Center, Building 7; University of Utah, Building 515; a former Utah Army National Guard vehicle maintenance facility; and a former U.S. Forest Service (USFS) Helicopter Pad (Figure 2).

VA Medical Center Building 7 (Former Dry Cleaning Facility)

A sewer line (Figure 3) associated with a former dry-cleaning facility at VA Medical Center Building 7 has been identified as the likely source area, despite limited and inconclusive groundwater, soil, and soil-gas data (UDEQ, 2012).

During routine cleaning of the sanitary sewer line near the VA Medical Center Building 7 in the early 1980s, employees of the Salt Lake City Department of Public Utilities (SLCDPU) documented discolored water and odors of drycleaner solvent (USEPA, 2012).

In November 1996, a soil-gas sample was collected near the southeast corner of Building 6 at the VA Medical Center; this soil-gas sample contained 1.9 ppb of PCE (UDEQ, 2000). This location is near the loading dock area of Building 7.

A video survey of the sewer line between Building 7 and Sunnyside Avenue, conducted in December 2003 by SLCDPU, documented numerous defects including cracks, root penetrations, offsets and a pipe sag, as well as evidence of historic breaks, repairs, and replacements of the clay pipe (USEPA, 2012).

In 2007, the VA contracted a soil gas investigation along the sanitary sewer line lateral beginning at Building 7 and running south to Sunnyside Avenue (Figure 3) (IHI, 2007). During the investigation, 48 passive soil gas samplers were installed along the sewer line. PCE was detected in four of the 48 samples; three of which were collected adjacent to the loading dock area of Building 7 and had PCE ranging from 34 to 90 nanograms. However, soil sampling performed in 2004, which happened before the correlative soil gas investigation in 2007, detected no affected soils at the Building 7 loading dock location (IHI, 2005).

University of Utah Building 515 (formerly the Fort Douglas Military Reservation)

Beginning in 1948, the University of Utah began acquiring land from the Fort Douglas Military Reservation. Building 515 was originally constructed in 1902 and used as a storeroom for the hospital until it was acquired by the University in 1948. The specific use of Building 515 is unknown between 1948 and 1980. Between 1980 and 1993, Building 515 was used by the University of Utah for storage of hazardous wastes accumulated from art studios, laboratories, maintenance, and other sources on campus (UDEQ, 2010). Containers stored in the area were reported to be of good quality and held volumes of waste ranging from 1 pint to 55 gallons; materials were segregated, lab-packed, placed into 55-gallon drums, and temporarily held in Building 515 until picked up for shipment to an off-site disposal facility. At the present time, no waste containment structures or features exist at the site (UDEQ, 2010).

Soil-gas samples were collected to assess the presence of PCE and other contaminants in soil and/or groundwater around Building 515 at the University of Utah. In November 1996, a soil-gas sample was collected near the loading dock of Building 515. This soil-gas sample contained 49.0 ppb of PCE and 3.4 ppb of trichloroethene (TCE) (UDEQ, 2000). In 2001, 18 passive soil-gas samples were collected in the vicinity of Building 515, with results ranging from non-detect (less than 25 nanograms) to 2,600 nanograms (Beacon, 2001). Because the 2001 soil-gas values were not correlated to corresponding concentrations of soil and/or groundwater contamination, these data are considered qualitative.

In August, 2010, The Utah Department of Environmental Quality, Division of Environmental Response and Remediation conducted an Expanded Site Inspection (ESI) of University of Utah Building 515. Ten soil samples were collected from five direct-push borings around Building 515. At each boring location, a soil sample was collected from the 0 to 4.0 feet below ground surface (bgs) interval and from the 4.0 to 8.0 feet bgs interval. Low levels of PCE contamination (0.24 mg/kg to 1.2 mg/kg) were detected in soil samples. The ESI report concluded that detected concentrations are low and present little risk to human health and the environment. However, elsewhere it states that “No groundwater samples were collected for this ESI” and “While the

detection of PCE indicates that a release has likely occurred at the site, it is difficult to ascertain if the releases have had an impact on the groundwater at the site." (UDEQ, 2013)

Former Utah Army National Guard Vehicle Maintenance Facility

The former Utah Army National Guard vehicle maintenance facility was located east of the Mt. Olivet Cemetery. According to UDEQ (2000), 15 soil-gas samples from the area surrounding the facility were collected in 1995. Only two contained chlorinated solvents: one sample collected near the Mt. Olivet Cemetery contained 16 ppb of PCE, and one sample collected near the former Utah Army National Guard vehicle maintenance building contained 1 ppb of TCE.

Former U.S. Forest Service Helicopter Pad

To support interagency fire-fighting efforts, the U.S. Forest Service maintained a helicopter pad near the northeast corner of the intersection of Sunnyside Avenue and Guardsman Way. This site is no longer in use by the U.S. Forest Service and has been converted to a University of Utah softball field. This site has not been previously investigated as a potential source area, and any reclamation efforts associated with the termination of use of the helicopter pad are unknown.

Existing Monitoring Network

The existing monitoring locations include monitoring wells, drinking water and irrigation wells, artesian wells, seeps and springs, and surface water. Additional details of these locations are provided below.

Monitoring Wells

A total of seven monitoring wells (MW-01S, MW-01D, MW-02, MW-03, MW-04, MW-05, and MW-06) have been installed during past investigations of the PCE plume. MW-03 was abandoned due to building construction within a year of its installation. Information on the existing groundwater monitoring well network is summarized on Table 1. The well data were compiled from the MWH (2012), UDEQ (2012), and UDEQ (2000) reports.

Drinking Water and Irrigation Wells

Information on the municipal drinking water wells and irrigation wells in the vicinity of the VA Medical Center well monitoring network is also provided on Table 1. The well data were compiled from the MWH (2012), UDEQ (2012), and UDEQ (2000) reports.

Artesian Wells

Existing artesian (flowing) wells are identified on Table 2. The artesian conditions imply confined aquifer conditions at these wells. The location identifications are from the UDEQ (2012) report.

Seeps and Springs

Seeps and springs in the area are located on residential, public, and private properties containing numerous homes, several public and private schools, a large public park, and several churches. Following the 2010 release of crude oil from a pipeline, Salt Lake City identified 25 springs along the Wasatch Fault line in the area between 800 South and Michigan Avenue (approximately 1300 South) and between 1100 East and 1300 East (UDEQ, 2012). During the investigation, although constituents of crude oil were not identified, PCE was detected in 6 of the 11 springs sampled and in a storm drain manhole (UDEQ, 2012).

Additional investigations performed by the SLCDPU resulted in the compilation of a more comprehensive list of identified springs and seeps along the East Bench segment of the Wasatch Fault (Attachment 1). The seep and spring locations and associated data do not provide insight into the chemistry of groundwater emanating from the springs and seeps, but they do elucidate the extent of groundwater daylighting in springs along the fault scarp.

The ESS-SW identification nomenclature is for springs identified and sampled by the UDEQ (2012); the SP identification nomenclature is for springs identified and sampled by the UDEQ (2000). The data for seeps and springs that were sampled are summarized in Table 3. The locations are shown on Figure 2.

Surface Water

Red Butte Creek. The headwaters of Red Butte Creek are located in the Wasatch Mountains. As Red Butte Creek exits the Wasatch Mountains through Red Butte Canyon, it enters the Salt Lake Valley and flows through developed business and residential areas. Surface exposure of Red Butte Creek terminates east of Liberty Park, and the creek is diverted underground. Water from Red Butte Creek is assumed to be connected to the Liberty Park Reservoir.

Mt. Olivet Reservoir. The Mt. Olivet Reservoir is located in the Mt. Olivet Cemetery near the northeast corner of the cemetery adjacent to 500 South. The reservoir is supplied by diversions from both Red Butte Creek and Emigration Creek (via a diversion to Red Butte Creek) and the Mt. Olivet Cemetery Irrigation Well (Per. Comm., 2014).

Liberty Park Pond. The Liberty Park Pond is located in Liberty Park, Salt Lake City. The pond is supplied by diversions from Red Butte Creek. In June of 2010, an oil pipeline rupture impacted Red Butte Creek, which in turn impacted the Liberty Park Pond. This resulted in the draining, dredging, and cleaning of the pond.

Geology and Geologic Setting

The Salt Lake Valley, located in the northern part of Utah, is an alluvial basin bounded by the Wasatch Range to the east, the Oquirrh Mountains to the west, the Traverse Mountains to the south, and the Great Salt Lake to the north-northwest. The Salt Lake Valley is within the Basin and Range Physiographic Province, which is characterized by generally parallel, north-to northeast-trending mountain ranges separated by broad

alluvial basins that are a result of Cenozoic-age extensional faulting. The Wasatch Range, formed by uplift along the Wasatch Fault, defines the eastern boundary of the Basin and Range.

The consolidated rocks in the Wasatch Range bounding the northeastern part of Salt Lake Valley, from Emigration Canyon northward to Dry Creek Canyon, are predominantly the Jurassic-age Twin Creek Limestone, the Triassic-age Nugget Sandstone, Ankareh Formation (sandstone, shale and mudstone), the Thaynes Formation (limestone, interbedded with sandstone and shale), the Permian Park City Formation (limestone and shale), and Weber Quartzite (Davis, 1983). These faulted and folded units maintain bedding planes striking approximately perpendicular to the mountain front (Thiros, 2010).

The basin-fill deposits in the Salt Lake Valley consist of unconsolidated to semi-consolidated Tertiary-age deposits overlain by unconsolidated Quaternary-age deposits. Based on geophysical studies by Mattick (1970), the contact between the basin-fill deposits and underlying consolidated bedrock near the center of the valley is estimated to be as deep as 4,000 feet below land surface.

The VA Medical Center is located on unconsolidated sediments of Quaternary age that were deposited mainly as alluvial fans, by streams, and as deltas and other lacustrine features associated with Lake Bonneville and older paleo-lakes that once filled the valley (Thiros, 2010). In general, sediments deposited near the mountain front (i.e., the location of the VA Medical Center) tend to be coarser-grained gravels and sands with no substantial, laterally continuous layers of fine-grained materials.

The Wasatch Fault and the East Bench Segment of the Wasatch Fault

The Salt Lake Valley alluvial basin is bounded on the east by the Wasatch Fault, which is comprised of several seismically-independent segments that have been active in Holocene time. This active fault zone has uplifted the Wasatch Mountains as much as 7,000 feet relative to the valley (Thiros, 2010).

The East Bench Fault segment of the Wasatch Fault runs predominately north-south, just west and approximately parallel to 1300 East in Salt Lake City. The surface expression of the fault scarp is apparent between approximately 1300 East and 1100 East (Figure 4). Personius and Scott (2009) mapped a spur of the East Bench Fault segment of the Wasatch Fault that strikes northeasterly in the vicinity of the SLC-18 well.

Site Lithology

The surficial geology changes from east to west across the 700 South 1600 East PCE plume site. Near the VA Medical Center, the surficial geology is comprised of coarse-grained alluvial fan deposits of gravel in a matrix of sand and silty sand, surrounded by lacustrine deposits to the south, west, and north. Generally, the lacustrine deposits become more fine-grained to the west of the Site, until the East Bench Fault (Personius

and Scott, 2009). The East Bench Fault is defined by the presence of mixed colluvium and alluvium deposited as a debris apron at the base of the fault's scarp (Personius and Scott, 2009). The sediments underlying the Site are hundreds of feet thick; bedrock is assumed to be located at a depth exceeding 1,000 feet bgs.

Boring logs for the USEPA monitoring wells are presented in the UDEQ (2000) report. These logs include depths of lithologic contacts, soil descriptions, and soil classifications. The logs also contain well construction data and measured depths to groundwater. The logs show that although several small lenses of fine-grained materials occur near the Site, the predominant lithology is coarser grained alluvial material.

Lithologic data for the Mt. Olivet Well and the SLC-18 well are available in the Utah Division of Water Rights (UDWRi) records (Water Right No. 57-2526 and 57-101/57-4413, respectively) (UDWRi, 2014) and summarized in the UDEQ (2000) and MWH (2012) reports. For these older water-supply wells, the data are limited to lithologic contact depths, soil descriptions, and some well construction details. Although the wells produce water from multiple screened intervals, the logs provide little information of value with respect to aquitard and aquifer intervals.

In 2004 and 2005, the United States Geological Survey (USGS) conducted a groundwater study using the USEPA monitoring wells as well as the Mt. Olivet irrigation well and SLC-18. This investigation used downhole geophysical tools to evaluate the lithology at the monitoring well locations, with an objective of using the geophysical data to correlate lithology between wells. Through the geophysical analysis, as well as the sediment type and moisture content of specified intervals documented in the boring logs, the USGS identified a series of shallow aquifers and aquitards and hypothesized the presence of a northwest-dipping clay layer at approximately 180.0 feet bgs (USGS, 2005). In recent discussions with the USGS (Per. Comm., 2014), the presence and nature of this clay-layer is an interpretation based on limited data and requires more thorough data collection and investigation to validate.

Several additional boring logs were identified in UDWRi records, including an abandoned 1,004 foot exploratory borehole on VA property (Water Right No. 1057004M00), and an abandoned 1,508 foot deep exploratory borehole on University of Utah property (Water Right No. 0757007M00 and 0657008M00) (see Figure 2 and Table 4). The abandoned exploratory borehole on the University of Utah property encountered bedrock at approximately 280.0 feet bgs, while the abandoned borehole on the VA property did not encounter bedrock.

Lithology from available boring logs and surficial geology descriptions provided by the Personius and Scott (2009) were used to develop a generalized cross-section, shown in Figure 5, and block diagram, shown in Figure 6. The sediment lithology characterized in the boring logs is coarse- to fine-grained upper-basin fill consisting of gravel, sand, silty sand, clay lenses, and interbedded sequences of the aforementioned sediment types. Upper-basin fill sediments are typical of the Wasatch Front and are primarily

unconsolidated Quaternary-age deposits, deposited mainly as alluvial fans by streams, and as deltas and other lacustrine features associated with Lake Bonneville and older paleolakes that once filled the valley (Thiros, 2010).

Surface Topography

The Site is located in a developed urban area. The topography of the area slopes to the southwest at a grade of approximately 4 percent until reaching the East Bench segment of the Wasatch Fault scarp, where it steepens to approximately 10 percent (USEPA, 2012). The ground surface elevation at the VA Medical Center is approximately 4,735 feet above mean sea level (ft amsl); the approximate elevation of 1300 East, which runs parallel to the Wasatch Fault scarp, is 4,530 ft amsl; and the elevation of Artesian Well Park is approximately 4,266 ft amsl. The fault scarp is the defining topographic feature shown on Figure 7.

Hydrology

Groundwater in the Salt Lake Valley occurs in basin-fill sediments that can be divided into four aquifers (Waddell et al., 1987; Thiros, 2003):

1. local, unconfined perched aquifers;
2. a deep unconfined aquifer between the artesian aquifer and the mountains;
3. a shallow unconfined aquifer overlying the artesian aquifer; and
4. a deep confined (artesian) aquifer.

The localized, unconfined perched aquifers are located near the Wasatch Mountains. Groundwater from the unconfined perched aquifers can move downward into the deep unconfined aquifer because the perched aquifers are discontinuous and lack substantial layers of fine-grained materials. The unconfined perched aquifers transition laterally to form the shallow unconfined aquifer to the west, away from the mountain front. As groundwater in the deep unconfined aquifer flows towards the center of the Salt Lake Valley, it becomes confined beneath laterally continuous fine-grained layers to form the deep confined (artesian) aquifer. The artesian or flowing wells at Liberty Park and Artesian Park tap this deep confined aquifer.

The basin-fill deposits are very complex because they consist of multiple aquifers and confining layers that are both laterally discontinuous and internally heterogeneous; however, all the unconsolidated water-bearing materials in the valley are connected hydraulically to some degree (Waddell, 1987). Combined, the deep confined aquifer and the deep unconfined aquifer form the “principal aquifer” that most groundwater wells in the Salt Lake Valley utilize (Wallace and Lowe, 2009).

<u>Primary and Secondary Recharge Zones</u>

The primary recharge area for the basin-fill aquifers is near the mountain fronts and associated fault zones where no continuous layers of fine-grained material that will impede the downward movement of water are present (Thiros, 2003).

Secondary recharge occurs where continuous layers of fine-grained material are thin or completely absent, and water flows through shallow basin-fill alluvial sediments (i.e., perched aquifers) into deeper basin-fill sediments (i.e., deep unconfined aquifer). The secondary recharge zone borders the primary recharge area on the west and includes the area of the East Side Springs (Figures 5 and 6).

The VA Medical Center and the 700 South 1600 East PCE Plume are within both primary and secondary recharge areas, based on boundaries defined by the USGS (Thiros, 2010). The SLC-18 well and the Mt. Olivet irrigation well are both located in the primary recharge area (Anderson, *et al*, 1994; Bowen Collins, 2004). The SLC-18 well log indicates "clay and gravel are present to a depth of 266 feet, but does not indicate there are significant clay layers in the area that would impede the downward migration of water or contamination to the aquifer." (Bowen Collins, 2004)

Groundwater Levels and Potentiometric Surfaces

The depth-to-groundwater in the unconfined part of the shallow unconfined basin-fill aquifer (i.e., along the mountain fronts) is typically from 150.0 to 200.0 feet bgs (Thiros, 2010). The depth-to-groundwater in the deep confined aquifer ranges from 100.0 to 140.0 feet bgs in the secondary recharge area along the mountain front, to only 1.0 to 5.0 feet bgs in the discharge areas in the center of the valley as a result of the lower surface elevations (Thiros, 2010).

The most recent water level data for the USEPA monitoring wells, SLC-18, and the Fountain of Ute were presented in the MWH (2012) report. These water levels are provided in Table 1. The EPA-MW-03 well was abandoned during construction of the Salt Lake City Sports Complex; as such, the water level presented for this well is from the UDEQ (2000) report and was measured just after well construction. Permission was not granted to MWH to collect water level data from the Mt. Olivet Well, and a water level for the University of Utah Well 2 (U of U #2) was also not obtained for the MWH (2012) report.

Thorough and consistent historical time-series water level records for these wells are not available; however, Table 5 summarizes the few water level records provided in the Site archival documents. The USGS National Water Information System (NWIS) maintains water level records for active (e.g., Bonneville Golf Course Well; Fountain of Ute) and inactive (e.g., SLC-18) wells across the State of Utah; these records are available through the USGS NWIS website (USGS, 2014). These records, while of general use on a regional scale, are generally not useful for tracking small scale changes or localized effects on water levels.

Based on the available data, two potentiometric surfaces can be defined by the existing groundwater monitoring well network (Figure 8). An upper potentiometric surface, representative of the shallow part of the unconfined aquifer, can be preliminarily defined by monitoring wells EPA-MW-01S, EPA-MW-02, EPA-MW-03 (abandoned), EPA-MW-04, and EPA-MW-05. The approximate elevation of this upper potentiometric surface near the VA Medical Center is 4,522 feet above mean sea level. A lower potentiometric surface, representative of deeper parts of the unconfined aquifer, can be preliminarily defined by EPA-MW-01D, SLC-18, and the Fountain of Ute. The approximate elevation of this lower potentiometric surface near the VA Medical Center is 4,489 feet above mean sea level. The potentiometric elevations of the nested wells EPA-MW-01S and EPA-MW-01D are approximately 15 feet in difference, indicating a relatively strong vertical hydraulic gradient of approximately 0.09 ft/ft (Table 2), as would be expected in a primary recharge area.

Horizontal Hydraulic Gradients and Flow Directions

The potentiometric surface for the basin-fill aquifer indicates that groundwater generally moves from recharge areas near the Wasatch Mountain front toward the Jordan River and the Great Salt Lake. In the northeastern part of the Salt Lake Valley, and in the vicinity of the VA Medical Center, groundwater generally flows from the northeast to the southwest (Thiros, 2010).

Contrarily, using data obtained from groundwater monitoring wells during a 1999 field investigation (UDEQ, 2000), the USEPA concluded that groundwater flow near the VA Medical Center is toward the northwest. However, MWH (2012) and Bowen Collins (2004) surmised that the northwest groundwater flow direction is representative of "perched and localized mounding in the shallow portion of the shallow unconfined aquifer, and the regional groundwater flow direction is from the northeast to the southwest." However, without better evidence of a perching unit (i.e., a laterally continuous clay or silt layer), it seems unlikely that perched conditions are present based on available boring logs.

As described above, two potentiometric surfaces were contoured: one for shallow groundwater (e.g., the shallowest part of the unconfined aquifer), and a second for deeper groundwater (e.g., the deeper part of the unconfined aquifer) (Figure 8). Shallow groundwater, represented by the "upper potentiometric surface" flows to the northwest, while the somewhat deeper groundwater represented by the "lower potentiometric surface" flows to the west-northwest. A preliminary horizontal hydraulic gradient calculation for the upper potentiometric surface, based on the difference in groundwater elevations and the distance between EPA-MW-05 and the spring ESS-SW-17 (118 feet, and 5,800 feet, respectively) is 0.02 ft/ft. A preliminary horizontal hydraulic gradient calculation for the lower potentiometric surface, based on the difference in groundwater elevations and the distance between SLC-18 and the Fountain of Ute (6 feet, and 1,400 feet, respectively) is 0.004 ft/ft.

Distortion in the upper potentiometric contours may be related to groundwater pumping from the U of U #2 well, or could be due to surveying errors or simply the limited groundwater elevation dataset. The lower potentiometric flow direction is based on simple interpolation from only three water level elevations; as more water elevation data from wells screen in this depth interval become available, the flow direction could change appreciably. As it stands now, the flow direction for groundwater in the lower zone appears to be influenced by groundwater pumping from the U of U #2 well, which operates at night during the summer and early fall months.

Horizontal Hydraulic Conductivity and Transmissivity

Regional hydraulic conductivity values from 0.03 feet/day (ft/d), to as much as 3,000 ft/d, with a log-normalized mean value of 30 ft/d have been reported for coarse-grained basin-fill deposits in the Basin and Range province (Thiros, 2003). Numerical modeling conducted by Lambert (1995) for regional Salt Lake Valley groundwater flow conditions, as cited in Thiros (2010), estimates the hydraulic conductivity for coarser grained deposits in the shallow unconfined aquifer of the Salt Lake Valley to be about 200 feet per day (ft/d). In contrast, Lambert's estimate of hydraulic conductivity for fine-grain lake-deposited clays, characteristic of the shallow unconfined aquifer in the center of the Salt Lake Valley, was about 1 ft/d.

The transmissivity (i.e., hydraulic conductivity multiplied by the saturated thickness of the aquifer)of the shallow unconfined aquifer ranges from 50 to 4,000 feet squared per day (ft^2/d) and the storage coefficient is estimated to average 0.15 (Wallace and Lowe, 2009). Locally, a 30-day pump test at SLC-18 and a slug test at EPA-MW-01D yielded estimated transmissivities

for the shallow unconfined aquifer of 22,700 to 35,800 ft^2/d, respectively, with hydraulic conductivities ranging from 45 ft/d to 140 ft/d (MWH, 2012). The local transmissivity values are an order of magnitude greater than the average transmissivity values for the shallow unconfined aquifer; however, Thiros (2010) notes that transmissivity is generally highest near the mountains where streams entering the valley deposit the coarsest-grained materials.

Transmissivity and storage coefficients (a dimensionless number representing the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head) range from 1,000 to 50,000 ft^2/d and 0.15 to less than 0.0001, respectively, for the two values, for the unconfined and confined parts of the principal (deep) aquifer, respectively (Wallace and Lowe, 2009).

Groundwater Velocity

Preliminary estimates of groundwater velocity for the unconfined aquifer range from 0.6 ft/d to 1.9 ft/d. This groundwater velocity estimate is based on an assumed sediment porosity of 0.3; the hydraulic conductivities (45 ft/d to 140 ft/d) of the unconfined aquifer measured during aquifer pump testing at SLC-18 and slug testing at EPA-MW-01D (MWH, 2012); and the horizontal hydraulic gradient (0.004 ft/ft) calculated for the lower potentiometric surface.

Vertical Hydraulic Conductivity

Groundwater moves downward in the primary and secondary recharge areas, from the source to the shallow unconfined aquifer, and ultimately to the deeper principal basin-fill aquifers. In locations where the shallow unconfined aquifer is present, where fine-grained deposits are present, vertical hydraulic conductivity values range from 0.01 to 1 ft/d (Thiros, 2003). The vertical hydraulic conductivity of the confining bed between the shallow unconfined and principal aquifer is estimated to average 0.025 ft/d (Wallace and Lowe, 2009).

Effects of Wasatch Fault on Groundwater Flow

MWH (2012) performed aquifer testing of the SLC-18 well, and concluded that the East Bench Fault Spur, which has been mapped adjacent to the SLC-18 well (Personius and Scott, 2009), is not a barrier to groundwater flow. This interpretation is the result of a strong response recorded at the EPA-MW-01D well, which indicated a hydraulic connection between the wells (MWH, 2012). The presence of PCE in springs and seeps downgradient of the fault further suggests that the East Bench Fault Spur is not a flow barrier.

Water Quality and Geochemistry

The shallow unconfined aquifer, and where present, the unconfined part of the deep principal aquifer are susceptible to contamination from activities related to land use because of its proximity to the land surface, and because it is generally comprised of coarse-grained sediments with high hydraulic conductivity values that enable rapid movement of contaminants from the surface to the water table. Water quality in the confined deep aquifer can be degraded by secondary recharge of contaminated water from the unconfined shallow and deep aquifers.

Water Quality

The chemical composition of groundwater in the Salt Lake Valley varies with location and depth, primarily due to quality of recharge sources and water-rock interactions as it moves from recharge to discharge areas.

Groundwater in the unconfined shallow aquifer in the northeastern part of the Salt Lake Valley generally has more dissolved sulfate relative to bicarbonate compared to upgradient source water (Thiros, 2010). Total-dissolved-solids (TDS) concentrations in the shallow unconfined aquifer are generally greater than 500 milligrams per Liter (mg/L), primarily as a result of water-rock interactions with easily eroded Triassic-age shale and mudstone (e.g., Ankareh Formation) in the mountain block and in the basin-fill deposits of the area (Thiros, 2010).

Based on maps presented in Wallace and Lowe (2009), groundwater in the vicinity of the Site would be classified as Class II – Drinking Water Quality Groundwater (TDS between 500 and 3,000 mg/l [UDEQ, 2014]). TDS concentrations in the Salt Lake Valley basin-fill aquifer range from 512 to 2,588 mg/L (Wallace and Lowe, 2009). Concentrations of dissolved oxygen in groundwater in the Salt Lake Valley range from 0.3 to 11.6 mg/L, and pH ranges from 6.8 to 8.0 standard units (Thiros, 2010). Groundwater in the Salt Lake Valley is generally oxic and neutral pH.

Thiros (2010) provides groundwater quality summary data for different parts of the Salt Lake Valley. For the east side of the Salt Lake Valley, Thiros (2010) states the following:

- Groundwater sampled from wells (5 wells) in the deeper unconfined basin-fill aquifer in the primary recharge area contain modern water; and median pH of 7.1, 7.4 mg/L dissolved oxygen, and 562 mg/L TDS concentrations.
- Groundwater sampled from wells (11 wells) in the shallow unconfined basin-fill aquifer in the secondary recharge area contain modern water; and a median pH of 7.3, 5.3 mg/L dissolved oxygen, and 414 mg/L TDS concentrations.
- Groundwater sampled from wells (15 wells) in the deeper confined basin-fill aquifer in the secondary recharge area contain modern and mixed-age waters; and median pH of 7.5, 5.8 mg/L dissolved oxygen, and 316 mg/L TDS concentrations.

Contaminant Distribution

PCE has been identified in monitoring wells (EPA wells), an irrigation well (Mt. Olivet Well), and a municipal drinking water well (SLC-18) downgradient and cross-gradient of the VA Medical Center (Figure 9). The potential width of the plume, as defined by the distance between SLC-18 and EPA-MW-06, is approximately 3,000 feet. The potential length of the plume, as defined by the distance between the upgradient well EPA-MW-05 and the East Side Springs (ESS-GW-07), is approximately 6,000 feet. Along the East Bench segment of the Wasatch Fault, which runs parallel to 1300 East in Salt Lake City, PCE has been detected in springs and seeps emerging from the fault scarp (Figure 2). This area, the East Side Springs, currently define the toe of the PCE plume. Although PCE has not been detected in the artesian wells at Artesian and Liberty Parks, it is unknown if any PCE-contaminated groundwater has flowed through or under the fault area.

PCE has been detected at depths ranging from 130.0 feet bgs (4,549 feet above mean sea level) at EPA-MW-06, down to 470.0 feet bgs (screened from 4,408 to 4,204 ft. amsl) at the SLC-18 drinking water well. The Mt. Olivet irrigation well is screened at a lower elevation, but the well contains multiple screened intervals (from 4,230 to 4,395 ft. amsl; from 4,350 to 4,253 ft. amsl; from 4,415 to 4,395 ft. amsl; and from 4,455 to 4,435 ft. amsl) in the same well casing; as such, it is unknown at what depth contamination is entering the well.

As previously discussed, the PCE source area is not well defined and PCE contamination may have originated from one or more source areas. The sanitary sewer line extending from VA Medical Center Building 7 to Sunnyside Avenue has been considered a likely source area (USEPA, 2012), but the soil and soil gas data previously collected along this sewer line have not revealed a definitive source area or "hot spot."

PCE Concentration Data

PCE data from 1995 to 2003 are available in Bowen Collins (2004) [Table 5] for the SLC-18 well. PCE concentration data for the other site monitoring wells are summarized in various reports (MWH, 2012; UDEQ, 2000; and UDEQ, 2012). The historical PCE concentration data from these reports have been compiled in Table 5.

Based on water levels, the EPA wells (except EPA-MW-01D) are likely screened in the upper part of the shallow unconfined aquifer. The PCE concentrations in this shallow zone have historically (1998-2011) ranged from 0.8 to 320 µg/L, with a maximum concentration of 320 µg/L observed at EPA-MW-01S in November 1998. PCE has not been detected in the upgradient background well (EPA-MW-05) since installation. The most recent maximum concentration for this upper zone was 150 µg/L at EPA-MW-01S in November 2011 (Table 5).

Based on water levels, the EPA-MW-01D monitoring wells, the Mt. Olivet irrigation well, and the SLC-18 drinking water well are likely screened in a deeper part of the unconfined aquifer. The PCE concentrations in this lower zone have historically (1990-2011) ranged from non-detect to 184 µg/L, with a maximum historical concentration of 184 µg/L observed at the Mt. Olivet irrigation well in 1997. The most recent maximum concentration for this deeper zone was 92 µg/L at the Mt. Olivet irrigation well in 2004 (Table 5).

Because the PCE data set is sporadic and incomplete, statistical interpretation of PCE concentration trends is not currently feasible. However, based on visual data observations, PCE concentrations in wells of the shallow zone (EPA-MW-01S, EPA-MW-02, EPA-MW-04, EPA-MW-06) appear to be lower than when the wells were first installed; whereas PCE concentrations in the wells of the deeper zone (EPA-MW-01D, SLC-18, Mt. Olivet Well) have remained relatively stable (Table 5).

Contaminant Fate & Transport

The physical and chemical properties of PCE dictate how it will interact with the environment. Parameters important to fate and transport of PCE include specific gravity, Henry's Law Constant (K_H), vapor pressure, vapor density, water solubility (C^w_{sat}), organic carbon partitioning coefficient (K_{oc}), octanol-water partitioning coefficient (K_{ow}), distribution coefficient (K_d), and viscosity. Henry's Law constant (K_H), water solubility, and K_d are of particular importance for evaluating an organic contaminant's partitioning into various environmental media (soil, water, air).

The distribution coefficient (K_d) of a compound describes the tendency of the compound to either adsorb to natural organic matter present in the soil or to remain in the aqueous or the pure phase. The K_d is a function of the fraction of soil that consists of organic matter (fraction of organic carbon [f_{oc}]) and the extent to which a compound partitions to organic carbon (K_{oc}). Often, the K_{oc} is estimated from the K_{ow}, which is the ratio of the concentration of a chemical in n-octanol and water at equilibrium at a specified temperature. A compound with a high K_{oc} value will tend to attach to the soil organic matter or remain in non-aqueous phases. The attachment kinetics described by the K_d value are at best an estimate of the short-term chemical

partitioning between the aqueous phase and soils. Fluctuations in groundwater elevation, changes in the compound or the soil attachment site caused by weathering processes, or water chemistry changes can result in the compound becoming remobilized in the dissolved phase.

In practice, a simplified K_d can be estimated using the organic carbon content of the soil (f_{oc}) and the contaminant partitioning coefficients to organic carbon (K_{oc}). Large values of f_{oc} and K_d indicate an affinity of the contaminant to partition onto soil; small values indicate an affinity of the contaminant to remain in the aqueous phase upon encountering organic solids.

The net effect of sorption is to retard the transport of contaminants relative to the groundwater. At Hill Air Force Base (AFB), Operable Unit 10, the transport velocities of TCE and PCE were calculated as 0.30 and 0.16 ft/d, respectively, for a relatively low organic carbon content environment (CH2MHILL, 2009). The organic contents of the Hill AFB sediments is likely greater than the organic content of the sediments present at the Site; as such, it is expected that groundwater flow rate and PCE velocities may be greater in the basin-fill deposits of the Site.

Significant levels of daughter products of anaerobic PCE degradation, such as trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride have not been detected in groundwater collected from monitoring wells or water supply wells. This is likely because the aquifers are generally aerobic and oxidizing (i.e., unfavorable conditions for the anaerobic biological reductive dechlorination mechanism). However, TCE has been detected in two direct push groundwater samples (ESS-GW-04 and ESS-GW-07) in the East Side Springs area (UDEQ, 2012). It is unknown if the TCE is an abiotic or biotic degradation product from natural attenuation of the 700 South 1600 East PCE plume, or if the TCE is from an entirely different source than the VAMC.

Data Gaps

Data gaps for the preliminary conceptual site model are summarized in Table 6; this table defines the data gaps, presents what data are already known that may be used to address the data gap, details what data are required to address the data gap, informs how the data will be applied to filling the data gap, and suggests what investigative tools or methods may be useful in the process. The remainder of this section discusses these identified data gaps in more detail.

Identify the Source Area(s)

The sanitary sewer line associated with VA Medical Center, Building 7 is the assumed source area for the PCE plume. However, few data are available tracing the PCE plume directly back to this location. If most of the contamination has already been “flushed out” of the vadose zone, linking the sewer line or Building 7 to existing PCE-impacted groundwater may not be possible. Never-the-less, a thorough investigation of this area is required. If the results of this investigation indicate that Building 7 and the sewer line are not the definitive source area, or not the only source area, then this phase of the investigation will continue to assess other potential source areas such as University of Utah Building 515, the former Army National Guard vehicle maintenance facility, or other potential areas north/northeast of the VA Medical Center. Methods to investigate the source areas are described below:

<u>Soil-gas Sampling</u>

Soil-gas sampling will be used to identify locations where residual contamination is present in the soil. This assessment would be used as a cursory evaluation tool to better focus additional

phases of the investigation, such as borehole drilling to collect soil samples and the installation of monitoring wells.

Soil Sampling

If soil gas data indicates the presence of a source area, soil samples will be needed to confirm contamination in the soil and whether soil contamination is present at concentrations that may still contribute to groundwater contamination and warrant remediation.

Monitoring Wells

Once a source area is identified, monitoring wells will be required to determine if contamination in the vadose zone is continuing to migrate to groundwater and evaluate the results of future source area mitigation and cleanup. Caution in placing monitoring wells in areas of suspected concentrated PCE will be used, including field sensing tools capable of real-time contaminant concentration information (e.g., membrane interface probe).

Characterize the Site Geology, Hydrostratigraphy, and Hydrogeology

To better understand likely groundwater flow and contaminant migration paths, it is important to better characterize the geology, hydrostratigraphy, and hydrogeology of the local basin-fill aquifer. Instrumentation, testing, and sampling of existing wells, as well as the installation of additional groundwater monitoring wells, will be fundamental to the characterization.

Geology

- Conduct further detailed review of existing well and exploratory borehole logs (Attachment 2) to better understand subsurface lithology, depth-to-bedrock, and potential marker beds that could be laterally continuous and compare to data obtained from new borings:
    - Abandoned VA Medical Center Exploratory Borehole (Water Right No. 1057004M00); 1,004 feet total depth.
    - University of Utah Exploratory Borehole (Water Rights No. 0757007M00 and 0657008M00); 1,508 feet total depth.
- Collect detailed lithology descriptions during installation of additional groundwater monitoring wells:
    - Determine the fraction of soil that consists of organic matter (fraction of organic carbon [f_{oc}]) to determine a site-specific PCE K_d value.
    - Develop more detailed cross-sections of the local subsurface stratigraphy; attempt stratigraphic correlations.
- Determine the thickness of the vadose zone in source areas and near the toe of the PCE plume:
    - Characterize the properties of the vadose zone to evaluate the migration of PCE from the source area to groundwater, and evaluate the risks of vapor intrusion near the toe of the plume. Understanding the characterization of the vadose zone will also support evaluation of soil remediation alternatives such as soil vapor extraction if a soil source is identified.

Hydrostratigraphy and Hydrogeology

- Determine hydrostratigraphic intervals:

  - Validate the hydrostratigraphic zones assigned to existing well screen intervals (i.e., Are the wells representative of upper versus lower potentiometric surfaces; are the wells representative of perched aquifers, or as suggested above, just shallow and deeper parts of the unconfined aquifer?). Validation will be conducted through the comparison of data from new wells to be installed during site investigation, the long-term results from water level data collection, and aquifer testing
  - Install multi-level monitoring wells constructed in a manner that permits characterization of groundwater flow conditions (e.g., horizontal and vertical hydraulic gradients and groundwater flow directions); aquifer testing (e.g., determine hydraulic gradients, hydraulic connectivity, and hydraulic conductivity and transmissivity); and long-term water level data collection (e.g., installation of pressure transducers).
- Install pressure transducers to monitor groundwater elevation changes during pumping of the U of U #2 pumping well:
  - Use data to understand how hydraulic gradients and groundwater flow directions are affected by pumping.
  - Use data to understand how pumping cycles may affect PCE transport.
- Characterize the geochemical conditions of the aquifer by collecting field parameter (temperature, pH, dissolved oxygen concentration, oxidation-reduction potential, specific conductivity), dissolved major cation and anion concentrations, TDS concentrations, and stable isotope (i.e., oxygen and hydrogen) data:
  - Use geochemical data, if possible, to develop signatures of specific hydrostratigraphic zones.
  - Use the data to determine groundwater flow paths, mixing relationships, and recharge areas.
  - Use the data for insight into what types of chemical contaminant degradation processes may be occurring in the environment.

Delineate Plume Boundaries and PCE Concentrations

The lateral boundaries and the toe of the 700 South 1600 East PCE plume are not well-defined. The vertical extent is also not well-defined. Additional data are required to delineate these boundaries and to contour PCE concentrations across the site. Data can be collected through several different phases of investigation:

Soil-gas Analysis

Soil-gas samples will provide a cursory assessment to better define areas of interest for suspected contamination in soil and groundwater. Soil-gas samples can be collected where groundwater is shallow (e.g., East Side Springs).

Direct-Push

Direct-push sampling will be used to sample groundwater in the East Side Springs area, near the toe of the previously defined groundwater plume. These samples would form the foundation for further delineating the toe of the PCE plume with monitoring wells. In addition, the direct-push borings would offer insight into the depth-to-groundwater as well as providing a means to insert soil-gas probes.

Monitoring Wells

Once a rough shape of the PCE plume is determined using soil-gas probes and direct-push groundwater screening samples, multi-level groundwater monitoring wells will be installed to evaluate long-term PCE concentrations and determine hydrostratigraphic properties and hydrogeological parameters (see subsequent section). The well network will include:

- wells in the core of the plume,
- wells along the plume boundaries,
- downgradient sentinel wells to monitor plume migration and expansion,
- upgradient wells to monitor background conditions,
- larger-diameter wells to facilitate aquifer testing,
- monitoring wells screened in specific hydrostratigraphic intervals.

Spring, Seep, and Surface Water Samples

Identified and accessible springs and seeps along the Wasatch Fault will be sampled to determine the lateral and downgradient extent of PCE contamination. The location of the springs with relation to contaminant concentrations may be useful in evaluating potential groundwater flow paths.

Evaluate Natural Attenuation "Lines of Evidence" for PCE

The overall goal of performing PCE concentration, plume mass, and plume migration trend analyses is to evaluate if natural attenuation processes are acting on the PCE plume and if natural attenuation could be incorporated as a component of the remedy.

The USEPA (1999) lays out a general three-tiered framework for the appropriate implementation of MNA. These three tiers of site-specific information, or "lines of evidence," are:

1. Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points.
2. Hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the Site, and the rate at which such processes will reduce contaminant concentrations to required levels.
3. Data from field or microcosm studies (conducted in or with actual contaminated site media) that directly demonstrate the occurrence of a particular natural attenuation process at the Site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

For the Site, collecting data to substantiate the Tier 1 and Tier 2 "lines of evidence" will be the focus of initial remedial investigations. To evaluate natural attenuation "lines of evidence," five years of consecutive groundwater monitoring data are generally required.

Tier 1

Tier 1 "Lines of Evidence" require statistical analyses of PCE plume stability and PCE concentrations trends at individual wells.

Plume Stability

Plume stability will be evaluated based on long-term monitoring well data and evaluated using a statistical trend analysis program. The primary metric for assessing overall plume stability are temporal trends in plume mass.

PCE Concentrations Trends at Individual Wells

The dissolved PCE concentration will be analyzed on a well-by-well basis over the same time period used for the plume mass analysis. Three different analyses can be used in the trend analysis:

1. Mann-Kendall trend analysis,
2. time series plots,
3. regression analysis following EPA (2011) guidance.

The Mann-Kendall trend analysis determines if PCE concentration trends at an individual well are decreasing, increasing, or stable. These individual well analyses can be compared to the overall plume stability analysis. It should be noted that increasing trends at an individual well does not signify a concern from a plume stability and natural attenuation perspective, as some movement of mass within plumes is common even as the plume as a whole is attenuating.

Time series plots provide a visual confirmation of the plume-mass and well-trend analyses. In some cases, a Mann-Kendall analysis, using a historical data set, may indicate a decreasing or increasing trend for an individual well; but upon examination of the time-series plot, more recent data may suggest the opposite trend. In these cases, these wells warrant continued assessment including further statistical trend analysis when sufficient results are available.

Regression analysis at individual wells can provide rate constants for attenuation that provide a "clear and meaningful trend of decreasing contaminant concentration over time (EPA, 2011)." Because higher-rate constants mean faster remediation timeframes, simple calculations in a spreadsheet can be used to determine whether the rate constants are different from zero at some predetermined level of statistical confidence, and to extract the statistical confidence interval on the rate of attenuation (i.e., predict how long it will take for groundwater in the well to reach the maximum contaminant level).

Tier Two

Tier 2 evidence consists of hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the Site and the rate at which such processes will reduce contaminant concentrations to required levels.

In many cases involving chlorinated solvent plumes, Tier 2 evidence focuses on demonstrating highly anaerobic and strongly reducing conditions; geochemical conditions that are favorable for anaerobic reductive dechlorination by native microbial consortia. In the case of the Site, where literature data suggest that the subsurface environment is aerobic and oxidizing, and anaerobic biodegradation daughter products (i.e., TCE, vinyl chloride) are generally absent in groundwater, or in the case of TCE, occur very sparingly only at the downgradient margin of the plume and may be a primary contaminant from a different source, the Tier Two evidence will need to focus on other natural attenuation mechanisms such as advection and dispersion, adsorption, and abiotic degradation.

Advection and Dispersion

In order to evaluate advection and dispersion, site-specific hydraulic conductivities and gradients will need to be understood. These parameters can be determined through aquifer testing, potentiometric contouring, and soil and sediment characterization.

Adsorption

In order to evaluate adsorption, site-specific f_{oc} and K_d values will need to be determined. These parameters can be determined through soil and sediment collection at various depths within the contaminated aquifers.

Abiotic Degradation

If data from Tier 1 suggest that the PCE plume is naturally attenuating, then abiotic degradation mechanisms can be considered as a potential natural attenuation pathway. Evaluation of abiotic degradation mechanisms can include mineralogical analyses of soil and sediment and groundwater analysis for specific abiotic degradation byproducts.

Identify Potential Exposure Points

To understand human and ecological risks associated with the 700 South 1600 East PCE plume, it is first important to understand the pathways in which potential receptors may be exposed to contamination. The potential exposure pathways include groundwater (as drinking water and irrigation water), surface water (groundwater from springs and seeps that reaches the surface forming drainages that some residents have incorporated into landscaping features [e.g., ponds, creeks, canals]; or may enter the storm drain network), and soil-gas (off-gassing of shallow groundwater resulting in vapor intrusion into homes and businesses). To address potential exposure pathways, it is necessary to identify physical locations where potential receptors may contact exposure pathways.

Groundwater

The SLC-18 municipal drinking water well has had detection of PCE since 1997, with a maximum concentration of 2.23 µg/L measured in October 2004 (Table 5). As a result of the PCE contamination, this well was removed from service. No other drinking water wells are located in the estimated footprint of the PCE plume; however, drinking water wells downgradient and cross-gradient of the Site should be evaluated during the remedial investigation.

Several irrigation wells are located within or in the vicinity of the estimated PCE plume footprint, including the U of U #2 pumping well and the Mt. Olivet irrigation well. The Mt. Olivet irrigation well has had PCE detections since 1990, with a maximum concentration of 184 µg/L measured in 1997. PCE-impacted irrigation wells have the potential to spread PCE-impacted groundwater on the land surface, which may pose a risk to human and ecological receptors. As such, irrigation wells downgradient and cross-gradient of the Site should be evaluated during the remedial investigation.

Springs and Seeps

PCE-impacted groundwater daylights in several springs and seeps in the East Side Springs area, potentially leading to PCE-impacted surface water (e.g., drains, ponds, and sumps). PCE-impacted surface water poses a risk to human and ecological receptors that may come into contact or ingest the surface water. Part of the nature and extent evaluation will be to locate,

document, and further assess sites where PCE-impacted surface water from springs and seeps exists.

Soil-Gas

Homes that overlie or are in direct contact with shallow groundwater within the footprint of the delineated PCE plume are at risk for vapor intrusion. Part of the nature and extent evaluation will be to use a soil-gas probe to locate potentially problematic sites and then evaluate overlying structures through indoor air monitoring.

Revise and Update Conceptual Site Model

This preliminary conceptual site model (CSM) will be used as a guide for project scoping, work planning, and further site assessment. However, as data and information are collected and analyzed during the Remedial Investigation phase, this CSM will be revised and updated. The CSM will remain a dynamic document, changing as new insights into the 700 South 1600 East PCE plume are discovered. Ultimately, the CSM will collect all of the data into a comprehensive picture of the nature and extent of contamination, plume dynamics, and human health and ecological risks and will support the Feasibility Study of remedial alternatives.

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TABLES

TABLE 1
Existing Monitoring Well Network
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Location Identification	Location Type	Latitude	Longitude	Measuring Point Elevation (ft amsl)	Static Water Depth (ft bmp)	Groundwater Elevation (ft amsl)	Well Depth (ft bgs)	Well Diameter (in)	Top Screen (ft bgs)	Bottom Screen (ft bgs)	Middle of Screen (ft bgs)
EPA-MW-01S	Monitoring Well	40.754157	-111.845086	4664.94	156.76	4508.18	224	2	184	224	204
EPA-MW-01D	Monitoring Well	40.754157	-111.845086	4664.98	172.34	4492.64	404	4	364	404	384
EPA-MW-02	Monitoring Well	40.754099	-111.843134	4680.00	164.49	4515.51	205.5	2	175.5	202.5	189
EPA-MW-03 (1)	Abandoned	40.755835	-111.843309	4697.98	189.75	4508.23	210	4	190	210	200
EPA-MW-04	Monitoring Well	40.752133	-111.843739	4657.07	137.12	4519.95	173	4	143	173	158
EPA-MW-05	Monitoring Well	40.755552	-111.838924	4735.04	211.39	4523.65	225	4	186	221	203.5
EPA-MW-06	Monitoring Well	40.751363	-111.840428	4678.63	123.98	4554.65	134	4	100	130	115
SLC-18	Production Well (Not in service)	40.758747	-111.846097	4673.95	183.35	4490.6	510	20	266	470	368
Fountain of Ute	Irrigation Well (Not in service)	40.758728	-111.851236	4610.63	125.98	4484.65	460	20	200	450	325
U of U Well 2 (3)	Irrigation Well	40.758700	-111.851131	4610.63	--	--	445	16	217	445	331
Mount Olivet Well (2)	Irrigation Well	40.754308	111.848544	4630	--	--	463	10	175	195	185
									215	235	225
									280	377	328.5
									400	463	431.5

Notes:

Data from Table 1 of MWH, 2012. Final Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18. July.

Groundwater elevations measured in August through November of 2011.

(1) Measuring point and static water level elevations from well logs presented in UDEQ, 2000. Mount Olivet Cemetary Plume, Salt Lake County, Utah. UTD981548985.

(2) Measuring point elevations estimated from Google Earth

(3) Location approximate; well located less than 100 feet east of Fountain of Ute.

ft bmp = feet below measuring point

ft amsl = feet above mean seal level

bgs = below ground surface

ft = feet

in = inches

-- = Data unavailable

TABLE 2
Monitored Artesian Wells Downgradient of
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Location Identification	Description	Latitude	Longitude	Elevation (ft amsl)
ESS-GW-2	Artesian drinking water fountain on southeast corner of Liberty Park (700 East and 1300 South)	40.741881	-111.871839	4275
ESS-GW-3	Artesian Well Park (804 South and 500 East)	40.751727	-111.877108	4266

Notes:
Ground elevation estimated from Google Earth.
ft amsl = feet above mean sea level

TABLE 3
Previously Monitored Springs and Seeps Downgradient of
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Location Identification	Description	Latitude	Longitude	Elevation [1] (ft amsl)	PCE [2] (mg/L)	Sample Date
ESS-SW-15	Spring at 1127 East Sunnyside Avenue residence; located rear of house.	40.750988	-111.858443	4425	ND	Nov-11
ESS-SW-16	Concrete spring water collection vault located at 1205 East Gilmer Drive residence.	40.748835	-111.855246	4460	20	Nov-11
ESS-SW-17	Spring at 1115 East Sunnyside Avenue residence; located rear of house.	40.751759	-111.858751	4406	3.7	Nov-11
SP-1	Our Lady of Lourds Spring; 1063 East and 700 South	40.753995	-111.860600	4440	ND	Aug-98
SP-2	Benson Spring; 761 South and 1100 East	40.751746	-111.859158	4410	ND	Aug-98
SP-3	Smith Spring; 1123 Alpine Place	40.749384	-111.857578	4420	ND	Aug-98
SP-4	Bowen Spring; 1220 East Yale Avenue	40.745876	-111.856832	4465	ND	Aug-98

Notes:

[1] Ground elevations estimated from Google Earth.

[2] 'ESS-SW' PCE data from UDEQ (2012); 'SP' PCE data from UDEQ (2000);

ft amsl = feet above mean sea level

mg/L = micrograms per Liter

PCE - tetrachloroethene

ND = Non-detect

Nov-11 = November of 2011

Aug-98 = August and September of 1998

TABLE 4
Other Existing Monitoring Wells and Boring Locations
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Well Name/Location Identification	Water Right Number	Latitude	Longitude	Elevation[1] (ft amsl)	Depth (ft bgs)	Comments
Bonneville Golf Course Well	57-4409	40.744161	-111.828967	4695	240	USGS water level data available from 1934 to 2014
SLC-1064	57-4410	40.750550	-111.841161	4659	502	Not measured/sampled by USGS since 1947
University of Utah Well - Diversion 1	57-112	40.763222	-111.836200	4840	750	SLC-18 filed under same water right number
Abandoned VA Exploratory Borehole	1057004M00	40.756486	-111.837700	4758	1004	Stratigraphic log available
University of Utah Exploratory Borehole	0757007M00	40.768444	-111.840422	4848	1508	Stratigraphic log available
University of Utah Exploratory Borehole Well	0657008M00	40.768444	-111.840422	4848	39	

[1] Measuring point elevations estimated from Google Earth
ft amsl = feet above mean seal level
bgs = below ground surface
ft = feet
in = inches
-- = Data unavailable

TABLE 5
Historical Data Summary of Potentiometric Elevation and PCE Concentration
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Sample Date	PCE (mg/L)	Water Level (ft amsl)	Reference
Wells screened in shallow part of unconfined aquifer			
EPA-MW-01S			
Sep-98	--	4506.83	UDEQ, 2000
Oct-98	--	4508.28	UDEQ, 2000
Nov-98	320	4509.22	UDEQ, 2000; UDEQ, 2012
Nov-98	310	4509.22	UDEQ, 2012
Feb-05	278	--	UDEQ, 2012
Nov-11	150	4508.18	UDEQ, 2012; MWH, 2012
EPA-MW-02			
Sep-98	--	--	UDEQ, 2000
Oct-98	--	4515.51	UDEQ, 2000
Nov-98	290	4516.31	UDEQ, 2000
Feb-05	296	--	UDEQ, 2012
Oct-05	160	--	UDEQ, 2012
Nov-11	--	4515.51	UDEQ, 2012; MWH, 2012
EPA-MW-03			
Sep-98	--	4510.38	UDEQ, 2000
Oct-98	--	4508.23	UDEQ, 2000
Nov-98	11	4509.08	UDEQ, 2000
Nov-11	--	Abandoned	UDEQ, 2012; MWH, 2012
EPA-MW-04			
Sep-98	--	4521.5	UDEQ, 2000
Oct-98	--	4522.8	UDEQ, 2000
Nov-98	196	4523.5	UDEQ, 2000
Feb-05	119	--	UDEQ, 2012
Oct-05	120	--	UDEQ, 2012
Nov-11	--	4519.95	UDEQ, 2012; MWH, 2012
EPA-MW-05			
Sep-98	--	4524.99	UDEQ, 2000
Oct-98	--	4526.59	UDEQ, 2000
Nov-98	ND	4527.38	UDEQ, 2000
Oct-04	ND	--	UDEQ, 2012
Feb-05	ND	--	UDEQ, 2012
Oct-05	ND	--	UDEQ, 2012
Nov-11	ND	4523.65	UDEQ, 2012; MWH, 2012
EPA-MW-06			
Sep-98	--	--	UDEQ, 2000
Oct-98	--	--	UDEQ, 2000
Nov-98	310	--	UDEQ, 2000
Feb-05	0.8	--	UDEQ, 2012
Nov-11	--	4554.65	UDEQ, 2012; MWH, 2012
Wells screened in deeper part of unconfined aquifer			
EPA-MW-01D			
Sep-98	--	4471.65	UDEQ, 2000
Oct-98	--	4480	UDEQ, 2000
Nov-98	1	4483.55	UDEQ, 2000
Oct-04	8.33	--	UDEQ, 2012
Feb-05	0.2	--	UDEQ, 2012
Oct-05	0.33	--	UDEQ, 2012
Dec-11	12	4492.64	UDEQ, 2012; MWH, 2012

TABLE 5
Historical Data Summary of Potentiometric Elevation and PCE Concentration
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Sample Date	PCE (mg/L)	Water Level (ft amsl)	Reference
SLC-18 municipal drinking water well (off-line)			
May-95	ND	--	Bowen Collins (2004)
Jul-97	0.6	--	Bowen Collins (2004)
Nov-98	ND	--	
Aug-00	0.8	--	Bowen Collins (2004)
Aug-00	0.8	--	Bowen Collins (2004)
Jun-01	1.22	--	Bowen Collins (2004)
Jul-01	0.9	--	Bowen Collins (2004)
Aug-01	1.3	--	Bowen Collins (2004)
Aug-01	1.2	--	Bowen Collins (2004)
Aug-01	1.4	--	Bowen Collins (2004)
Sep-01	ND	--	Bowen Collins (2004)
Aug-02	ND	--	Bowen Collins (2004)
Jan-03	ND	--	Bowen Collins (2004)
Jun-03	ND	--	Bowen Collins (2004)
Oct-04	2.23	--	UDEQ, 2012
Sep-05	1.2	--	UDEQ, 2012
Sep-05	1.5	--	UDEQ, 2012
Sep-05	1.7	--	UDEQ, 2012
Sep-05	1.8	--	UDEQ, 2012
Nov-11	--	4490.60	UDEQ, 2012; MWH, 2012
Mt. Olivet irrigation well			
1990	32	--	Bowen Collins (2004)
Oct-90	25.7	--	UDEQ, 2012
1995	85	--	Bowen Collins (2004)
1997	184	--	Bowen Collins (2004)
Nov-98	150	--	UDEQ, 2012
Oct-04	128	--	UDEQ, 2012
Oct-04	92	--	UDEQ, 2012
Fountain of Ute (off-line)			
Nov-11	--	4484.65	UDEQ, 2012; MWH, 2012

Notes:
PCE = Tetrachloroethene
mg/L = micrograms per Liter
-- = Data unavailable/not identified

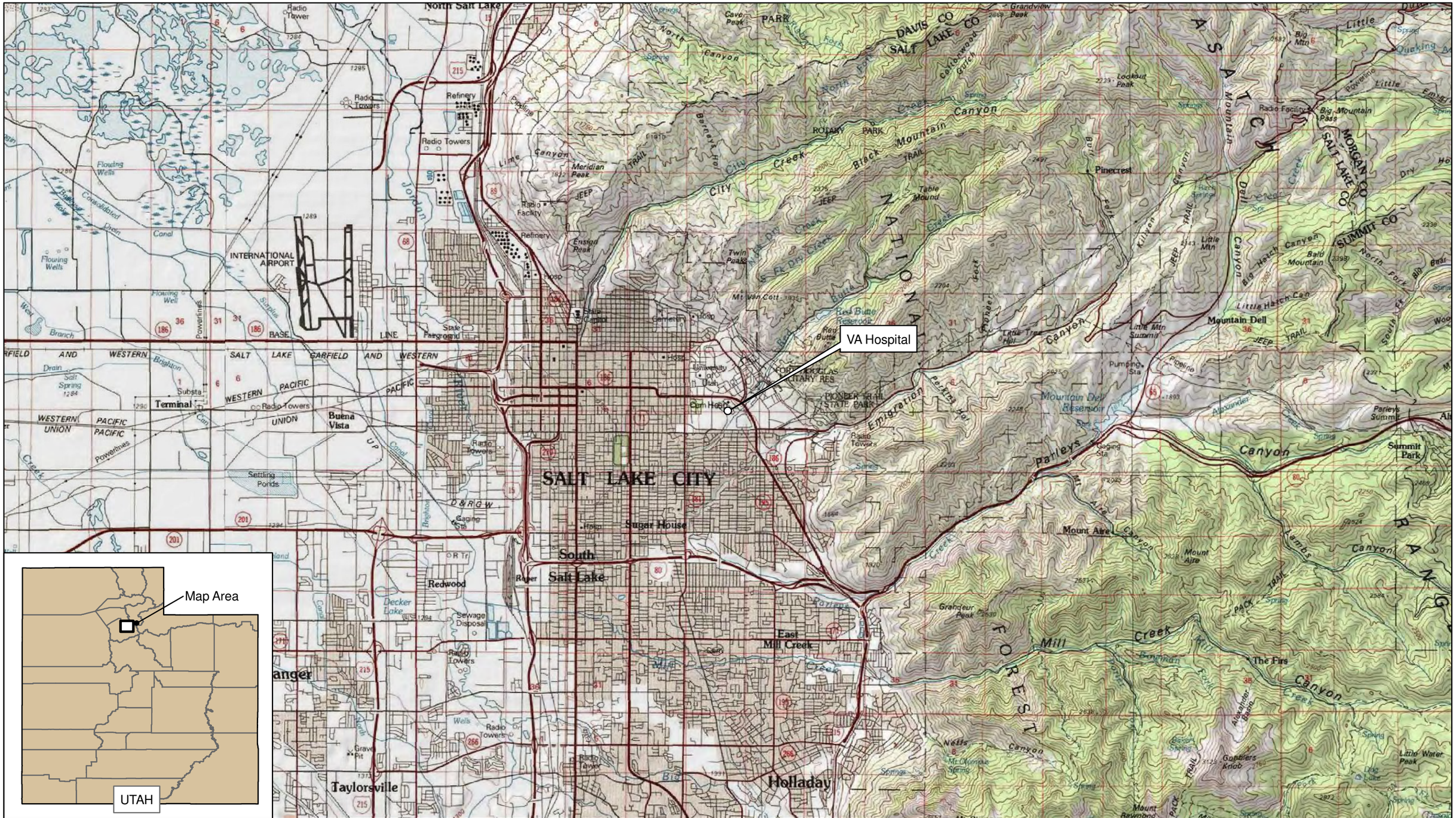
TABLE 6
Evaluation of Data Gaps in Conceptual Model
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Data Gap	Available Data		Data Required	Data Application	Investigation Methods
Identify the Source Areas	VA Medical Center Building 7	- Soil and soil-gas data - Sanitary sewer line video - Monitoring well network	Definitive evidence of a historical or continuing source of tetrachloroethene (PCE) contamination; this could be one or more identified "hot spot(s)"	- Delineate the source area - Determine source area PCE concentrations - Determine if source area is a continuing source for groundwater contamination - Determine whether other sources are contributing to the PCE plume by understanding distribution of PCE with respect to Building 7	- Soil-gas probes to screen locations - Soil samples - Groundwater data from source area monitoring wells
	University of Utah Building 515	Soil-gas data	Definitive evidence of a historical or continuing source of PCE contamination; this could be one or more identified "hot spot(s)"		
	Former Utah National Guard Vehicle Maintenance Facility	Soil-gas data	Definitive evidence of a historical or continuing source of PCE contamination; this could be one or more identified "hot spot(s)"		
	Former US Forest Service Helicopter Pad	None	Definitive evidence of a historical or continuing source of PCE contamination; this could be one or more identified "hot spot(s)"		
Site Geology	- Literature data from USGS, UGS, and other peer-reviewed publications - EPA well and boring Driller's Logs; VA Medical Center and University of Utah boring logs, available through UDWRi - Lithologic correlations from the USGS - USGS and UGS geologic and fault maps		- Detailed borehole lithology through PCE-impacted stratigraphy - Vadose zone thickness in the source area, footprint of the plume, and the toe of the plume	- Correlate lithology in cross-sections to better understand potential aquifers, preferential flow paths (if any), and perching confining layers - Evaluate migration of PCE from the source area to groundwater; evaluate risk of vapor intrusion near the toe of the plume	- Detailed borehole logging during drilling of monitoring wells - Direct-push drilling in the toe of the plume
Site Hydrostratigraphy	- Literature data from USGS, UGS, and other peer-reviewed publications - Groundwater elevation data from existing monitoring wells and production wells		Aquifer testing data from the unconfined aquifers east of the East Bench segment of the Wasatch Fault; and the shallow unconfined and deeper confined aquifers west of the East Bench segment of the Wasatch Fault	Characterize and define the hydrostratigraphic units and aquifers based on potentiometric elevations and hydrogeological parameters	Multi-level monitoring wells, constructed in a manner that permit: - Aquifer testing - Groundwater sampling - Installation of pressure transducers
Site Hydrogeology	- USGS, UGS, and other peer-reviewed literature data about the regional shallow basin-fill aquifer - Previous groundwater models		Site-specific groundwater parameters, including: - Water level measurements - Vertical hydraulic gradients - Horizontal hydraulic gradients - Hydraulic connectivity/transmissivity - Groundwater flow rate - Groundwater geochemical parameters	- Apply the data to hydrostratigraphic interpretations - Use geochemical data as a signature of specific hydrostratigraphic zones - Use the data to determine potential groundwater flow paths, mixing relationships, and recharge - Use the data for insight into what kinds of chemical contaminant degradation processes may be occurring in the environment	- Collect temperature, pH, dissolved oxygen (DO) concentration, oxidation-reduction potential (ORP), specific conductivity, dissolved cation and anion concentrations, total-dissolved-solid concentrations, and stable isotope (i.e., oxygen and hydrogen) data from groundwater monitoring well network - Use groundwater data analysis tools (e.g., Piper plots and Stiff Diagrams) to understand relationships between hydrostratigraphic units and recharge sources

TABLE 6
Evaluation of Data Gaps in Conceptual Model
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Data Gap	Available Data		Data Required	Data Application	Investigation Methods
PCE Plume Boundaries and PCE Concentration Contours	- Existing monitoring well network that poorly delineates the shape, depth, and concentration of PCE-impacted groundwater - PCE-impacted springs and seeps in the East Side Springs Area (toe of the plume)		- Multi-level groundwater data from the core, periphery and toe of PCE plume to define the vertical and lateral extent of PCE-impacted groundwater - Soil-gas and groundwater data to define the toe of the PCE plume in the East Side Springs area	- Develop a PCE plume map and cross-sections with defined lateral and vertical PCE concentration contours - Use PCE plume map and cross-sections to evaluate potential receptors, assess PCE plume migration, and ultimately, evaluate plume remediation	Develop a comprehensive monitoring well network to collect long-term groundwater data
PCE Concentration Trends and Plume Stability	Limited and sporadic historical groundwater and spring water PCE data		Long-term (5-years) groundwater PCE concentration data from a comprehensive monitoring well network	- Plume stability is assessed using temporal trends in Plume concentration and mass - Mann-Kendall trend analysis determines if PCE concentrations trends at an individual well are decreasing, increasing or stable - Time series plots are used to visualize data trends - Regression analysis at individual wells can provide rate constants for attenuation	- Mann-Kendall trend analysis performed using a statistical trend analysis program - Time series plots generated in graphical database (Excel) - Regression analysis calculations performed in a spreadsheet (Excel) to determine rate constants at a predetermined level of statistical confidence
Natural Attenuation Processes	Literature values for the shallow basin-fill aquifer indicate that the environment is likely oxic and not conducive to anaerobic biodegradation processes		- Site specific hydrogeologic data (see above) - Site-specific *foc* and *Kd* values - PCE daughter product concentrations in groundwater - Field parameters, such as DO, ORP, iron and sulfate concentrations	Generate hydrogeological and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels (e.g., MCL)	Multi-level monitoring wells, constructed in a manner that permit: - Groundwater sampling for field parameters and VOC concentrations - Collection of soil samples below the water table to determine *foc* value and evaluate minerals present that may promote abiotic degradation processes (e.g., magnetite)
Exposure Pathways	Groundwater	PCE-impacted groundwater has been identified at the SLC-18 municipal drinking water well and the Mt. Olivet irrigation well	Map showing drinking water wells and irrigation wells that may be impacted by future migration of the PCE plume	Evaluate potential risk to the drinking water and irrigation wells given knowledge of plume stability, PCE transport rate, and groundwater flow direction	Compare mapped well locations to the PCE plume dynamics (developed to fill previous data gaps)
	Springs and Seeps	PCE-impacted groundwater emerging from springs and seeps in the East Side Springs area	PCE concentration data from springs and seeps, and associated surface water features, in the East Side Springs area	Develop a database of PCE-impacted sites (e.g., location, concentration) in the East Side Springs area	Sample springs and seeps, and associated surface water features, in the East Side Springs area
	Soil Gas	Groundwater is shallow in the East Side Springs area; thus, there is potential for vapor intrusion	Soil-gas PCE data adjacent to homes and businesses in the East Side Springs area	Develop a database of soil-gas PCE-impacted sites (e.g., location, concentration) in the East Side Springs area	Direct-push drilling and installation of soil-gas probes

FIGURES

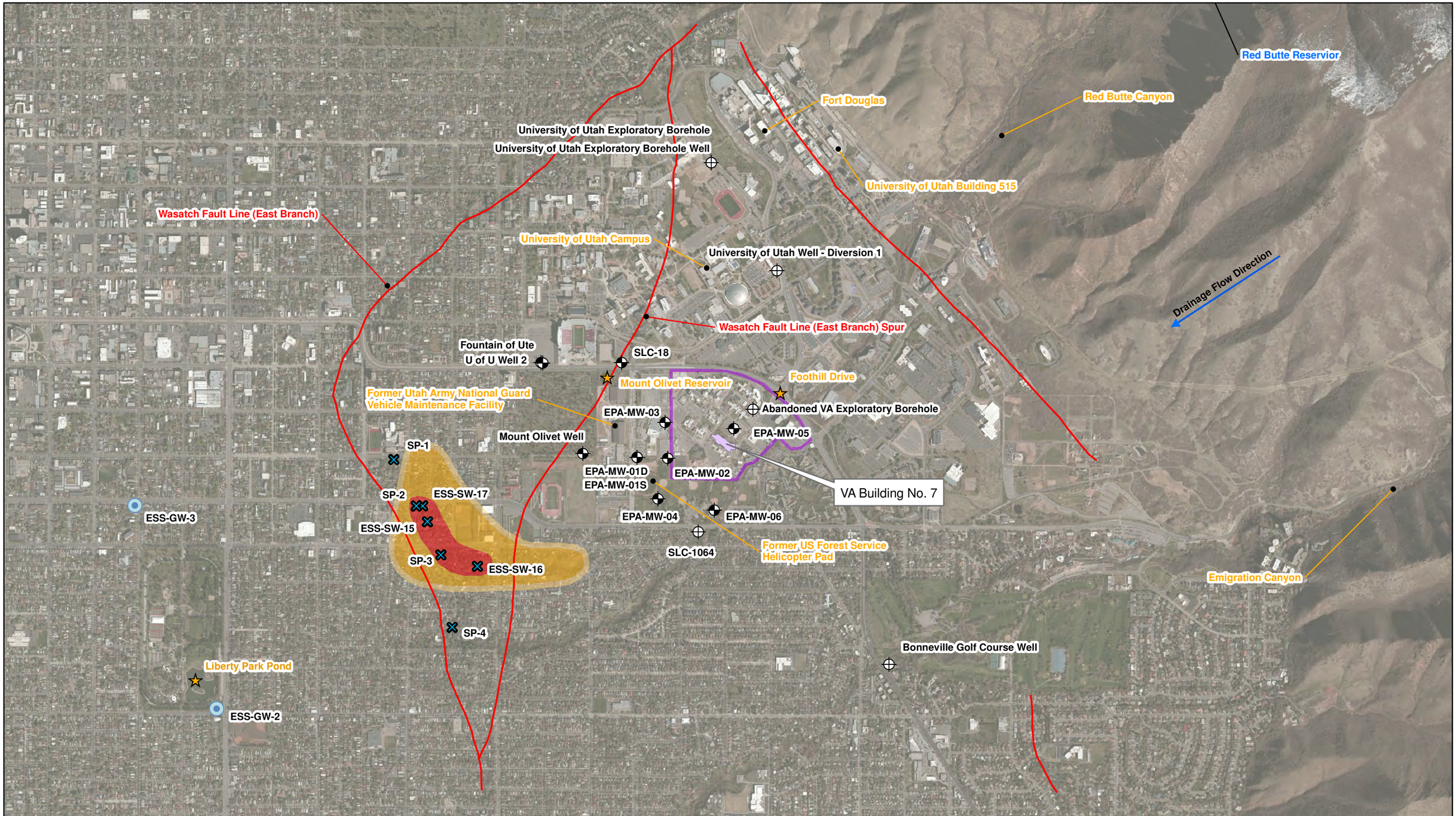


FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 1
SITE LOCATION MAP

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	NMT	4/29/14



Legend

- AOU-1 Area of Known Groundwater/Spring PCE Concentration
- AOU-1 Area Where PCE in Groundwater may be within 50' of Surface
- AOU-1 100' Buffer Area
- VA Medical Center
- Potential Monitoring Wells
- Monitoring Wells
- Artesian Wells
- Seeps
- Landmarks
- Wasatch Fault Line

N W E S

0 400 800 1,600 Feet

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 2
SITE FEATURE MAP

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	EJR	5/27/14

Legend

- Monitoring Wells
- Sanitary Sewer Line

0 62.5 125 250 Feet

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

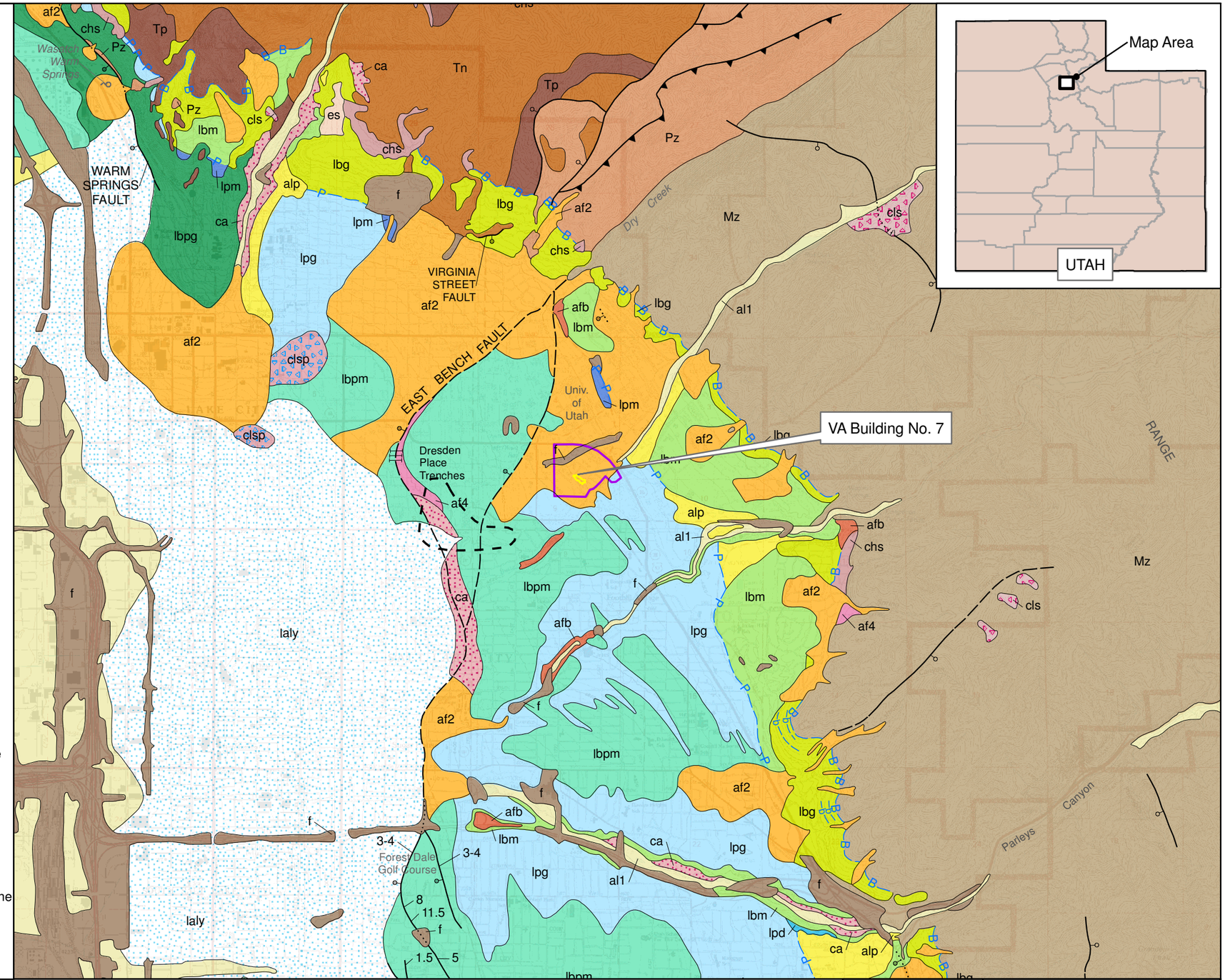
SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 3
SANITARY SEWER LINE MAP

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	NMT	5/7/14

Geologic Units

Unit Symbol, Name, Age

- Mz, Mesozoic sedimentary rocks, Cretaceous to Triassic
- Pz, Palezoic sedimentary rocks, Permian to Cambrian
- Ti, Tertiary intrusive igneous rocks, Oligocene
- Tn, Tertiary sedimentary and volcanic rocks, Neogene
- Tp, Tertiary sedimentary and volcanic rocks, Paleogene
- af1, Fan alluvium 1, upper Holocene
- af2, Fan alluvium 2, middle Holocene to uppermost Pleistocene
- af4, Fan alluvium 4, upper middle Pleistocene
- af5, Fan alluvium 5, middle Pleistocene
- afb, Fan alluvium related to transgressive phase, upper Pleistocene
- afo, Older fan alluvium, undivided, middle Pleistocene
- afy, Younger fan alluvium, undivided, Holocene to uppermost Pleistocene
- al1, Stream alluvium 1, upper Holocene
- al2, Stream alluvium 2, middle Holocene to uppermost Pleistocene
- alp, Stream alluvium related to regressive phase, uppermost Pleistocene
- aly, Younger stream alluvium, undivided, Holocene to uppermost Pleistocene
- ca, Colluvium and alluvium, undivided, Holocene to middle Pleistocene
- cd1, Debris-flow deposits 1, upper Holocene
- cd2, Debris-flow deposits 2, middle Holocene to uppermost Pleistocene
- chs, Hillslope colluvium, Holocene to upper Pleistocene
- cls, Landslide deposits, Holocene to middle Pleistocene
- clsp, Lateral-spread deposits, Holocene to upper Pleistocene
- es, Eolian sand, Holocene and upper Pleistocene
- f, Manmade fill, historic
- gbco, Outwash of Bells Canyon age, upper Pleistocene
- gbct, Till of Bells Canyon age, upper Pleistocene
- gdco, Outwash of Dry Creek age, middle Pleistocene
- gdct, Till of Dry Creek age, middle Pleistocene
- laly, Lacustrine, marsh, and alluvial deposits, Holocene to uppermost Pleistocene
- lbg, Lacustrine sand and gravel related to transgressive phase, upper Pleistocene
- lbm, Lacustrine clay and silt related to transgressive phase, upper Pleistocene
- lbpg, Lacustrine sand and gravel, undivided, upper Pleistocene
- lbpm, Lacustrine clay and silt, undivided, upper Pleistocene
- lbps, Lacustrine sand, undivided, upper Pleistocene
- lpd, Deltaic deposits related to regressive phase, uppermost Pleistocene
- lpg, Lacustrine sand and gravel related to regressive phase, uppermost Pleistocene
- lpm, Lacustrine clay and silt related to regressive phase, uppermost Pleistocene
- ly, Marsh and lacustrine deposits, Holocene to uppermost Pleistocene
- pC, Precambrian metamorphic rocks, Proterozoic and Archean



Legend

AOU-1 Boundary; VA Medical Center

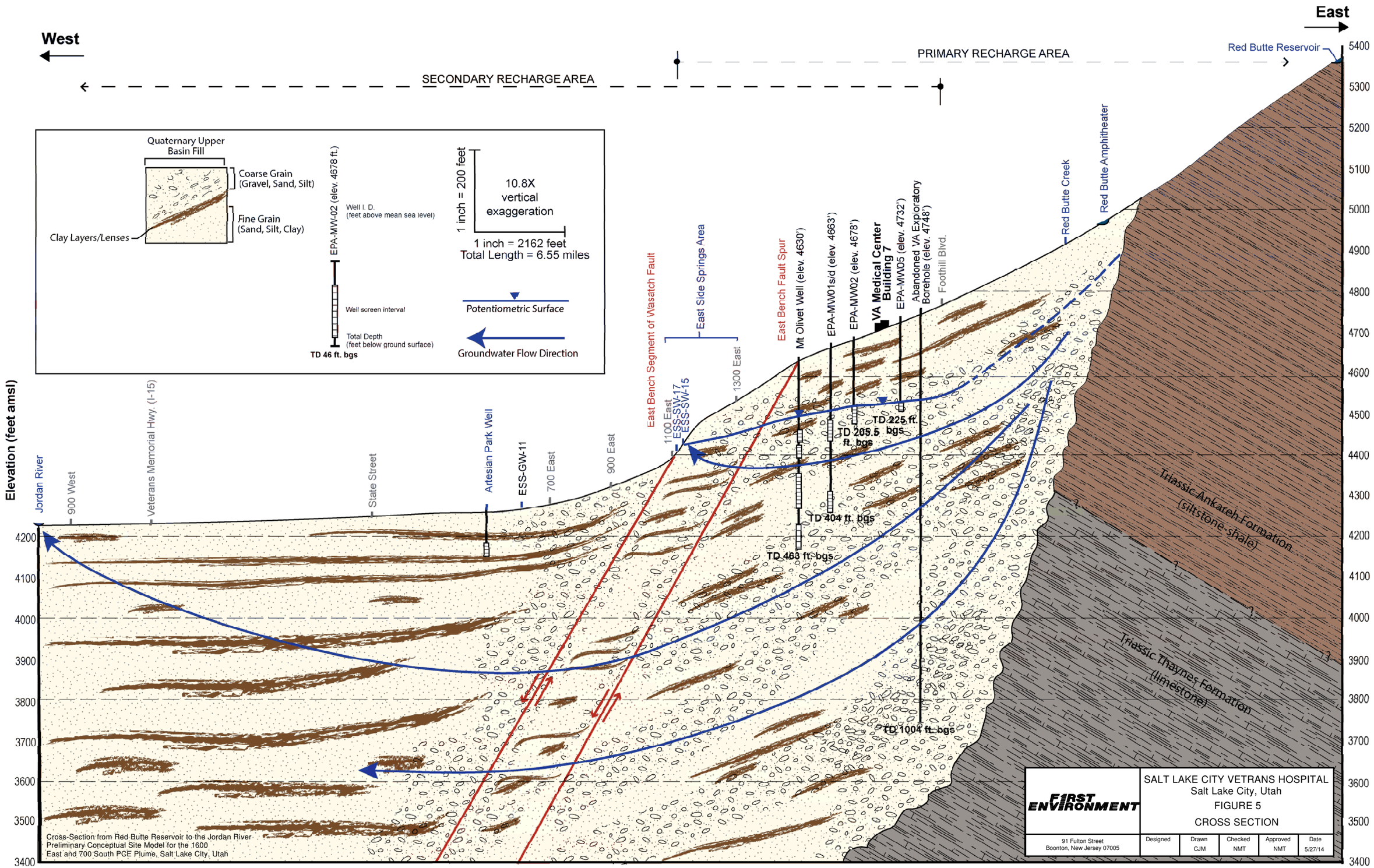
Source: Utah Geological Survey Map 243DM, digitized from U.S. Geological Survey Miscellaneous Investigations Series Map I-2106 (1992).

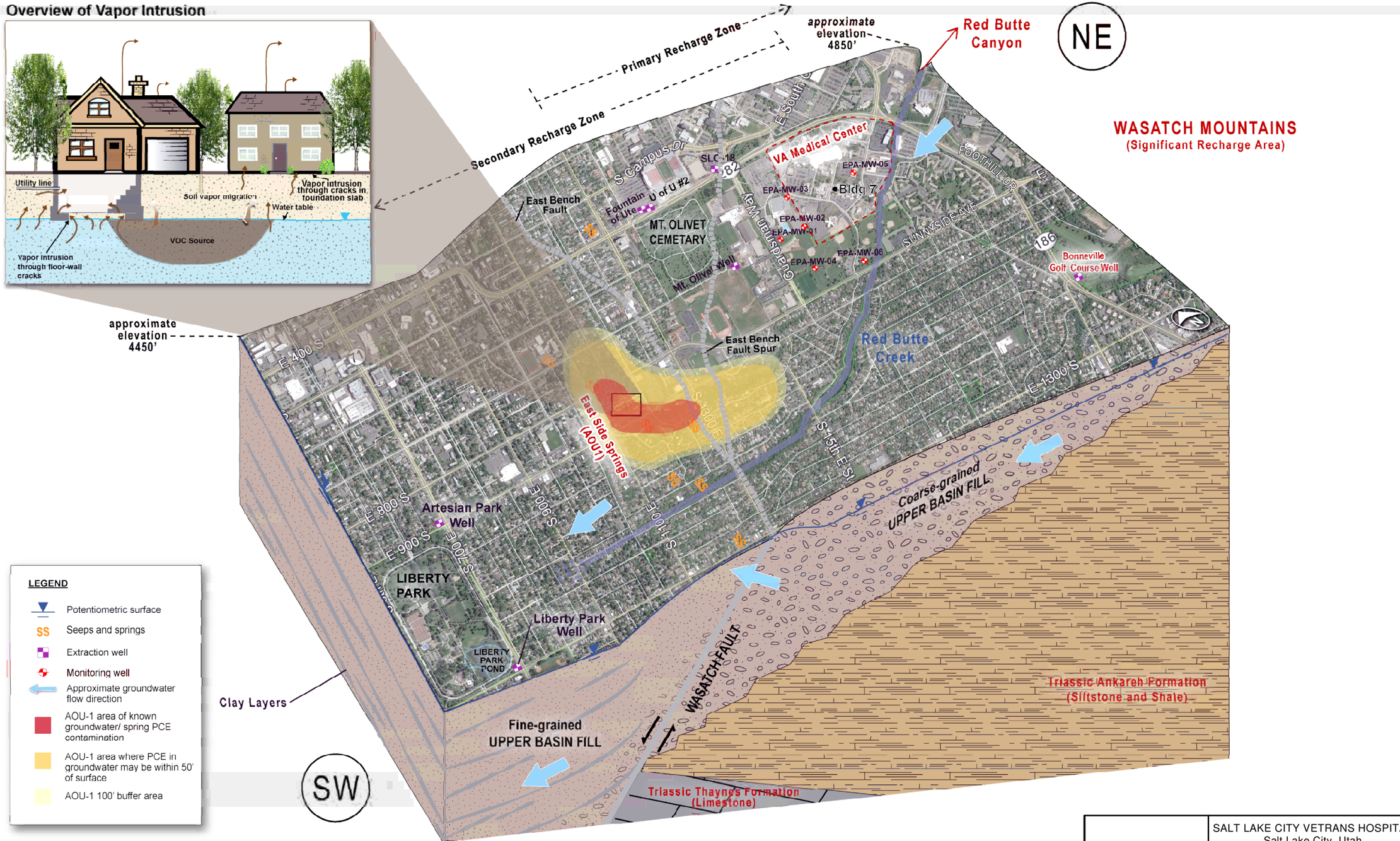
0 1,000 2,000 4,000 Feet

FIRST ENVIRONMENT
91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 4
SURFACE GEOLOGY AND FAULTS

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	EJR	5/27/14


West
East
SECONDARY RECHARGE AREA
PRIMARY RECHARGE AREA
Red Butte Reservoir
Quaternary Upper Basin Fill
Coarse Grain (Gravel, Sand, Silt)
Fine Grain (Sand, Silt, Clay)
Clay Layers/Lenses
EPA-MW-02 (elev. 4678 ft.)
Well I. D. (feet above mean sea level)
Well screen interval
Total Depth (feet below ground surface)
TD 46 ft. bgs
1 inch = 200 feet
10.8X vertical exaggeration
1 inch = 2162 feet
Total Length = 6.55 miles
Potentiometric Surface
Groundwater Flow Direction
Elevation (feet amsl)
Jordan River
900 West
Veterans Memorial Hwy. (I-15)
State Street
Artesian Park Well
ESS-GW-11
700 East
900 East
East Bench Segment of Wasatch Fault
1100 East
ESS-SW-17
ESS-SW-15
East Side Springs Area
1300 East
East Bench Fault Spur
Mt Olivet Well (elev. 4630')
EPA-MW01s/d (elev. 4663')
EPA-MW02 (elev. 4678')
VA Medical Center Building 7
EPA-MW05 (elev. 4732')
Abandoned VA Exploratory Borehole (elev. 4748')
Foothill Blvd.
Red Butte Creek
Red Butte Amphitheater
TD 225 ft.
TD 205.5 ft. bgs
TD 404 ft. bgs
TD 463 ft. bgs
TD 1004 ft. bgs
Triassic Ankareh Formation (siltstone-shale)
Triassic Thaynes Formation (limestone)
5400
5300
5200
5100
5000
4900
4800
4700
4600
4500
4400
4300
4200
4100
4000
3900
3800
3700
3600
3500
3400
Cross-Section from Red Butte Reservoir to the Jordan River
Preliminary Conceptual Site Model for the 1600 East and 700 South PCE Plume, Salt Lake City, Utah
FIRST ENVIRONMENT
91 Fulton Street
Boonton, New Jersey 07005
SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 5
CROSS SECTION
Designed
Drawn CJM
Checked NMT
Approved NMT
Date 5/27/14



FIRST ENVIRONMENT

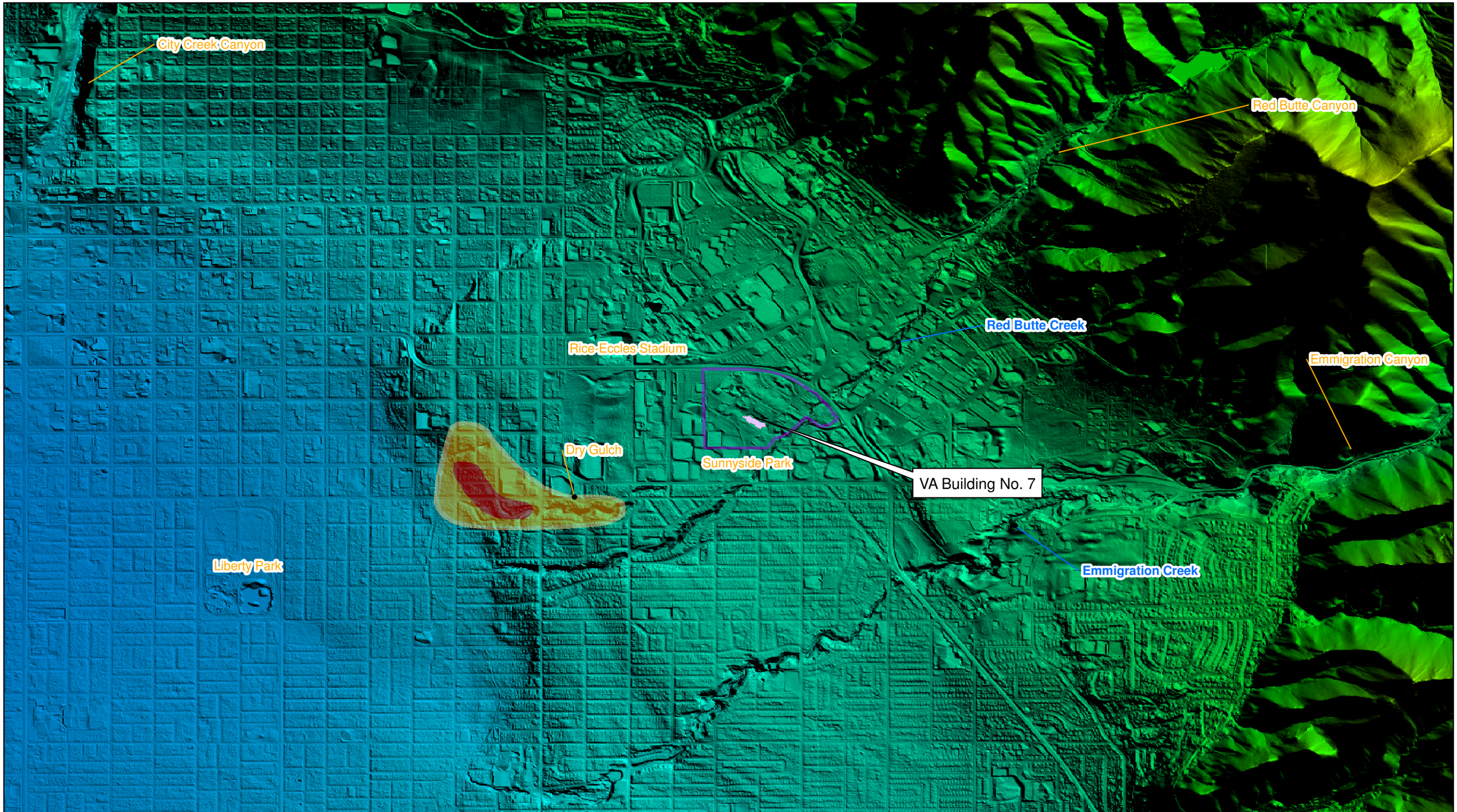
91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah

FIGURE 6

BLOCK DIAGRAM

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	NMT	5/28/14



Surface Elevation Range

6,600'

4,200'

Source: USGS National Elevation Dataset 2006 , 1/9 Arc (approximately 3 meters).

Legend

- AOU-1 Area of Known Groundwater/Spring PCE Concentration
- AOU-1 Area Where PCE in Groundwater may be within 50' of Surface
- AOU-1 100' Buffer Area
- VA Medical Center

N W E S

0 550 1,100 2,200 Feet

FIRST ENVIRONMENT

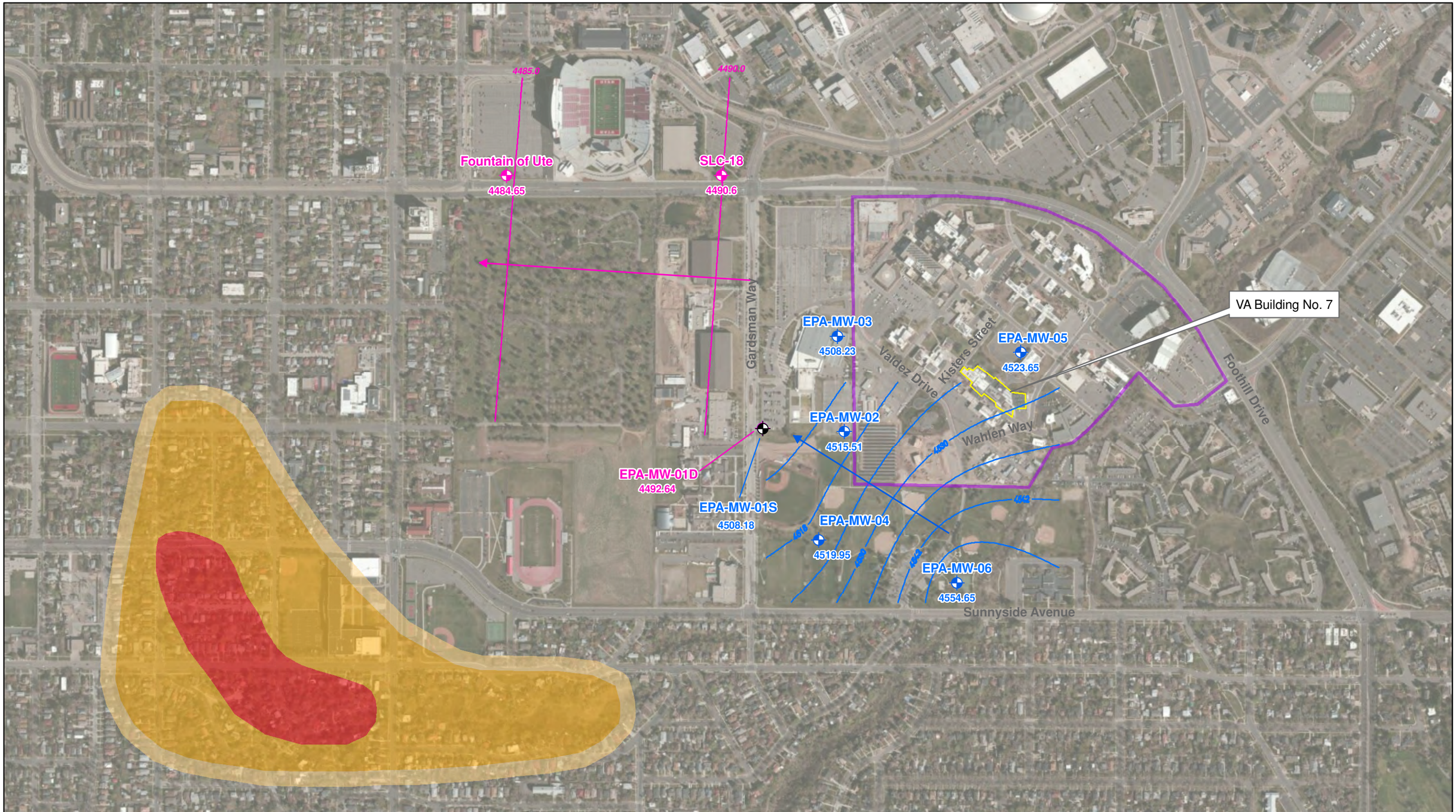
91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah

FIGURE 7

SURFACE TOPOGRAPHY

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	EJR	5/28/14



Legend

- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Groundwater Contour (Shallow)
- Groundwater Contour (Deep)
- AOU-1 Area of Known Groundwater/Spring PCE Concentration
- AOU-1 Area Where PCE in Groundwater may be within 50' of Surface
- AOU-1 100' Buffer Area
- VA Medical Center

Water level measurements were collected in November 2011.

N W E S

0 150 300 600 Feet

FIRST ENVIRONMENT

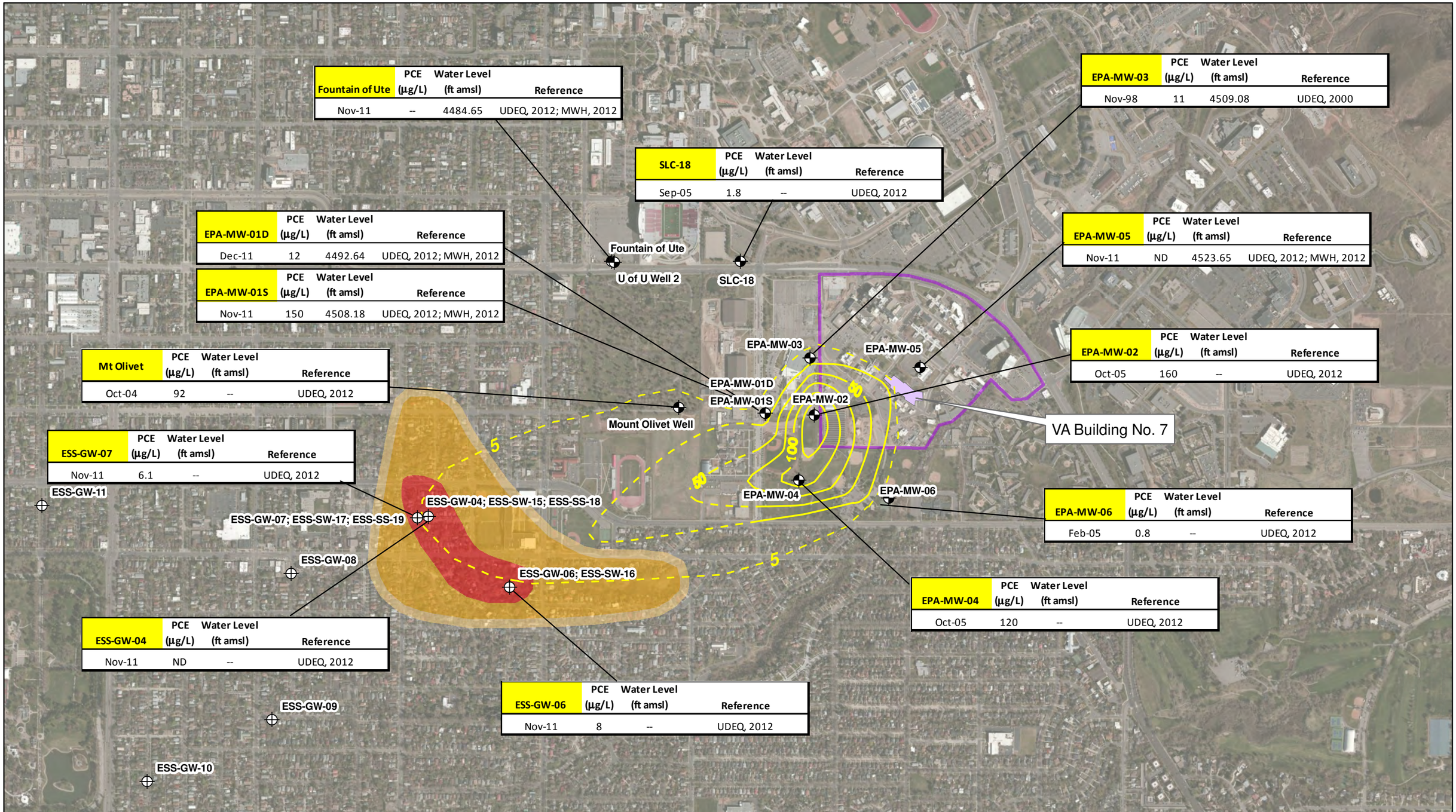
91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah

FIGURE 8

POTENTIOMETRIC SURFACE MAPS

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	EJR	5/27/14



Fountain of Ute	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	--	4484.65	UDEQ, 2012; MWH, 2012

SLC-18	PCE (µg/L)	Water Level (ft amsl)	Reference
Sep-05	1.8	--	UDEQ, 2012

EPA-MW-03	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-98	11	4509.08	UDEQ, 2000

EPA-MW-01D	PCE (µg/L)	Water Level (ft amsl)	Reference
Dec-11	12	4492.64	UDEQ, 2012; MWH, 2012

EPA-MW-01S	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	150	4508.18	UDEQ, 2012; MWH, 2012

EPA-MW-05	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	ND	4523.65	UDEQ, 2012; MWH, 2012

Mt Olivet	PCE (µg/L)	Water Level (ft amsl)	Reference
Oct-04	92	--	UDEQ, 2012

EPA-MW-02	PCE (µg/L)	Water Level (ft amsl)	Reference
Oct-05	160	--	UDEQ, 2012

ESS-GW-07	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	6.1	--	UDEQ, 2012

EPA-MW-06	PCE (µg/L)	Water Level (ft amsl)	Reference
Feb-05	0.8	--	UDEQ, 2012

EPA-MW-04	PCE (µg/L)	Water Level (ft amsl)	Reference
Oct-05	120	--	UDEQ, 2012

ESS-GW-04	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	ND	--	UDEQ, 2012

ESS-GW-06	PCE (µg/L)	Water Level (ft amsl)	Reference
Nov-11	8	--	UDEQ, 2012

Legend

- Temporary Wells
- Monitoring Wells
- PCE Plume (Inferred)
- PCE Plume
- AOU-1 Area of Known Groundwater/Spring PCE Concentration
- AOU-1 Area Where PCE in Groundwater may be within 50' of Surface
- AOU-1 100' Buffer Area
- VA Medical Center

N W E S

0 250 500 1,000 Feet

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

SALT LAKE CITY VETRANS HOSPITAL
Salt Lake City, Utah
FIGURE 9
PCE PLUME MAP/
CONTAMINANT DISTRIBUTION

Designed	Drawn	Checked	Approved	Date
	CJM	NMT	EJR	5/27/14

ATTACHMENT 1

ATTACHMENT 1
Known Spring and Seep Locations
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Site ID	Location Address	Latitude	Longitude	Comments
SL11	658 South 1000 East	40.754771	-111.862235	Located on east side of road
SL12	1034 East 700 South	40.754276	-111.861416	Located on north side of road
SL13	1066 East 700 South	40.753995	-111.860600	Located on parcel to the west of addres; SP-1 - Our Lady of Lourds Spring
SL14	731 South Mcclelland	40.753346	-111.860697	
SL15	735 South mcclelland	40.752985	-111.860324	
SL16	741 South Elizabeth St	40.753215	-111.857715	
SL17	1149 East Sunnyside Ave	40.751082	-111.857737	
SL18	1143 East Sunnyside Ave	40.750995	-111.857978	
SL19	1139 East Sunnyside Ave	40.750989	-111.858150	
SL20	1133 East Sunnyside Ave	40.750991	-111.858354	
SL21	833 South 1100 East	40.750994	-111.859327	
SL22	827 South 1100 East	40.751208	-111.859347	
SL23	1155 East 900 South	40.750333	-111.857707	Located on back of parcel, by alley
SL24	1154 East Sunnyside Ave	40.750433	-111.857711	Located on back of parcel, by alley
SL25	1173 East 900 South	40.749929	-111.857119	
SL26	1208 East 900 South	40.749647	-111.856531	
SL27	803 South 1100 East	40.751746	-111.859158	SP-2 - Benson Spring
SL28	1123 Alpine Place	40.749384	-111.857578	SP-3 - Smith Spring
SL29	1151 East Gilmer Dr	40.748457	-111.857226	
SL30	1205 East Gilmer Dr	40.748835	-111.855246	ESS-SW-16
SL31	1225 East Gilmer Dr	40.748837	-111.854451	
SL32	1223 East Gilmer Dr	40.748666	-111.854297	
SL33	1170 East Gilmer Dr	40.748165	-111.856134	
SL34	1165 East Gilmer Dr	40.748134	-111.856515	
SL35	1203 East Yale Ave	40.745876	-111.856832	SP-4 - Bowen Spring
SL36	1126 East 1300 South	40.741176	-111.858763	
SL37	1259 East Roosevelt Ave	40.738115	-111.854813	
SL38	1250 East Emerson Ave	40.737111	-111.855170	
SL39	1218 East Wood Ave	40.735086	-111.855994	
SL40	1593 South 1200 East	40.734851	-111.856586	
SL41	1656 South 1200 East	40.734397	-111.856553	
SL42	1170/72 East 1700 South	40.733418	-111.857183	
SL43	1840 South 1300 East	40.733404	-111.855912	Located south side of road at 1215 East 1700 South
SL44	1319 East Sherman Ave	40.740868	-111.853121	
SL45	1947 South 400 East	40.727683	-111.879614	
SL46	286 East Hollywood Ave	40.726798	-111.882712	Located in backyard
SL47	278 East Hollywood Ave	40.727001	-111.883059	
SL48	1958 South 300 East	40.727542	-111.882682	
SL49	339/41 East Blaine Ave	40.732752	-111.881295	
SL50	327 East Blaine Ave	40.732740	-111.881405	
SL52	623 South Lake St	40.755639	-111.869454	
SL53	618 South 800 East	40.755714	-111.868468	
SL76	Jasper St., 2700 South	40.712667	-111.863258	Under cob in road
SL57	1300 South 700 East	40.741459	-111.870580	Located in northwest corner of baseball park
SL58	1300 South 700 East	40.741469	-111.870754	Located in northwest corner of baseball park
SL59	600 South 600 East	40.756495	-111.873776	Located on 600 East, in road

ATTACHMENT 1
Known Spring and Seep Locations
700 South 1600 East Tetrachloroethylene Plume
Salt Lake City, Utah

Site ID	Location Address	Latitude	Longitude	Comments
SL60	564 South 600 East	40.756810	-111.873777	Located on road
SL61	600 South 600 East	40.756424	-111.873668	On 600 South, on road
SL62	804 South 500 East	40.751727	-111.877108	Artesian Well Park
SL63	1300 South 700 East	40.741881	-111.871838	Liberty Park Well, southeast corner of Liberty Park
SL64	974 Jasper Circle	40.713952	-111.863018	
SL65	2375 South 900 East	40.714351	-111.863130	Located on golf course property; on south property line
SL75	1208 East Kensington Ave	40.736356	-111.856478	Located on road
SL69	1199 East Bryan Ave	40.735958	-111.856517	Located in alley
SL77	1340 East Yale Ave	40.745356	-111.852571	
SL80	1340 South 400 East	40.740566	-111.880095	
SL81	1346 South 400 East	40.740516	-111.880095	
SL82	1127 East Sunnyside Ave	40.750988	-111.858443	ESS-SW-15
SL83	1123 East Sunnyside Ave	40.750994	-111.858604	
SL84	1157 East Sunnyside Ave	40.751089	-111.857627	
SL85	1115 East Gilmer Dr	40.749499	-111.858915	
SL86	865 South 1100 East	40.750342	-111.859097	Located in backyard, south of box in alley
SL87	1140 East Sunnyside Ave	40.750400	-111.858169	Located in back yard, north of box in alley
SL88	815 South 1100 East	40.751386	-111.859351	
SL89	1136 East 1300 South	40.741534	-111.858420	
SL93	2700 South 700 East	40.712410	-111.872308	2" pipe sticking out of creek, by bridge in golf course
SL95	369 East Redondo Ave	40.726724	-111.880375	Located in backyard
SL94	373 East Redondo Ave	40.726734	-111.880250	Located in backyard
SL100	1122 East 800 South	40.751759	-111.858751	ESS-SW-17
		40.751593	-111.859331	
SL102	1211 East Gilmer Dr	40.749090	-111.854797	Located in meter box
SL103	2500 South 700 East	40.716186	-111.871363	Located in the middle of the south bound lanes
SL104	1087 South 1300 East	40.745088	-111.853380	Located behind house
SL106	1212 East Kensington Ave	40.736176	-111.856189	
SL107	1095 East Simpson Ave	40.722003	-111.859451	

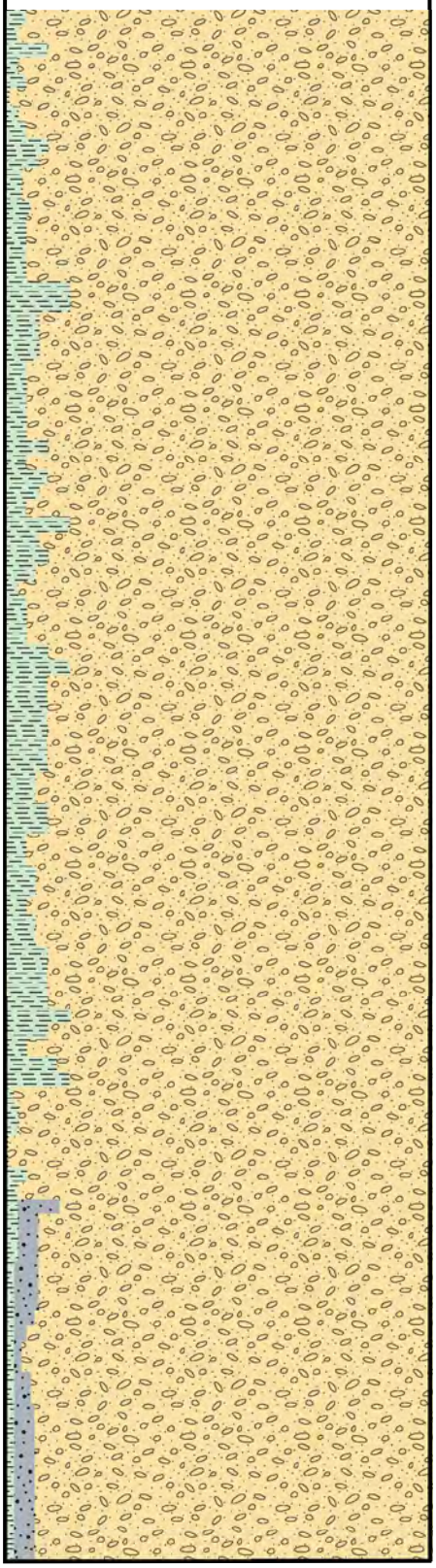
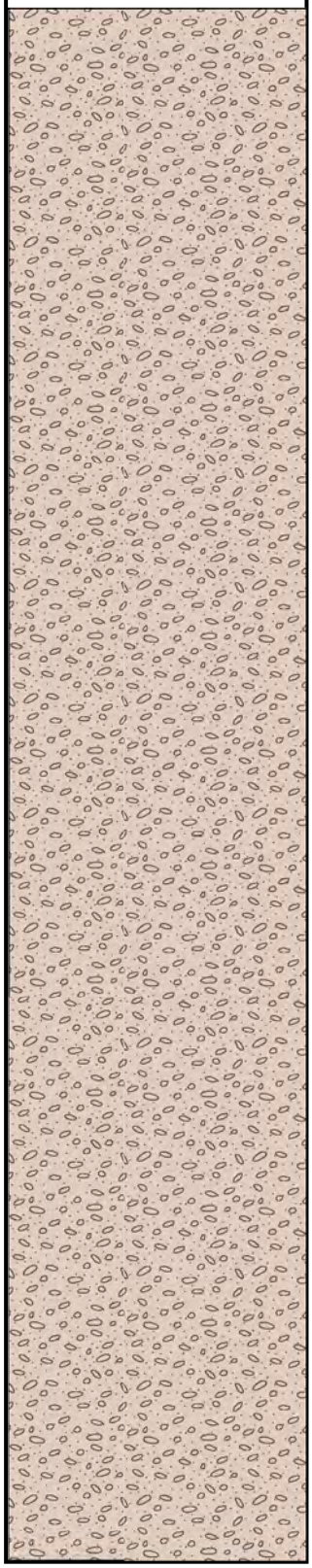
ATTACHMENT 2

GEOLOGIC LOG OF WATER-WELL CUTTINGS

UTAH GEOLOGICAL SURVEY

DWRi Appropriation #: 10-57-004-M00
Location: (D-1-1)4ddc, Salt Lake County, Utah
Driller: Grimshaw Drilling

Well Owner: U.S. Dept. of Veteran Affairs
Win #: 433935
Geologist: Gary J. Hunt, 11/30/10

DEPTH (feet)	CUTTINGS (%)	INTERPRETED LITHOLOGY	DESCRIPTION
0–1000			Unconsolidated gravel composed of various colored quartzite and sandstone, black limestone/dolostone, and white chert clasts with a small component of silt and clay.

0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000

Clay/silt | Sand | Gravel | Alluvium | No sample

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DWRi Appropriation #: 10-57-004-M00 **Well Owner: U.S. Dept. of Veteran Affairs**
Location: (D-1-1)4ddc, Salt Lake County, UT **Win #: 433935**
Driller: Grimshaw Drilling **Geologist: Gary J. Hunt, 12/08/2010**

DEPTH RANGE (FEET)		PERCENTAGES unconsolidated			COMMENTS
		css*	sand	gravel+	
0	20	0	0	0	NO SAMPLE
20	30	5	0	95	all 1000' consists of sub-angular clasts of green, gray, red sandstone and quartzite; black limestone (dolostone); white chert; pink clay; maximum clast size (MCS) = 1.0 cm, average clast size (ACS) = 0.3 cm
30	40	3	0	97	" MCS = 0.9 cm; ACS = 0.3 cm
40	50	10	0	90	" more silt and slightly smaller grain size; MCS = 0.8 cm , ACS = 0.3 cm
50	60	3	0	97	" unconsolidated gravel; MCS = 1.2 cm, ACS = 0.4 cm
60	70	5	0	95	" MCS =1.1 cm , ACS = 0.4 cm
70	80	1	0	99	" coarser; same provenance; MCS = 3.0 cm , ACS = 1.0 cm
80	90	3	0	97	" MCS = 2.5 cm, ACS = 1.0 cm
90	100	5	0	95	" slightly smaller grain size; MCS = 1.5 cm, ACS = 0.8 cm
100	110	10	0	90	" finer grained; more silt; MCS = 0.8 cm, ACS = 0.4 cm
110	120	8	0	92	" MCS = 0.8 cm, ACS = 0.3 cm
120	130	4	0	96	" MCS = 1.0 cm, ACS = 0.3 cm
130	140	4	0	96	" MCS = 1.0 cm, ACS = 0.5 cm
140	150	6	0	94	" MCS = 0.7 cm, ACS = 0.3 cm
150	160	5	0	95	" MCS = 1.0 cm, ACS = 0.5 cm
160	170	5	0	95	" MCS = 1.0 cm, ACS = 0.5 cm
170	180	5	0	95	" multi-colored quartzite and sandstone, black dolostone, white chert; MCS = 0.7 cm, ACS = 0.3 cm
180	190	15	0	85	" more clay and sand; MCS = 0.6 cm, ACS = 0.2 cm

***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DEPTH RANGE (FEET)		PERCENTAGES unconsolidated			COMMENTS
		css*	**sand**	**gravel**	
190	200	8	0	92	" A little coarser, but finer than most; MCS = 0.7 cm, ACS = 0.3 cm
200	210	15	0	85	" siltier; same provenance; MCS = 0.6 cm, ACS = 0.3 cm
210	220	8	0	92	" MCS = 0.8 cm, ACS = 0.4 cm
220	230	8	0	92	" MCS = 0.8 cm, ACS = 0.4 cm
230	240	8	0	92	" MCS = 0.8 cm, ACS = 0.4 cm
240	250	5	0	95	" MCS = 1.0 cm, ACS = 0.5 cm
250	260	5	0	95	" MCS = 1.0 cm, ACS = 0.4 cm
260	270	5	0	95	" MCS = 1.0 cm, ACS = 0.4 cm
270	280	5	0	95	" MCS = 0.9 cm, ACS = 0.3 cm
280	290	5	0	95	" MCS = 0.8 cm, ACS = 0.3 cm
290	300	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
300	310	5	0	95	" MCS = 1.0 cm, ACS = 0.4 cm
310	320	10	0	90	" MCS = 0.8 cm, ACS = 0.3 cm
320	330	8	0	92	" MCS = 0.9 cm, ACS = 0.4 cm
330	340	5	0	95	" MCS = 0.8 cm, ACS = 0.3 cm
340	350	15	0	85	" MCS = 0.6 cm, ACS = 0.3 cm
350	360	8	0	92	" slightly smaller grain size; same provenance; MCS = 0.6 cm, ACS = 0.3 cm
360	370	10	0	90	" MCS = 0.5 cm, ACS = 0.3 cm
370	380	7	0	93	" siltier, smaller clasts; same provenance; MCS = 0.7 cm, ACS = 0.3 cm
380	390	3	0	97	" coarser; less silt; MCS = 0.8 cm, ACS = 0.4 cm

***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DEPTH RANGE (FEET)		PERCENTAGES unconsolidated			COMMENTS
		css*	**sand**	**gravel**	
390	400	5	0	95	" MCS = 0.9 cm, ACS = 0.4 cm
400	410	5	0	95	" MCS = 0.9 cm, ACS = 0.4 cm
410	420	5	0	95	" MCS = 0.9 cm, ACS = 0.4 cm
420	430	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
430	440	15	0	85	" siltier MCS = 0.7 cm, ACS = 0.3 cm
440	450	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
450	460	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
460	470	10	0	90	" poorly sorted with more silt than average; same clast provenance; MCS = 0.7 cm, ACS = 0.3 cm
470	480	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
480	490	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
490	500	10	0	90	" MCS = 0.7 cm, ACS = 0.3 cm
500	510	7	0	93	" slightly smaller grain size MCS = 0.6 cm, ACS = 0.3 cm
510	520	7	0	93	" MCS = 0.6 cm, ACS = 0.3 cm
520	530	10	0	90	" MCS = 0.5 cm, ACS = 0.3 cm
530	540	10	0	90	" MCS = 0.5 cm, ACS = 0.3 cm
540	550	5	0	95	" coarser with less fine grain clay and silt; same provenance; MCS = 0.9 cm, ACS = 0.3 cm
550	560	5	0	95	" MCS = 0.9 cm, ACS = 0.3 cm
560	570	7	0	93	" MCS = 0.9 cm, ACS = 0.3 cm
570	580	7	0	93	" MCS = 1.0 cm, ACS = 0.4 cm

***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DEPTH RANGE (FEET)		PERCENTAGES unconsolidated			COMMENTS
		css*	**sand**	**gravel**	
580	590	5	0	95	" MCS = 1.0 cm, ACS = 0.4 cm
590	600	7	0	93	" MCS = 0.8 cm, ACS = 0.3 cm
600	610	7	0	90	" MCS = 0.9 cm, ACS = 0.3 cm
610	620	10	0	90	" more clay and the addition of gypsum; MCS = 0.8 cm, ACS = 0.3 cm
620	630	10	0	90	" gypsum, smaller grains MCS = 0.7 cm, ACS = 0.3 cm
630	640	10	0	90	" muddier matrix; gypsum; MCS = 0.7 cm, ACS = 0.3 cm
640	650	10	0	90	" same provenance plus gypsum; MCS = 0.6 cm , ACS = 0.3 cm
650	660	15	0	85	" MCS = 0.4 cm, ACS = 0.3 cm
660	670	10	0	90	" MCS = 0.5 cm, ACS = 0.3 cm
670	680	5	0	95	" coarser with less silt and NO gypsum; MCS = 0.7 cm, ACS = 0.3 cm
680	690	12	0	88	" more mud; trace gypsum; MCS = 0.6 cm, ACS = 0.3 cm
690	700	15	0	85	" MCS = 0.6 cm, ACS = 0.3 cm
700	710	2	0	98	" strikingly coarser with much less silt and more black limestone clasts; no gypsum; MCS = 0.8 cm, ACS = 0.3 cm
710	720	3	0	97	" MCS = 0.7 cm, ACS = 0.3 cm
720	730	3	0	97	" MCS = 0.7 cm, ACS = 0.3 cm
730	740	1	0	99	" clean gravel with same provenance; MCS = 0.7 cm, ACS = 0.3 cm
740	750	1	0	99	" MCS = 0.7 cm, ACS = 0.3 cm
750	760	5	0	95	" slightly muddier; MCS = 0.7 cm, ACS = 0.3 cm
760	770	3	0	97	" coarser; MCS = 0.8 cm, ACS = 0.3 cm
770	780	3	10	87	" coarse and medium sand with few large angular clasts; MCS = 0.6 cm, ACS = 0.2 cm

***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DEPTH RANGE (FEET)		PERCENTAGES unconsolidated			COMMENTS
		css*	**sand**	**gravel**	
780	790	3	5	92	" very few large clasts with more sand; MCS = 0.7 cm, ACS = 0.3 cm
790	800	3	5	92	" MCS = 0.7 cm, ACS = 0.3 cm
800	810	3	5	92	" MCS = 0.8 cm, ACS = 0.3 cm
810	820	2	6	92	" MCS = 0.8 cm, ACS = 0.3 cm
820	830	2	6	92	" MCS = 0.8 cm, ACS = 0.3 cm
830	840	2	6	92	" MCS = 0.8 cm, ACS = 0.3 cm
840	850	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm
850	860	2	3	95	" MCS = 0.8 cm, ACS = 0.3 cm
860	870	2	2	96	" coarser with less sand and more gravel; MCS = 1.0 cm, ACS = 0.4 cm
870	880	2	2	96	" MCS = 0.9 cm, ACS = 0.3 cm
880	890	2	4	94	" sandy gravel; MCS = 0.8 cm, ACS = 0.3 cm
890	900	2	4	94	" MCS = 0.7 cm, ACS = 0.3 cm
900	910	2	5	93	" MCS = 0.7 cm, ACS = 0.3 cm
910	920	2	5	93	" MCS = 0.7 cm, ACS = 0.3 cm
920	930	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm
930	940	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm
940	950	2	5	93	" MCS = 0.7 cm, ACS = 0.3 cm
950	960	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm
960	970	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm

***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

970	980	2	5	93	" MCS = 0.8 cm, ACS = 0.8 cm
980	990	2	5	93	" MCS = 0.8 cm, ACS = 0.3 cm
990	1000	2	5	93	" same provenance MCS = 0.8 cm, ACS = 0.3 cm

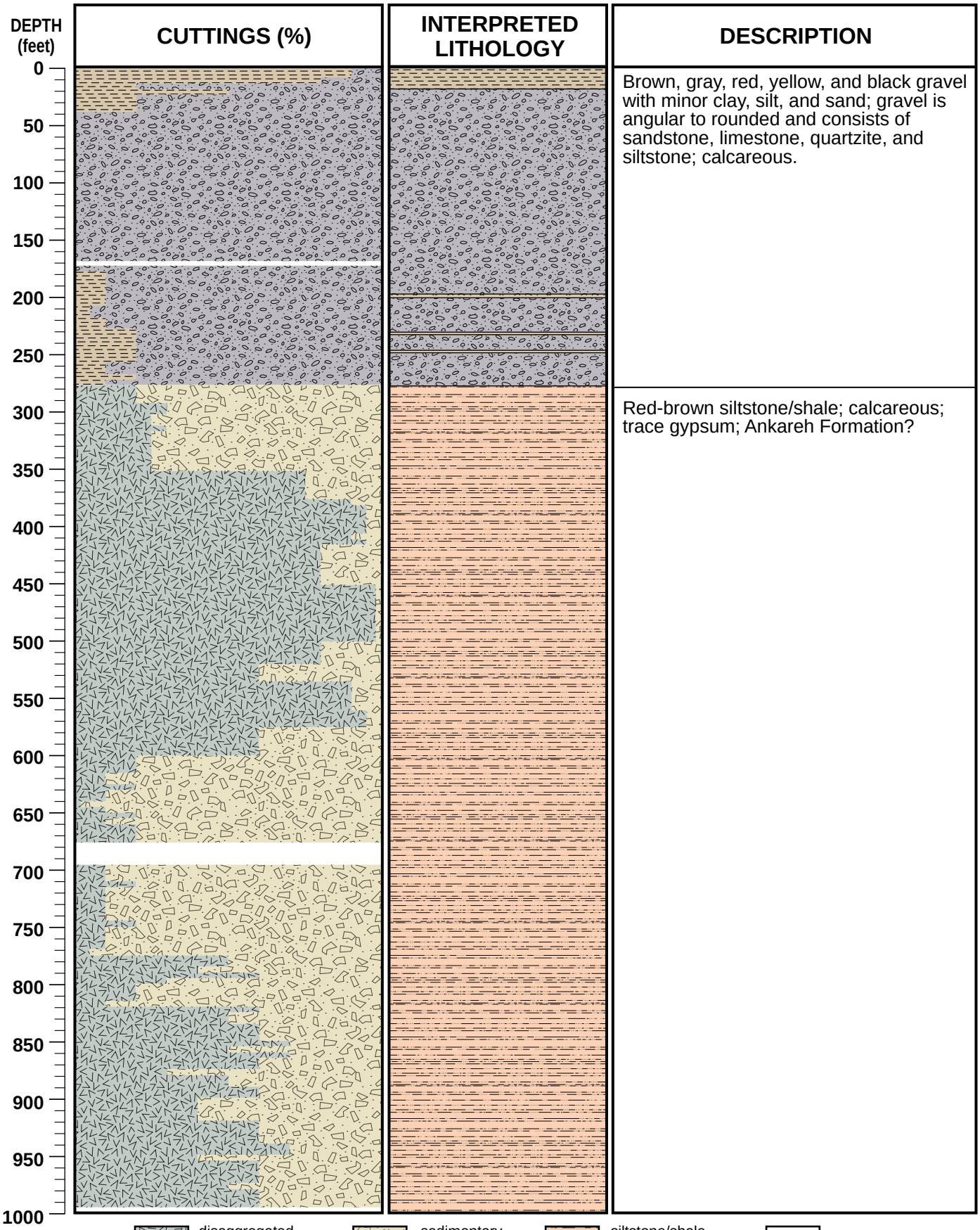
***css = clay, silt, and sand; + estimated clast size may not reflect actual size due to action of the drill bit**

GEOLOGIC LOG OF WATER-WELL CUTTINGS

UTAH GEOLOGICAL SURVEY

DWRi Appropriation #: 06-57-008-M00
Location: (D-1-1)4aba, Salt Lake County, Utah
Driller: Zimmerman Well Service

Well Owner: University of Utah
Win #: 427083
Geologist: Janae Wallace, 5/30/07



DESCRIPTION

Brown, gray, red, yellow, and black gravel with minor clay, silt, and sand; gravel is angular to rounded and consists of sandstone, limestone, quartzite, and siltstone; calcareous.

Red-brown siltstone/shale; calcareous; trace gypsum; Ankareh Formation?

disaggregated clay/silt and sand | sedimentary rock fragments | siltstone/shale | no sample
clay, silt, and sand | gravel

PERCENTAGE LOG OF WATER-WELL CUTTINGS
UTAH GEOLOGICAL SURVEY

DWRi Appropriation #: 06-57-008-M00 Well Owner: University of Utah
Location: (D-1-1)4aba, Salt Lake County, Utah Win #: 427083
Driller: Zimmerman Well Service Geologist: Janae Wallace, 5/30/07

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
0	5	90	10	0	0	brown clay, silt, sand, and gravel; gravel is angular to rounded and consists of quartzite, limestone, sandstone, and chert; maximum clast size (MCS) is 1 cm, average clast size (ACS) is 0.5 cm; calcareous
5	10	90	10	0	0	" MCS is 1 cm, ACS is 0.3 cm
10	15	80	20	0	0	" MCS is 0.3 cm, ACS is 0.3 cm
15	20	20	80	0	0	" MCS is 2 cm, ACS is 0.5 cm
20	25	50	50	0	0	" MCS is 2 cm, ACS is 0.3 cm
25	30	20	80	0	0	tan and gray gravel with minor clay, silt, and sand; gravel is angular to rounded and consists of limestone, quartzite, shale, sandstone, and conglomerate; MCS is 2.5 cm, ACS is 1 cm; calcareous
30	35	20	80	0	0	" MCS is 2.5 cm, ACS is 1 cm
35	40	20	80	0	0	" MCS is 3 cm, ACS is 0.5 cm
40	45	0	100	0	0	brown, gray, red, tan, yellow, and black gravel; gravel is angular to rounded and consists of limestone, quartzite, shale, sandstone, and conglomerate; MCS is 0.3 cm, ACS is 0.3 cm; calcareous

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
45	50	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
50	55	0	100	0	0	“ MCS is 2 cm, ACS is 0.5 cm
55	60	0	100	0	0	“ MCS is 1.5 cm, ACS 0.5 cm
60	65	0	100	0	0	“ MCS is 2 cm, ACS is 1 cm
65	70	0	100	0	0	“ MCS is 1 cm, ACS is 0.5 cm
70	75	0	100	0	0	“ MCS is 2 cm, ACS is 0.5 cm
75	80	0	100	0	0	“ MCS is 3 cm, ACS is 1 cm
80	85	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
85	90	0	100	0	0	“ MCS is 1 cm, ACS is 0.5 cm
90	95	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
95	100	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
100	105	0	100	0	0	“ MCS is 1 cm, ACS is 0.5 cm
105	110	0	100	0	0	“ MCS is 1 cm, ACS is 0.5 cm
110	115	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm
115	120	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm
120	125	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm
125	130	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
130	135	0	100	0	0	“ MCS is 1.5 cm, ACS is 0.3 cm
135	140	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm
140	145	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm
145	150	0	100	0	0	“ MCS is 1 cm, ACS is 0.3 cm

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
150	155	0	100	0	0	“ MCS is 2 cm, ACS is 0.5 cm
155	160	0	100	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
160	165	0	100	0	0	“ MCS is 3 cm, ACS is 1.5 cm
165	170	0	100	0	0	“ MCS is 2 cm, ACS is 1 cm
170	175	0	0	0	0	no sample
175	180	0	100	0	0	brown, gray, red, tan, yellow, and black gravel; gravel is angular to rounded and consists of limestone, quartzite, shale, sandstone, and conglomerate; MCS is 2 cm, ACS is 1 cm; calcareous
180	185	10	90	0	0	tan, brown, gray, red, yellow, and black gravel with minor brown clay, silt, and sand; gravel is angular to rounded and consists of limestone, quartzite, shale, sandstone, and conglomerate; MCS is 1 cm, ACS is 0.5 cm; calcareous
185	190	10	90	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
190	195	10	90	0	0	“ MCS is 1 cm, ACS is 0.3 cm
195	200	10	90	0	0	“ MCS is 1 cm, ACS is 0.5 cm
200	205	10	90	0	0	“ MCS is 1 cm, ACS is 0.5 cm
205	210	10	90	0	0	“ MCS is 1 cm, ACS is 0.5 cm
210	215	5	95	0	0	“ MCS is 1 cm, ACS is 0.3 cm
215	220	5	95	0	0	“ MCS is 1.5 cm, ACS is 0.5 cm
220	225	10	90	0	0	“ MCS is 4 cm, ACS is 0.5 cm
225	230	10	90	0	0	“ MCS is 1 cm, ACS is 0.3 cm

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
230	235	20	80	0	0	“ MCS is 1 cm, ACS is 0.5 cm
235	240	20	80	0	0	“ MCS is 2 cm, ACS is 0.5 cm
240	245	20	80	0	0	“ MCS is 1 cm, ACS is 0.5 cm
245	250	20	80	0	0	“ MCS is 0.5 cm, ACS is 0.3 cm
250	255	20	80	0	0	“ MCS is 1 cm, ACS is 0.3 cm
255	260	20	80	0	0	“ MCS is 3 cm, ACS is 1 cm
260	265	10	90	0	0	“ MCS is 2 cm, ACS is 1 cm
265	270	10	90	0	0	“ MCS is 1 cm, ACS is 0.3 cm
270	275	20	80	0	0	“ MCS is 2 cm, ACS is 0.3 cm
275	280	10	90	0	0	“ MCS is 1.5 cm, ACS is 0.5 cm
280	285	0	0	20	80	pink-brown clay and silt with red, gray, and tan sand-sized sedimentary rock fragments (siltstone, sandstone, and limestone); calcareous; Ankareh Formation?
285	290	0	0	20	80	“
290	295	0	0	20	80	“
295	300	0	0	30	70	“
300	305	0	0	30	70	“
305	310	0	0	25	75	“
310	315	0	0	25	75	“
315	320	0	0	30	70	“
320	325	0	0	25	75	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
325	330	0	0	25	75	“
330	335	0	0	25	75	pink-brown clay and silt with red, gray, and tan sand-sized sedimentary rock fragments (siltstone, sandstone, and limestone); calcareous
335	340	0	0	25	75	“
340	345	0	0	25	75	“
345	350	0	0	25	75	“
350	355	0	0	25	75	“
355	360	0	0	75	25	“
360	365	0	0	75	25	“
365	370	0	0	75	25	“
370	375	0	0	75	25	“
375	380	0	0	75	25	“
380	385	0	0	90	10	“
385	390	0	0	95	5	“
390	395	0	0	95	5	“
395	400	0	0	95	5	“
400	405	0	0	95	5	“
405	410	0	0	95	5	“
410	415	0	0	90	10	“
415	420	0	0	95	5	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
420	425	0	0	80	20	“
425	430	0	0	80	20	red-brown clay and silt with red, gray, and tan sand-sized sedimentary rock fragments (siltstone, sandstone, and limestone); calcareous
430	435	0	0	80	20	“
435	440	0	0	80	20	“
440	445	0	0	80	20	“
445	450	0	0	80	20	“
450	455	0	0	80	20	“
455	460	0	0	98	2	“ trace gypsum
460	465	0	0	98	2	“
465	470	0	0	98	2	“
470	475	0	0	98	2	“
475	480	0	0	98	2	“
480	485	0	0	98	2	“
485	490	0	0	98	2	“
490	495	0	0	98	2	“
495	500	0	0	98	2	“
500	505	0	0	98	2	“
505	510	0	0	80	20	“
510	515	0	0	80	20	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
515	520	0	0	80	20	“
520	525	0	0	80	20	red-brown clay and silt with red, gray, and tan sand-sized sedimentary rock fragments (siltstone, sandstone, and limestone); trace gypsum; calcareous
525	530	0	0	60	40	“
530	535	0	0	60	40	“
535	540	0	0	60	40	“
540	545	0	0	90	10	“ pink brown
545	550	0	0	90	10	“
550	555	0	0	90	10	“
555	560	0	0	90	10	“
560	565	0	0	90	10	“
565	570	0	0	95	5	“
570	575	0	0	95	5	“
575	580	0	0	95	5	“
580	585	0	0	60	40	“
585	590	0	0	60	40	“
590	595	0	0	60	40	“
595	600	0	0	60	40	“
600	605	0	0	60	40	“
605	610	0	0	20	80	red-brown clay with sand-sized quartz, feldspar, and sedimentary rock fragments

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
						(siltstone, sandstone, and limestone); calcareous
610	615	0	0	20	80	“
615	620	0	0	20	80	“
620	625	0	0	10	90	“
625	630	0	0	10	90	“
630	635	0	0	20	80	“
635	640	0	0	10	90	“
640	645	0	0	10	90	“
645	650	0	0	2	98	“
650	655	0	0	10	90	“
655	660	0	0	20	80	“
660	665	0	0	10	90	“
665	670	0	0	20	80	“
670	675	0	0	20	80	“
675	680	0	0	20	80	“
680	700	0	0	0	0	no sample
700	705	0	0	10	90	pink-brown clay with sand-sized quartz, feldspar, and sedimentary rock fragments (siltstone, sandstone, and limestone); calcareous
705	710	0	0	10	90	“
710	715	0	0	10	90	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
715	720	0	0	20	80	“
720	725	0	0	10	90	“
725	730	0	0	10	90	“ red brown; trace gypsum
730	735	0	0	10	90	“
735	740	0	0	10	90	“
740	745	0	0	10	90	“
745	750	0	0	10	90	“
750	755	0	0	20	80	“
755	760	0	0	10	90	“
760	765	0	0	10	90	“
765	770	0	0	10	90	“
770	775	0	0	10	90	“
775	780	0	0	5	95	“
780	785	0	0	50	50	“
785	790	0	0	50	50	“
790	795	0	0	40	60	“
795	800	0	0	60	40	“
800	805	0	0	30	70	“
805	810	0	0	20	80	“
810	815	0	0	20	80	“
815	820	0	0	20	80	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
820	825	0	0	10	90	“
825	830	0	0	60	40	“
830	835	0	0	50	50	“
835	840	0	0	50	50	“
840	845	0	0	60	40	“
845	850	0	0	60	40	“
850	855	0	0	60	40	“
855	860	0	0	70	30	“
860	865	0	0	50	50	“
865	870	0	0	70	30	“
870	875	0	0	60	40	“
875	880	0	0	60	40	“
880	885	0	0	30	70	“
885	890	0	0	50	50	“
890	895	0	0	50	50	“
895	900	0	0	60	40	“
900	905	0	0	60	40	“
905	910	0	0	40	60	“
910	915	0	0	40	60	“
915	920	0	0	40	60	“
920	925	0	0	40	60	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

DEPTH RANGE (FEET)		PERCENTAGES				COMMENTS
		unconsolidated		disaggregated		
		css*	gravel+	css*	SRF*	
925	930	0	0	60	40	“
930	935	0	0	60	40	“
935	940	0	0	60	40	“
940	945	0	0	60	40	“
945	950	0	0	70	30	“
950	955	0	0	70	30	“
955	960	0	0	40	60	“
960	965	0	0	60	40	“
965	970	0	0	60	40	“
970	975	0	0	60	40	“
975	980	0	0	60	40	“
980	985	0	0	50	50	“
985	990	0	0	60	40	“
990	995	0	0	60	40	“
995	1005	0	0	60	40	“

*css=clay, silt, and sand; SRF=sedimentary rock fragment; +angular nature of gravel and estimated clast size may result from drill-bit action

APPENDIX E

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Risk Assessment Work Plan
700 South 1600 East PCE Plume
AOU-1: East Side Springs
Salt Lake City, Utah

BPA No. VA259-14-A-0021
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Revision #0

Prepared for: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

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Acronyms and Abbreviations

µg/m^3	microgram(s) per cubic meter
AOU	accelerated operable unit
ATSDR	Agency for Toxic Substance and Disease Registry
AT	averaging time
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
CSEM	conceptual site exposure model
DCE	dichloroethene
ED	exposure duration
EF	exposure frequency
EFH	Exposure Factors Handbook
ELCR	excess lifetime cancer risk
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HQ	hazard quotient
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
LANL	Los Alamos National Laboratory
mg/m^3	milligram(s) per cubic meter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OSWER	Office of Solid Waste and Emergency Response
PCE	tetrachloroethene
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RBSL	risk-based screening level
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure

RSL	Regional Screening Level
SQL	sample quantification limit
TCE	trichloroethene
UDEQ	Utah Department of Environmental Quality
VA	Department of Veteran's Affairs
VC	vinyl chloride
VOC	volatile organic compound

1.0 Executive Summary

1.1 Introduction and Background

This work plan describes the methods for preparation of a Human Health Risk Assessment (HHRA) for the Accelerated Operable Unit (AOU) 1 (AOU-1) at 700 South 1600 East Street Tetrachloroethene (PCE) Plume (Plume), Salt Lake City, Utah. This work plan also contains a description of potential risks to ecological receptors. CH2M HILL was the lead technical author of this work plan and prepared the work under contract to First Environment, Inc. The HHRA will be used to support the remedial investigation (RI) and site management decisions regarding PCE-contaminated groundwater and surface water/seeps located in the southwestern, downgradient portion of the Plume. The HHRA methods presented in this work plan are consistent with guidance developed by the United States Environmental Protection Agency (EPA).

An AOU is applicable to remedial action where prompt action may be necessary and can be performed prior to completion of the final Record of Decision for that remedial action. The scope of this HHRA is primarily to evaluate the vapor intrusion pathway from the East Side Springs portion of the Plume. Other exposure pathways, including incidental exposures to surface water and soil and ingestion of homegrown produce, were also evaluated but the analyses detailed in this work plan suggest they are unlikely to contribute significantly to site risks.

AOU-1 is located in a predominantly residential area along the Wasatch Fault Scarp. In 2010, PCE was detected in surface water associated with seeps and springs along the fault. The location of the seeps and springs near residences and other occupied structures and the shallow depth-to-groundwater has raised concerns regarding potential vapor intrusion into homes and businesses. The discovery of the PCE-contaminated springs led to the establishment of a new site called “East Side Springs.” The AOU-1 RI is the initial effort in an expected site-wide RI/feasibility study program to characterize the larger Plume and develop remedial action alternatives.

This work plan specifically addresses PCE and PCE degradation products, contaminated groundwater, soil vapor, and indoor air at the East Side Springs. The full aerial extent of the Plume is unknown, but with the recent discovery of downgradient contaminated springs, the site covers approximately 300 acres.

This work plan describes HHRA methods that will support risk-based decision making and overall protection of human health in a manner that is consistent with the Comprehensive Environmental Response, Compensation, and Liability Act guidance and the National Oil and Hazardous Substances Contingency Plan (NCP). This HHRA Work Plan was prepared in accordance with the EPA Office of Solid Waste and Emergency Response (OSWER) policy as defined by the Risk Assessment Guidance for Superfund guidance documents. OSWER’s *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (EPA, 2002) is also used in the vapor intrusion evaluation.

The HHRA will follow a process designed to provide the Salt Lake City Veteran’s Health Care System, EPA, and State of Utah Department of Environmental Quality risk managers and other

stakeholders with useful information on which to base site management decisions. This process includes the steps in the following paragraphs.

1.2 Data Evaluation

The data evaluation process will identify chemical analysis results and other information available and appropriate for use in the risk assessment. This includes not only site contaminant data (e.g., PCE concentrations in groundwater and surface water), but also exposure factors and other elements of the risk assessment. The data evaluation also addresses data quality and specifies a process for selecting data of sufficient quality to meet the risk assessment objectives.

1.3 Identifying Contaminants of Potential Concern

Contaminants that are addressed in the HHRA are limited to PCE and its principal biodegradation products in water (trichloroethene, cis- and trans-1,2-dichloroethene, vinyl chloride). 1,4-dioxane, a stabilizer used in the manufacture of certain chlorinated solvents (although typically not PCE), was specifically requested by EPA to be included as a contaminant of potential concern. Other analytes included in the site analytical dataset will be deemed not attributable to the site based on the fact that they are not PCE daughter products, nor are they related to the process that was the potential source of contamination (e.g., dry cleaning). The quantitative risk assessment methods presented in this work plan will provide information on potential human health risks.

1.4 Exposure Assessment

There must be a complete exposure pathway between the contaminated media and a human receptor for a potential human health risk to exist due to the presence of a chemical in the environment. It is then necessary to estimate the amount of contaminant a receptor would be exposed to during its lifetime to estimate the degree of associated risk. The exposure assessment will identify the exposure setting and appropriate human receptors, potentially complete exposure pathways and their significance, and a description of the methods for quantifying lifetime exposures.

The exposure estimates will be based on a reasonable maximum exposure (RME) scenario, which is defined by EPA as “the highest exposure that is reasonably expected to occur at a site.” The RME approach provides estimates covering the general population as well as sensitive subpopulations, such as those who may spend more time in an exposure setting or have greater-than-typical contact with contaminated media. The RME reasonably bounds exposures for potential sensitive subpopulations.

The exposure assessment will include residential scenario reflecting current and future use of the site. This scenario best reflects actual current characteristics of the site which are (1) residential, and (2) commercial/school workers. Evaluation of these receptors will provide an upper bound on risks for other potentially exposed populations, such as school students, because these other populations will have shorter exposure frequencies and durations relative to full-time, year-round workers.

1.5 Estimating Risk

Risk estimates will be calculated by (1) estimating the exposure concentration of PCE, and breakdown products, intake by the receptor; (2) comparing the exposure concentration with the chemical's toxicity to estimate potential risk; and (3) totaling risk from exposure across multiple chemicals.

1.6 Uncertainty Analysis

There is uncertainty associated with the dose estimates, toxicity values, exposure factors, and models used to calculate risk. The work plan specifies that an uncertainty analysis will (1) describe assumptions and procedures that introduce the greatest amount of uncertainty in the HHRA, as well as their effect on the estimates of potential risk, and (2) provide guidance to risk managers and other stakeholder on how the uncertainties might affect site-management decision making.

1.7 Risk Description

The work plan specifies that a risk description section will be prepared to give a narrative interpretation of the HHRA results for use by risk managers and other stakeholders involved in the remedy selection process. The risk description may be the most important component of the HHRA. It will interpret the results relative to applicable regulations (e.g., the NCP) and guidance. It will also discuss mitigating factors that risk managers may consider when deciding on acceptable target risks and evaluating site management options.

An HHRA Report will be prepared following the review and acceptance of this work plan by EPA and Utah Department of Environmental Quality and completion of the RI data-collection activities.

2.0 Introduction

This work plan describes the methods that will be used for preparing a Human Health Risk Assessment (HHRA) focused on tetrachloroethene (PCE) contamination in groundwater at Accelerated Operable Unit (AOU) 1 at 700 South 1600 East Street, Salt Lake City, Utah (Figure 1-1). The HHRA will address PCE-contaminated groundwater, surface water, soil vapor, and indoor air located in the southwestern, downgradient portion of the 700 South 1600 East Street PCE Plume (Plume) Site (Figure 1-2). The HHRA will support remedial investigation (RI) and the need for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal or remedial action pertaining to the PCE-contaminated groundwater of AOU-1. This work plan also addresses other contaminants, including PCE biodegradation daughter products and 1,4-dioxane.

An AOU pertains a remedial action where prompt action is necessary and can be performed prior to completion of the final Record of Decision for that remedial action. The scope of this HHRA is primarily to evaluate the vapor intrusion pathway from the “East Side Springs” portion of the Plume. Other exposure pathways discussed include incidental exposure to surface water located in residential backyards and exposure to homegrown produce impacted by contaminated surface or groundwater.

Documents pertaining to the site history, previous investigations, and analytical data and modeling for the 700 South 1600 East PCE Plume were reviewed, including the following:

- *Preliminary Conceptual Site Model for the 700 South 1600 East PCE Plume, Salt Lake City, Utah. May 2014* (First Environment, 2014a;)
- *Sampling and Analysis Plan, 700 South 1600 East PCE Plume, AOU-1: East Side Springs, Salt Lake City, Utah*. (First Environment, 2014b);
- *East Side Springs, Salt Lake County, Utah Site Investigation Analytical Results Report* (Utah Department of Environmental Quality [UDEQ], 2012);
- Results of Initial Groundwater Sampling Event, 700 South 1600 East PCE Plume, Salt Lake City, Utah (First Environment, 2014c).

2.1 Background

AOU-1 is located within the southwestern and western boundary of the 700 South 1600 East Street PCE Plume. The overall Plume, including AOU-1, was listed on the United States Environmental Protection Agency’s (EPA’s) National Priorities List in 2013. Source areas for the PCE contamination and the extent of the plume were not clearly identified. However, a sewer line originating from a former dry-cleaning facility in the Veteran’s Administration (VA) Medical Center was identified as a potential source.

Seeps and springs in the area are located on residential, public, and private properties containing numerous homes, several public and private schools, a large public park, and several churches. Following the 2010 release of crude oil from a pipeline, Salt Lake City identified 25 springs along the Wasatch Fault line in the area between 800 South and Michigan Avenue (approximately 1300 South) and between 1100 East and 1300 East (UDEQ, 2012). During the investigation, although constituents of crude oil were not identified, PCE was

detected in springs and in a storm drain manhole (UDEQ, 2012). PCE was also detected in shallow groundwater samples collected within AOU-1 (UDEQ, 2012). Table 1-1 summarizes the existing shallow groundwater and surface water (spring and seep) analytical results. PCE concentrations in surface water and shallow groundwater ranged from non-detect (less than 5 micrograms per liter [µg/L]) to 20 µg/L.

2.2 Purpose and Scope

2.2.1 Purpose

The purpose of this work plan is to specify methods that will be used in preparing the HHRA for PCE-contaminated groundwater, surface water, soil vapor, and indoor air within AOU-1. The HHRA will rely on analytical data and other information generated as part of the upcoming RI and the HHRA findings will be presented in companion to the RI Report. The HHRA will ultimately serve as a key input to making site management decisions for AOU-1.

2.2.2 Scope

This HHRA Work Plan outlines a process that conforms to EPA risk assessment guidance documents (Section 1.5). This process includes the following elements:

- identification of contaminated media (Section 2.3.0);
- identification of contaminants of potential concern (COPCs) (Section 3.1);
- identification of current and reasonable anticipated future human receptors (Section 3.2);
- identification of possible exposure pathways between the contaminated media and the human receptors (Section 3.2);
- an evaluation of the completeness or incompleteness of the exposure pathways (Section 3.2);
- an evaluation of the contaminants' toxicity (3.3);
- a quantitative estimate of potential human health risks (Section 3.3);
- a discussion of the inherent uncertainties in quantifying potential risks and how these will be addressed during the HHRA (Section 3.4).

The scope of the HHRA was discussed during a risk-assessment scoping conference call held on October 9, 2014. Representative from EPA, UDEQ, the Agency for Toxic Substance and Disease Registry (ATSDR), the VA, First Environment, and CH2M HILL attended the call. This work plan was prepared consistent with the discussion during the scoping call.

2.3 Scientific Management Decision Points

Following are a selection of the scientific management decision points anticipated in relation to the HHRA:

- Following regulatory review and comments on this work plan, a scientific management decision point will exist with respect to agreement on the media, COPCs, receptors, and exposure pathways to be addressed by the HHRA.

- Following completion of the RI data collection but prior to conducting of the HHRA, a second scoping meeting will occur to summarize the RI findings and assess whether refinements to the conceptual site model warrant modification to the HHRA assumptions or methods.
- Following completion of the HHRA, the risk assessors will communicate the HHRA results to the State of Utah and EPA risk managers who will need to determine whether the information supports remedial action decision making.

2.4 Guidance Documents

This HHRA Work Plan was prepared in accordance with EPA Office of Solid Waste and Emergency Response (OSWER) policy as defined by the Risk Assessment Guidance for Superfund (RAGS) guidance documents, including the following:

- Part A: Human Health Evaluation Manual (RAGS Part A) (EPA, 1989);
- Part B: Development of Risk-based Preliminary Remediation Goals (RAGS Part B) (EPA, 1991);
- Part E: Supplemental Guidance for Dermal Risk Assessment (RAGS Part E) (EPA, 2004);
- Part F: Supplemental Guidance for Inhalation Risk Assessment (RAGS Part F) (EPA, 2009).

Other primary guidance and reference documents used in development of this work plan include the following:

- *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (EPA, 2002);
- *EPA Regional Screening Levels (RSL) Table: User's Guide (EPA, 2014a).*

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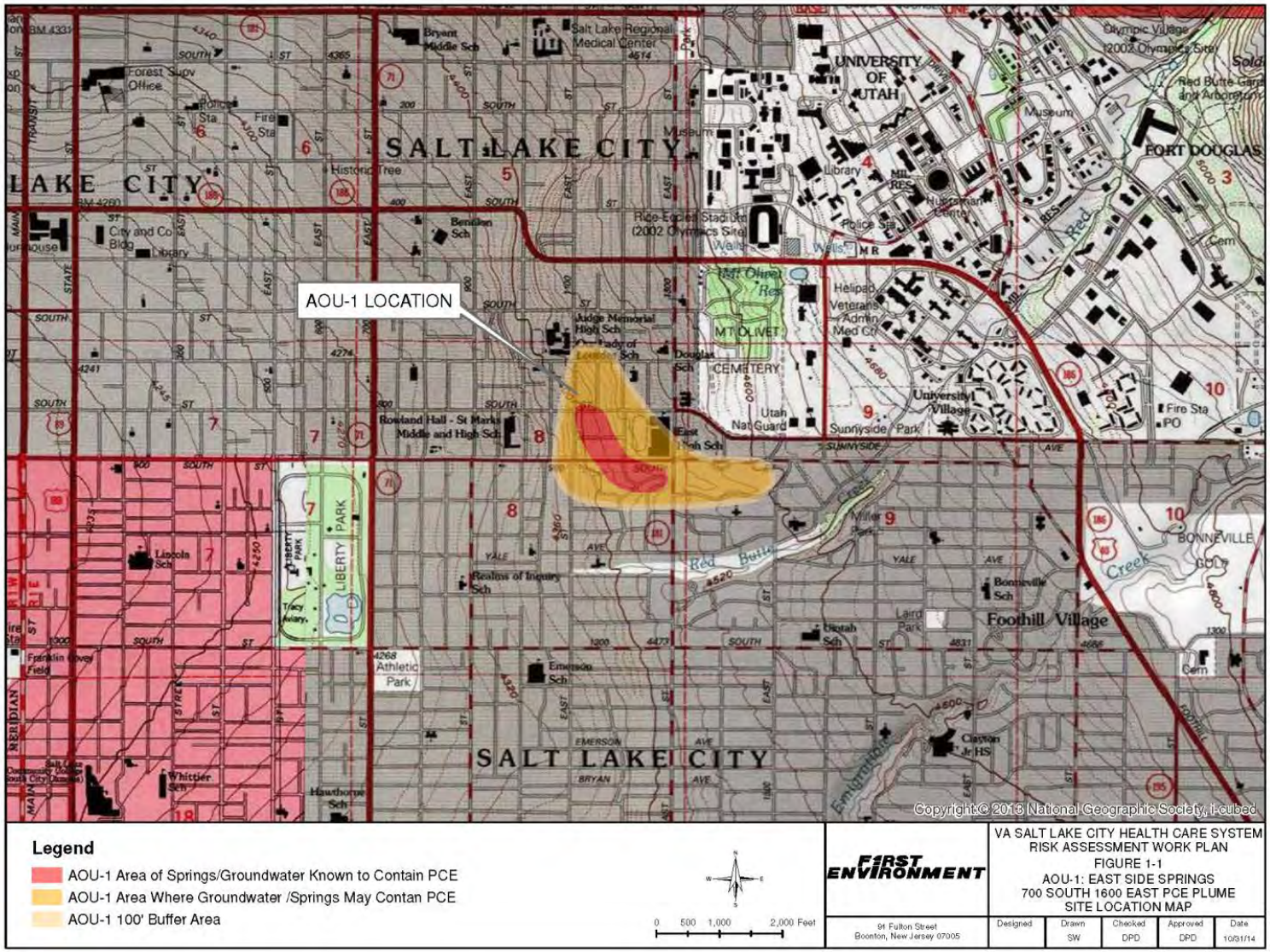
TABLE 1-1 Summary Statistics for Groundwater and Surface Water

Analyte	Detects	Sample Size	Frequency of Detection	Units	Minimum Concentration	Maximum Concentration
Groundwater						
Tetrachloroethene	2	3	66.67%	mg/L	<5	8
Trichloroethene	1	3	33.33%	mg/L	<5	13
cis-1,2-Dichloroethene	0	3	0.00%	mg/L	<5	<5
trans-1,2-Dichloroethene	0	3	0.00%	mg/L	<5	<5
Vinyl chloride	0	3	0.00%	mg/L	<5	<5
1,4-Dioxane[a]	0	3	0.00%	mg/L	<100	<100
Surface Water						
Tetrachloroethene	2	3	66.67%	mg/L	<5	20
Trichloroethene	1	3	33.33%	mg/L	<5	4.6
cis-1,2-Dichloroethene	0	3	0.00%	mg/L	<5	<5
trans-1,2-Dichloroethene	0	3	0.00%	mg/L	<5	<5
Vinyl chloride	0	3	0.00%	mg/L	<5	<5
1,4-Dioxane[a]	0	3	0.00%	mg/L	<100	<100
Notes:						
Groundwater data set includes November 2011 sampling at:						
ESS-GW-04						
ESS-GW-06						
ESS-GW-07						
Surface water data set includes November 2011/2012 sampling at:						
ESS-SW-15						
ESS-SW-16						
ESS-SW-17						
a. The 1,4-Dioxane were rejected (flagged "R") during data validation						
mg/L = micrograms per liter						
% = percent						
< = less than						

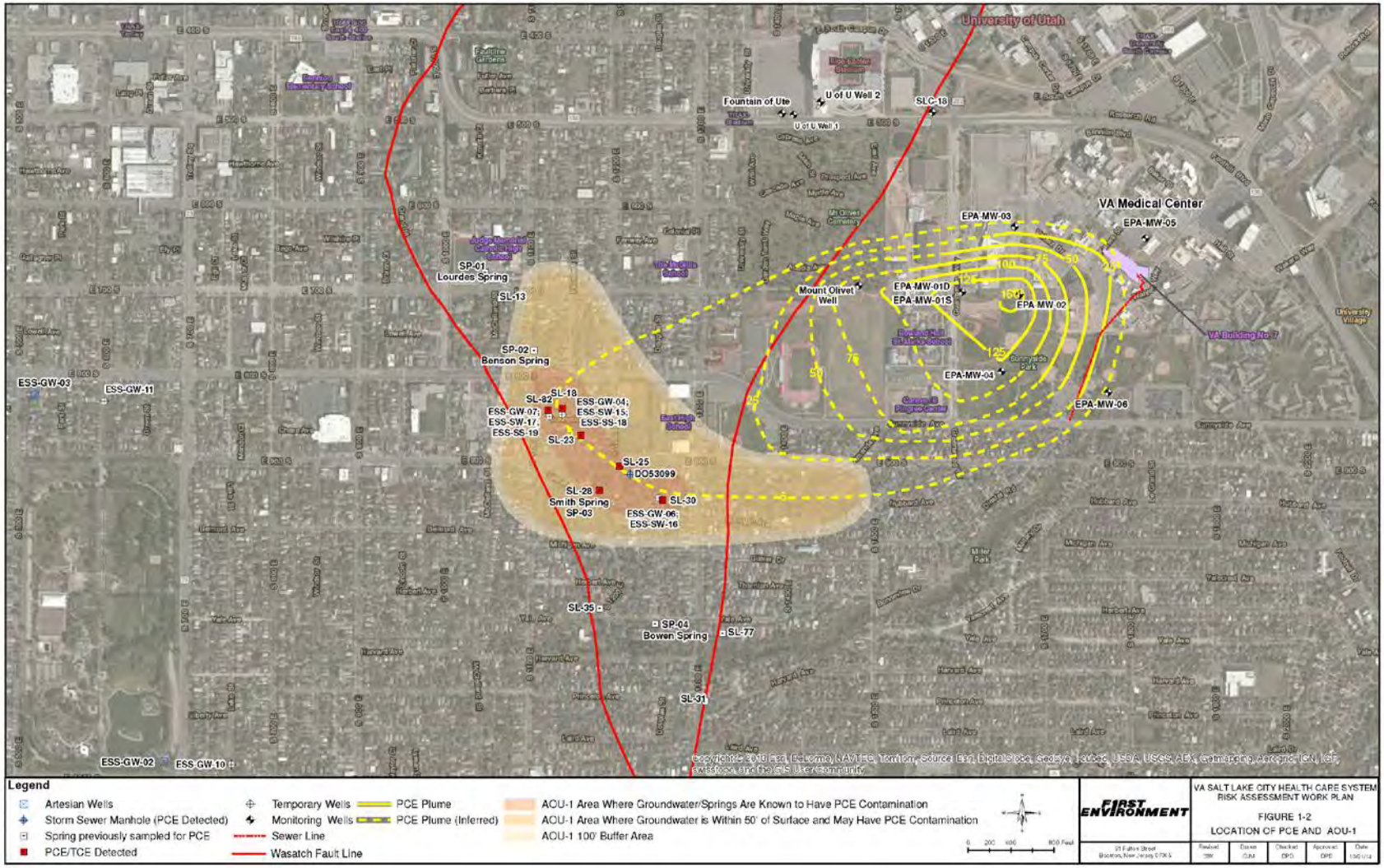
FINAL

FIGURE 1-1 Site Location Map



FINAL

FIGURE 1-2 Location of PCE Plume and AOU-1



3.0 Data Evaluation

Multiple phases of investigations associated with the 700 South 1600 East Street Plume have produced information regarding the physical system and the nature, extent, fate, and transport of contamination. Documents specifically relevant to the AOU-1 include the following:

- *Mount Olivet Cemetery Plume Analytical Results Report* (UDEQ, 2000);
- *East Side Springs, Salt Lake County, Utah Site Investigation Analytical Results Report, UTN000802825* (UDEQ, 2012);
- *Expanded Site Investigation Work Plan, University of Utah Building 515, Salt Lake County, Utah, UT0001908821* (UDEQ, 2010).

The purposes of this section are to (1) describe the process for determining which information from these existing reports will be useful and appropriate for use in the HHRA, to supplement data collected during the RI sampling activities if necessary; and (2) describe the methods for distilling the HHRA inputs to the most relevant and useful information.

This section also presents the methods that will be used to define contaminant concentration terms consistent with the exposure scenarios and assumptions discussed in Section 3.2. The overarching goal of this data evaluation is to select data that represent current groundwater/ surface water/soil gas/indoor air contamination conditions as accurately as possible, thereby increasing confidence in the HHRA results.

3.1 Data Selection

Not all data collected during the RI will be directly useful for the HHRA. Other data is typically required for determination of nature and extent, as well as to support the Feasibility Study (FS). For example, some samples will be collected for characterization of groundwater geochemistry and are not directly pertinent to assessing potential contaminant exposures. The following paragraphs describe the data selection process for AOU-1 analytical data that will help formulate the assumptions in the exposure assessment (Section 3.2). This data selection is directed toward evaluating exposures for a current and future resident and commercial/school worker exposure scenarios. Section 3.2 presents information on the selection of representative exposure scenarios for AOU-1.

3.1.1 Matrices

The data used in this risk assessment include results from RI sampling of surface water from numerous springs, seeps, and spring-fed small ponds, as well as sampling of shallow groundwater along and near the portion of the Wasatch Fault Scarp within the AOU-1 area. Indoor air sampling of residences and occupied structures will be used to assess potential VI pathways and human exposures. Analytical results from groundwater and soil gas (near-slab) sampling will be generated during the RI and will be used to refine the conceptual site model and assess the need for further investigation. However, these data will not be used to directly assess human exposures because indoor air data will be available for that purpose.

The surface water data will be used to assess whether the information presented in Section 3.2.2 of this work plan is correct and the estimated human health risks for direct exposure to surface water or ingestion of irrigated homegrown produce are insignificant. Barring major

changes in the conceptual site model following the RI data collection, these surface water data will not be carried forward into the quantitative risk assessment.

3.1.2 Analytes and Methods

The RI analytical dataset for the AOU-1 consists predominantly of laboratory analytical results for volatile organic compounds (VOCs). Validated analytical data from the accredited laboratories will be used as HHRA inputs. Field screening data will not be used for quantitative risk assessment. In addition, other laboratory analyses, such as general water quality parameters, will be excluded from the HHRA data set because they will not be directly applicable to assessing exposures and risks.

3.1.3 Location and Date

Analytical data for groundwater, surface water, and indoor air samples collected from within AOU-1, as shown in Figures 3 and 4 of the Sampling and Analysis Plan (First Environment, 2104b), will be included in the data evaluation. Generally, data collected during the RI will be used and previous data will be excluded. Case-by-case exceptions could be made if pre-RI data were need to address a significant data gap.

3.1.4 Site Relatedness

The data to be included in the HHRA should represent impacts associated with PCE releases on VA property. Reasons that VOCs may be present for other reasons include the following:

- PCE (and its daughter product trichloroethene [TCE]) have been commonly used for decades in wide variety of consumer and commercial products and they are among the most common groundwater contaminants in the U.S. Releases from other sites upgradient of AOU-1 and unrelated to VA operations could contribute to AOU-1 contamination.
- Also, due to their widespread use, PCE and its daughter product TCE are commonly detected in indoor air (EPA, 2012)

The RI Report will present multiple lines of evidence in assessing site-relatedness. To assess the potential for other VOC releases, the RI analysis will consider such factors as the location of VOC detections in AOU-1, the locations of other potential sources, existing and new information on solvent uses and releases at those potential sources, and the overall understanding of groundwater movement. Multiple line of evidence for assessing indoor background VOC sources will include the results of real-time VOC analysis with and without building depressurization, analysis of VOC concentration ratios in subsurface media and indoor air, and the results of chemical product inventories. Battelle (2011) provides further information about these and other methods for assessing background during vapor intrusion assessments. Analytical results found to be present at AOU-1 for reasons unrelated to VA-related releases will be excluded from the HHRA.

3.2 Data Quality Assessment

The RI groundwater, surface water, soil vapor, and indoor air samples that will be evaluated during the HHRA will be collected, analyzed, and validated during the RI according to the *Quality Assurance Project Plan (QAPP) 700 South 1600 East Street PCE Plume AOU-1: East Side Springs* (First Environment, 2014d).

The QAPP specifies procedures for each step of the data generation process, including planning, sampling, sample handling, laboratory and field analyses, recordkeeping, reporting, data validation, and data management. Adherence to the QAPP will result in a quality analytical dataset. Data rejected during the validation process for any reason will be excluded from the HHRA dataset.

In addition to data quality, the completeness and representativeness of the data are important components of assessing their usability for risk assessment. This will involve evaluating the overall conceptual model and assessing whether the sufficient numbers of samples were collected at enough locations to adequately characterize the nature and extent of VOC concentrations and support estimates of reasonable maximum exposure (RME). Figures 3 and 4 of the Sampling and Analysis Plan (First Environment, 2014b) illustrate the current planned extent of groundwater, soil gas, and indoor air sampling, which may be supplemented by additional samples as data gaps are identified during the RI.

3.3 Sample Quantitation Limit Evaluation

Risk assessments for contaminated environmental media require numerical contaminant concentration data for the media of interest (e.g., soil, water, and/or air). These concentration data will be used as inputs for calculations that estimate exposures and risks. For each analytical method used to generate these data, a concentration exists below which the analytes cannot be reliably detected or quantified. For this HHRA, this concentration will be termed the sample quantification limit (SQL), defined as the laboratories' reported method detection limit corrected for sample dilution and other sample-specific adjustments (EPA, 1992).

The HHRA will include a comparison of the SQLs to EPA's RSLs and identify cases where non-detect results exceed conservative screening levels. A certain number of such cases is normal and expected, most commonly due to elevated concentrations of one analyte, resulting in the need for dilutions and elevated reporting limits for other analytes in a given sample. The uncertainties associated with such cases will be addressed in the uncertainty evaluation (Section 3.4).

3.4 Data Reduction

Following the data selection (Section 2.1) and data quality review (Section 2.2) procedures described, further data reduction will be necessary during the HHRA to resolve instances where multiple valid analytical results exist for a single analyte from a single sample. This complication results from several situations, including when (1) analytical results exist for both a parent sample and a field duplicate sample; (2) multiple analytical results exist if serial dilutions were performed when an analyte was out of the analytical instrument's calibration range; (3) an analyte was measured by more than one analytical method; or (4) samples have been reanalyzed to address analytical quality issues.

When multiple analytical results exist, the HHRA will include data reduction using the following procedures:

- For duplicate samples, when each sample has concentrations reported above the SQL, the higher of the two concentrations will be used.

- For duplicates and dilutions for which neither sample has concentrations measured above the SQL, the lower of the two SQLs will be used.
- For duplicates and dilutions in which one sample contains a result measured above the SQL and another has a result reported as below the SQL, the result measured above the SQL will be used.
- For dilutions, the result for the lowest dilution that was within the instrument's calibration range for the specific analyte will be used.

3.5 Environmental Modeling

Based on the evaluation described in the Exposure Assessment (Section 3.2), vapor intrusion will be the primary pathway evaluated quantitatively during the HHRA. Since measured indoor air VOC concentrations will serve as the exposure point concentration (EPC) for this pathway, no modeling of contaminant partitioning between media will be necessary.

However, some of the analysis and recommendations presented in this work plan incorporated modeling of cross-media partitioning, including the following:

- partitioning from irrigation water to homegrown produce using the Briggs and Travis & Arms models;
- partitioning from surface water to soil using linear adsorption (Kd) model; and
- partitioning from soil air using the particulate emission factor (PEF) and volatilization factor models intrinsic to the residential soil regional screening levels.

While soil gas and groundwater data will not be used quantitatively to asses vapor intrusion in the HHRA, they will be used to refine the overall AOU-1 conceptual site model and, thus, will factor into the HHRA data quality and uncertainty analyses. Vapor intrusion screening levels for soil gas and groundwater were calculated in separate technical memorandum (First Environment, 2014e). These screenings incorporated attenuation factors that address the partitioning from soil gas and groundwater to indoor air.

In each of the cases described previously, well-established models recommended in current EPA guidance were selected. The guidance supports assessment that these models result in realistic to conservative estimates of inter-media contaminant transfer.

4.0 Human Health Risk Assessment

The HHRA is multiple-step process required by CERCLA and directed under guidance developed by EPA. First, the HHRA process determines the contaminants of concern. In this case, PCE and its degradation products have been identified as the COPCs based on previously collected data. The next step is the exposure assessment, which is conducted to evaluate the likelihood and potential magnitude of PCE (and degradation products) exposure for a variety of human receptors at the sites, such as current and residents and workers. Following the exposure assessment, a toxicity assessment and risk estimation are conducted to estimate the health risk to humans potentially exposed to PCE at the site. Finally, the HHRA concludes with an uncertainty analysis that considers each step of the process that is used to estimate the human health risk due to exposure to PCE.

The VA, working collaboratively with UDEQ, EPA, Salt Lake City, and the Salt Lake County Health Department, will use the results of the HHRA described in this work plan as an aid in making decisions regarding actions necessary to manage risk related to PCE at the East Side Springs.

This section describes how the contaminant select process, exposure assessment, toxicity assessment, and risk description will comprise the core the quantitative HHRA. In the process of developing this work plan, certain conclusions were made about matters such as the completeness or significance of certain potential exposure pathways. For example, the uptake of VOCs from groundwater into homegrown vegetables and subsequent consumption is a plausible exposure scenario. However, current information about site conditions and scientific knowledge about this potential pathway show that it is likely to result in estimated health risks that are far below target levels established in the applicable rules and guidance. Therefore, this work plan recommends excluding this pathway from the quantitative risk assessment so that HHRA effort can focus on more significant pathways that will play a larger role in making site management decisions.

These types of analyses and recommendation will result in a more efficient HHRA. However, should changes to the conceptual site model or new scientific information becomes available during the RI that challenge the assumptions underlying such recommendations, the HHRA will incorporate this new information and incorporate exposure pathways that are likely to contribute significantly to overall estimated risks.

4.1 Contaminants of Concern

PCE, TCE, and their principal degradation products in water (cis- and trans-1,2-dichloroethene [DCE], vinyl chloride [VC]) have been selected as the contaminants of concern. In addition, 1,4-dioxane is included at the request of EPA because of its use historically as a stabilizer for chlorinated solvents, notably 1,1,1-trichloroethane. However, because (1) there is no knowledge of 1,1,1-trichloroethane use associated with historical VA operations; and (2) 1,4-dioxane was not commonly used in association with PCE. Other analytes included in the site analytical dataset will be deemed not attributable to the site based solely on the fact that they are not PCE daughter products.

4.2 Exposure Assessment

Exposure assessment is a multistep process that allows for the development of estimates for human exposure to a COPC—in this case, PCE and potentially its daughter products in groundwater, surface water, soil vapor, and indoor air. The exposure assessment is based on site-specific conditions, called "exposure settings" in this work plan, that affect the extent of a receptor's exposure to the media containing COPCs. Once the potential setting is understood, the specific routes (or exposure pathways) by which humans can make contact contaminated media are described. Then, the potential concentration of PCE and degradation products to which a human could be exposed by each pathway is developed. The relationships among setting, pathways, and concentration are described in a series of equations that estimate the human exposure to media containing COPCs at AOU-1 through applicable intake routes (e.g., inhalation).

There must be a complete exposure pathway between the contaminated media and the human receptor for a potential human health risk to exist due to the presence of a chemical in the environment. If complete pathways are shown to exist, it is necessary to estimate the amount of contaminant a representative receptor could be exposed to during its lifetime to estimate the degree of risk associated with the contaminated media. The HHRA will incorporate the exposure assessment methods and assumption described in this section, which includes the following elements: (1) a description of the exposure setting and identification of appropriate human receptors; (2) identification of potentially complete exposure pathways and assessing their significance; (3) a description of appropriate contaminant concentration terms that account for each type of contaminated media and the significant exposure pathways; and (4) showing the methods for quantifying lifetime exposures.

The exposure estimates will be based on an RME, which is defined by EPA as "the highest exposure that is reasonably expected to occur at a site." The RME is not meant to be an upper-bound exposure estimate wherein each of the underlying factors is selected to result in the highest possible exposure. EPA rejected the upper-bound approach in favor of the RME approach because the upper-bound approach can result in exposure estimates that may be above the range of possibility (EPA, 1989).

The RME approach provides estimates covering the general population as well as sensitive subpopulations, such as those who may spend more time in an exposure setting or have greater-than-typical contact with contaminated media. The RME reasonably bounds exposures for potential sensitive subpopulations.

4.2.1 Exposure Setting

The HHRA will incorporate the qualitative site evaluation described in the following paragraphs, including (1) the location of contamination; (2) physical characteristics; (3) current and reasonable future land uses; and (4) potentially exposed populations. The purpose of this evaluation will be to identify a representative range of human receptors to include in the HHRA.

The AOU-1 portion of the 700 South 1600 East PCE Plume is currently developed, with well-established residential neighborhoods (East Central and Yalecrest), a public high school, several small retail shops (a convenience store, an automotive service station, and a coffee shop), churches, and daycare centers. The public land area overlying AOU-1 is accessible to residents and visitors due to the location in an urban setting beneath multiple publically owned lands and roads. The residential areas where the East Side seeps discharge PCE- and TCE-

containing water are also readily accessible to residents and visitors. Salt Lake City's Master Plan (Salt Lake City, 2005) shows that future land use at AOU-1 is consistent with current land use.

4.2.3 Exposure Pathways

For exposure to occur, a complete pathway must exist by which contamination moves from the contaminated media and is ingested, inhaled, or dermally absorbed by a receptor. An exposure pathway will be considered **potentially complete** in the following situations:

- Surface water, soil, groundwater, soil vapor, or indoor air is contaminated with PCE, TCE, cis-1,2-DCE, VC, or 1,4-dioxane.
- A mechanism exists to retain the contamination at its current location where exposure could occur, or a transport mechanism exists that can move the contaminants to another location where exposure could occur—when transport occurs, the primary contaminated medium and the exposure medium may be different, as in the case of airborne volatiles derived from contaminated groundwater.
- A point of potential human contact with a contaminated medium exists.
- A route for chemical intake by a receptor (e.g., ingestion, inhalation, and dermal contact) exists at the exposure point.

If one of these factors is missing, the exposure pathway is incomplete and does not pose a health hazard. In addition, cases may exist in which a pathway is hypothetically complete but is not likely to result in significant exposure. The term "significant" in this case means that estimated lifetime exposures could result in estimated excess lifetime cancer risks (ELCRs) in excess of 1×10^{-6} or a non-cancer hazard quotient (HQ) above 1. These are the risk management criteria established in the National Oil and Hazardous Substance Contingency Plan (NCP; 40 *Code of Federal Regulations* [CFR] Section 300).

Figure 3-1 is a conceptual site exposure model (CSEM) showing the plausible potential exposure pathways for AOU-1 and identifies their potential completeness and significance. The CSEM identifies those pathways that are potentially complete and will be quantitatively evaluated in the HHRA. Consistent with the concept of an AOU, the CSEM focuses on potential current, plausible exposure pathways between known contaminated media and actual receptors. As such, hypothetically complete, future exposure pathways, such as ingestion of groundwater through tap water, uses are not addressed as part of AOU-1 but will be addressed as part of the baseline risk assessment for the broader 700 South 1600 East PCE Plume.

4.2.3.1 Vapor Intrusion

The CSEM identifies AOU-1 shallow, VOC-impacted groundwater as the primary contaminated media from which subsequent impacted media are derived. VOCs present at the water table in groundwater may volatilize into soil gas where it may enter occupied structures through vapor intrusion pathways. Currently, insufficient information exists to assess whether this pathway is actually complete. However, known detections of PCE at or near water table at concentrations of EPA's residential vapor intrusion screening level for PCE (http://www.epa.gov/oswer/vaporintrustion/documents/VISL-Calculator.xlsm) suggests that further assessment of vapor intrusion as a potentially complete exposure pathway is warranted.

4.2.3.2 Potentially Complete but Insignificant Exposure Pathways

Field observations show the presence of seeps and springs along the AOU-1 hillside (Figure 3-2) and samples collected from these surface water features had detectable concentrations of PCE (UDEQ, 2012). It is plausible that people could be exposed directly to this surface water, to surface soil that has adsorbed VOCs from the surface water, or to outdoor air impacted by volatilization or emission of particulates from contaminated soil. In addition, homegrown produce could be irrigated with VOC-impacted water and uptake VOCs. Each of these potentially complete exposure pathways is discussed in more detail in the following paragraphs. As shown on the CSEM, analysis of these pathways shows that they are unlikely to contribute significantly to human health risks.

Surface Water. People could be exposed directly to contaminated surface water while doing yard work, for example. In this case, VOCs could be absorbed through the skin of the hands or feet (dermal contact) or ingested through incidental contact between the hand and mouth. Inhalation exposures could occur from outdoor air receiving VOCs through volatilization from surface water.

Screening levels were calculated for this scenario based on EPA's RSL level online calculator tool (EPA 2014a). Only dermal exposures were considered for the surface water scenario. This is because the oral and inhalation pathways for exposure to VOCs daylighting in seeps and springs are accounted for with the soil exposure pathways. In other words, the VOCs in water are assumed to adsorb to soil to which residents could be exposed through incidental soil ingestion or volatilization and particulate emissions to air.

The exposure factors for surface water exposures (duration, frequency, etc.) were set at values intended to represent conservative estimates for a resident contacting spring or seep water with their hands and feet while doing yard work or gardening. It was assumed that someone could be in contact with the water 12 times per month (roughly 3 times per week) for the 8 non-winter months of the year with each event lasting one-half hour. This is likely greater than a reasonable maximum exposure because it is unlikely a resident would spend that much time in direct contact with PCE-impacted surface water. Attachment 2 summarizes the assumptions, methods, and screening levels for this scenario. The known VOC surface water concentration at AOU-1 (Table 1-1) are far below the site-specific screening levels and thus, the surface-water direct-contact pathway is considered *potentially complete but insignificant* on the CSEM.

Soil. VOCs in seeps and springs could partition to organic matter in soil, which residents could contact while doing yard work, gardening, or other outdoor activities. This pathway was assessed by calculating the soil concentrations corresponding to known AOU-1 surface water concentrations (see Attachment 3) using a linear soil-water portioning coefficient (Kd). The Kd values were derived from the EPA RSL tables. These estimated soil concentrations were then compared to the residential soil RSLs (EPA 2014c) and shown to be orders of magnitude below the RSLs. Thus, the surface-water direct-contact pathway is considered *potentially complete but insignificant* on the CSEM.

Homegrown vegetables. It is possible that garden plants irrigated with water from the seeps and springs could uptake VOCs, which could then make up a portion of a resident's diet. Two lines of evidence were considered in assessing the potential significance of this exposure pathway, namely, (1) scientific literature on VOC plant uptake and (2) modeling of potential plant uptake and dietary exposure.

Researchers at Utah State University conducted multi-year field and laboratory studies to assess the uptake of TCE into edible and non-edible plant portions (Doucette et al., 2007). Samples were collected from residential plots with shallow groundwater with TCE concentrations up to 300 µg/L. While TCE was found in tree trunks, showing that plant uptake was occurring, TCE was not detected above 0.1 µg/kg (fresh weight) in edible fruits and vegetables, including apples, peaches, tomatoes, and carrots. A concurrent laboratory study using fruit trees irrigated with radiolabeled TCE (500 µg/L) likewise did not detect TCE in the edible fruits. These finding are relevant to PCE due to the PCE's and TCE's similar chemical structure and physical properties and they suggest that detectable fruit and vegetable uptake of PCE and its chlorinated-ethane daughter products is unlikely at AOU-1.

To explore the question of uptake into homegrown produce further, two empirical models recommended by EPA (EPA 2005) were used in conjunction with estimates of both aboveground and belowground vegetable consumption to calculated conservative screening levels for irrigation water. The Travis & Arms model and the Briggs model were used as described in Attachment 4. Estimates of the potential homegrown produce ingestion rates were based on values in EPA's Exposure Factors Handbook (EFH) (EPA 2011). The residential lots in AOU-1 are typically in the range of 0.1 to 0.2 acre, most of which is consumed by structures, driveways, and non-garden landscaping. Therefore, it is unlikely that the national statistics in the EFH overestimate consumption rates for an urbanized environment such as AOU-1, which also has a shorter growing season than many of the regions included in the EFH due to the latitude and elevation of AOU-1.

Attachment 4 summarizes the equations, assumptions and results of the homegrown produce screening level calculations. The lowest PCE screening level value of 300 µg/L is at least 15 times higher than concentrations detected in surface water and shallow groundwater at AOU-1. As noted previously, the partitioning models and exposure assumptions likely result in overestimation of potential exposures. In addition, the screening levels do not account for VOC mass losses associated with (1) water agitation and increased volatilization during the irrigation process; (2) plant transpiration and metabolism of VOCs; and (3) food preparation (e.g., peeling, cooking, and canning). Based on (1) the two lines of evidence presented; (2) the multiple levels of conservatism incorporated into this assessment; and (3) current site knowledge, the homegrown produce pathway is considered *potentially complete but insignificant* on the CSEM.

4.2.4 Exposure Point Concentrations

The EPCs are the contaminant concentration in the exposure medium a receptor may contact over the exposure period. For AOU-1, validated VOC analytical results from indoor air samples collected during the RI will be the basis of the EPCs. In cases where multiple results are available for the same VOC at a particular building due to multiple sampling locations or events, EPCs representing the minimum and maximum concentrations will be used. This will provide risk managers with a sense of the range of potential exposures and associated risks. It is not expected that a given VOC and building will have sufficient results to calculate central tendency concentrations such as the mean or upper confidence limit on the mean.

4.2.5 Quantification of Exposure

RME estimates will be calculated using methods described in EPA's RAGS series of guidance—in particular, RAGS Part A (General) [REF] and Part F (Inhalation) [REF]. Exposure factors will be selected such that the combination of the factors results in an exposure estimate

that reflects a reasonable maximum case. By design, the estimated RME intakes will be higher than those expected to be experienced by most of the exposed population.

For the vapor intrusion inhalation pathway, a lifetime averaged exposure concentration will be estimated from exposure models that combine various exposure factors related to behavior, such as exposure time, frequency, and an exposure averaging time.

Residential exposures will be age weighted (assuming 6 years as a child and 20 years as an adult) for a total exposure duration of 26 years (EPA, 2014e). Separate exposure equations are provided in the following paragraph for the adult (industrial/school worker) and age-weighted (residential) scenarios.

The variables common to most of the exposure quantification calculations include the following:

- **Exposure Duration (ED)** (years): The number of years that a receptor is potentially exposed to contamination.
- **Exposure Frequency (EF)** (days per year): The number of days per year a receptor spends in the exposure location.
- **Exposure Time (ET)** (hours per day): The amount of time a receptor spends in an exposure setting on a daily basis (e.g., inside a building); used for inhalation exposures.
- **Averaging Time (AT)** (days): For cancer effects, the dose (oral) or concentration (inhalation) averaged over an assumed lifetime of 70 years (25,500 days); non-cancer doses averaged over the period of exposure.

These common variables may be receptor or age specific. The value assigned to each variable for these specificities is presented in and are consistent with EPA's most recent guidance (EPA, 2014f). Equations 3-1 and 3-2 summarize the general approach to incorporating the exposure to estimate the lifetime average exposure concentration for use in estimating cancer and non-cancer risks. Certain calculations for TCE and VC are different than the general approach shown below due to the underlying toxicity evaluation approach (presented in Attachment 5).

Equation 3-1: Industrial/commercial Indoor Inhalation—Adult

$$\frac{C_{Air} \times ET \times 1/24 \text{ hours/day} \times EF \times ED}{AT \times 365 \text{ days/year}} = Conc_{LifeAvg}$$

Equation 3-2: Residential Indoor Inhalation—Age weighted

$$\frac{C_{Air} \times ET_{Child} \times 1/24 \text{ (day/hour)} \times EF_{Child} \times ED_{Child}}{AT \times 365 \text{ days/year}} +$$

$$\frac{C_{Air} \times ET_{Adult} \times 1/24 \text{ (day/hour)} \times EF_{Adult} \times ED_{Adult}}{AT \times 365 \text{ days/year}} = Conc_{LifeAvg}$$

where:

$Conc_{LifeAvg}$ = Lifetime averaged concentration (milligram per cubic meter [mg/m^3]); receptor, age, and analyte specific

C_{Air} = VOC concentration in air due to vapor intrusion (mg/m^3)

ET = Exposure time (hours/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (years)

Table 3-1 summarizes the values for the exposure factors shown in the preceding equations.

4.3 Toxicity Assessment

The toxicity assessment is also a multistep process that allows for estimation of potential human health effects due exposure to the COPCs. The toxicity factors inherent to each COPC, combined with the results of the exposure assessment based on site-specific conditions, allow for an overall estimate of non-carcinogenic hazards and carcinogenic health risks associated with exposure COPCs at AOU-1.

The relationship between the magnitude of exposure to a chemical from environmental media and the likelihood of adverse health effects to potentially exposed populations will be incorporated into the toxicity assessment step. The toxicity assessment will provide, where possible, a numerical estimate of the increased likelihood of adverse effects associated with chemical exposure (EPA, 1989) as discussed in the following subsections.

4.3.1 Hazard Characterization

Hazard characterization identifies the types of toxic effects a chemical can exert. For the human health toxicity assessment, toxicity effects will be divided into two broad categories—non-carcinogenic effects and carcinogenic effects. This classification is selected because health risks will be calculated in a different manner for carcinogenic and non-carcinogenic effects, and toxicity values are based on one or both of these classifications.

Carcinogens are those chemicals known or reasonably suspected to cause cancer following exposure. Non-carcinogenic effects cover a wide variety of systemic effects, such as liver toxicity or developmental effects. Some chemicals (such as PCE) are capable of eliciting both carcinogenic and non-carcinogenic responses and will be evaluated for both. Information considered in assessing carcinogenicity includes human studies of the association between cancer incidence and exposure, as well as long-term animal studies under controlled laboratory conditions. Other supporting evidence considered includes short-term tests for genotoxicity, metabolic and pharmacokinetics properties, toxicological effects other than cancer, structure-activity relationships, and physical and chemical properties of the chemical.

For non-cancer effects, toxicity values will be derived based on the critical toxic endpoint (i.e., the most sensitive adverse effect following exposure). These potential non-cancer effects will be assessed based on data from human exposures or from controlled laboratory studies.

4.3.2 Toxicity Values

Inhalation reference concentrations (RfCs) will be used to evaluate potential adverse non-cancer health effects (i.e., hazards). Inhalation unit risk (IUR) factors will be used to evaluate potential cancer risks. A hierarchy of sources for toxicity values is presented in the User's Guide for the RSL Table (EPA, 2014b). The following hierarchy will be used for the HHRA and includes the following tiers (in order of preference):

- **Tier 1: EPA's Integrated Risk Information System (IRIS).** IRIS is an online database that contains EPA-approved reference doses (RfDs), RfCs, IURs, and slope factors. It also contains health risk and EPA regulatory information on specific chemicals. The IRIS database is available online (EPA, 2014c through the EPA National Center for Environmental Assessment in Cincinnati, Ohio. RfDs and slope factors have undergone extensive review over many years and are recognized as high-quality, agency-wide consensus information.
- **Tier 2: EPA's Provisional Peer-reviewed Toxicity Values.** The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Assessment Technical Support Center develops provisional peer-reviewed toxicity values on a chemical-specific basis when requested by EPA's Superfund Program.
- **Tier 3: Other Peer-reviewed Toxicity Values.** Tier 3 includes additional EPA and non-EPA sources of toxicity information. EPA recommends using Tier 3 sources that have a clear and transparent basis for toxicity values and are publicly available. Examples of Tier 3 sources include the following:
  - ATSDR minimal risk levels.
  - California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, *Toxicity Criteria Database* (California Environmental Protection Agency, 2003).
  - EPA's Health Effects Assessment Summary Tables (HEAST) (EPA, 1997)—Provided by EPA OSWER, HEAST is a compilation of toxicity values published in various health effects documents issued by EPA. HEAST provides a listing of provisional RfDs and slope factors that have undergone agency review but have not achieved agency-wide consensus.

4.3.3 Non-cancer Effects

Non-cancer inhalation toxicity will be quantified through use of inhalation RfCs. The RfC has units of mg/m^3. As defined in RAGS Part F, the RfC is "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime." The RfC is derived after a review of the health effects database for a chemical and after identification of the most sensitive and relevant endpoint along with the principal study or studies demonstrating that endpoint. EPA chemical managers use uncertainty factors to account for recognized uncertainties in the extrapolations from the experimental data conditions to an estimate appropriate to the assumed human scenario (EPA, 2009a).

RfCs that will be applied in the HHRA are summarized in Table 3-2**.**

4.3.4 Cancer Effects

Inhalation-related carcinogenicity is quantified through use of the IUR factor. The IUR has units of $(mg/m^3)^{-1}$, or the inverse units of air concentration. By convention, IUR is often tabulated using micrograms instead of milligrams (i.e., $[\mu g/m^3]^{-1}$), but the milligram units were used in this report to maintain consistent mass units across all exposure pathways. The IUR is defined in RAGS Part F as "the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air" (EPA, 2009). Similar to the oral slope factor, the IUR is calculated by a linear extrapolation from exposures observed in the animal or human occupational study. The cancer slope factors and unit risk factors that will be applied in the HHRA are summarized in Table 3-5.

4.3.5 Non-cancer Hazard Estimation

The potential for individuals to experience effects other than cancer will be evaluated by comparing a lifetime averaged inhalation exposure concentration over a specific exposure period with an RfC developed for a similar exposure period. This comparison will take the form of a ratio termed the HQ, which will be calculated by dividing the lifetime average concentration by the RfC as shown in Equation 3-3:

Equation 3-3: Hazard Quotient

INHALATION

$$\frac{Conc_{LifeAvg}}{RFC_i} = HQ$$

where:

RFC_i = Inhalation reference concentration for chronic exposure (mg/m^3); chemical specific

HQ = Non-cancer HQ (unitless); receptor, age, exposure pathway, and analyte specific

The HQ is not a mathematical prediction of the incidence or severity of effects (i.e., probability) but is instead a numerical index (i.e., a ratio) that can be used to determine whether the estimated exposure may present a potential health threat. When the daily intake or estimated lifetime exposure concentration of a chemical exceeds the RfD or RfC (i.e., HQ greater than 1), a potential exists for non-cancer health effects.

The potential cumulative non-cancer effects from exposure to multiple chemicals will be addressed by calculation of a hazard index (HI), which is the sum of the HQ values. Uncertainties introduced by this simple summation approach will be addressed during the uncertainty evaluation.

4.3.6 Cancer Risk Estimation

For carcinogens, the ELCR represents the incremental probability that a representative receptor will develop cancer over a lifetime because of exposure to a particular carcinogen or a set of carcinogens (EPA, 1989). Site-related ELCRs will be calculated using Equation 3-4:

Equation 3-4: Excess Lifetime Cancer Risk

INHALATION

$$Conc_{LifeAvg} \times IUR = ELCR$$

where:

IUR = Inhalation unit risk $(mg/m^3)^{-1}$; chemical specific

ELCR = Excess lifetime cancer risk (unitless); receptor, age, exposure pathway, and analyte specific

The potential cumulative cancer effects from exposure to multiple chemicals will be addressed by calculating a cumulative ELCR, which is the sum of the ELCR values for individual chemicals. Uncertainties introduced by this simple summation approach will be addressed during the uncertainty evaluation.

4.3.7 Risk Management Criteria

The NCP (40 CFR Part 300) establishes acceptable risk criteria for “systemic toxicants” (non-cancer effects) and for carcinogens. The calculated risk results will be presented in the context of the acceptable levels described in the NCP. For non-cancer effects estimated using the exposure and toxicity evaluation methods described previously, the acceptable exposure level would result in a hazard index less than one. Hazard index values greater than one generally indicate the need for remedial action.

The NCP specifies an acceptable ELCR range of 10^{-6} to 10^{-4} (1 per 1 million to 1 per 10,000), as opposed to a single value. Cumulative ELCRs less than 10^{-6} typically indicate no further action will be required. Cumulative ELCRs greater than 10^{-4} exceed the acceptable range and usually indicate the need for remedial action. In practice, if cumulative ELCRs are between 10^{-6} and 10^{-4}, risk managers will weigh site-specific information in determining the need for remedial action, including exposure factors (such as exposure pathways and exposure to sensitive persons), technical factors (such as detection limits and background levels), and uncertainty factors (e.g., reliability of data, weight of scientific evidence regarding chronic health effects).

4.4 Uncertainty Analysis

The uncertainty analysis will present a discussion of the assumptions and procedures that introduce the greatest amount of uncertainty in the HHRA, as well as their effect on the estimates of potential risk. The discussion of uncertainties will mostly be qualitative because there is usually not enough information to quantify their magnitude. The analysis will address uncertainties related to the major steps of the HHRA, including the following:

- data evaluation,
- exposure assessment,
- toxicity assessment,
- risk characterization.

The completeness and representativeness of the vapor intrusion characterization data will receive particular attention in the uncertainty analysis. The RI will include methods specifically developed to reduce uncertainties, including the following:

- Sampling of shallow groundwater and soil gas across AOU-1 to identify areas where the subsurface vapor source is sufficient to warrant targeted sampling of overlying structures.

- Indoor air sampling under (1) spring high water table conditions, and (2) during the heating season under to assess indoor air quality under to conditions that may increase vapor intrusion.
- Application of emerging technologies including real-time, sensitive chemical analysis and building depressurization to increase confidence regarding the occurrence of vapor intrusion and to identify structures impacted by background indoor VOC sources.

The uncertainty analysis will summarize the sources and magnitude of HHRA uncertainties and provide guidance to risk managers and other on how the uncertainties might affect site-management decisions.

4.5 Risk Description

The risk description section will provide a narrative interpretation of these results for use by risk managers and other stakeholders involved in the remedy selection process.

A separate subsection presenting the results for each type of receptor and exposed media will be included in this section.

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TABLE 3-1 Exposure Factors

Exposure Parameter	Abbreviation	Units	Industrial Worker	Source	Resident	Source
Exposure Frequency (Adult)	EF	day/yr	250	USEPA, 2014	350	USEPA, 2014
Exposure Frequency (Child)	EF	day/yr	-	USEPA, 2014	350	USEPA, 2014
Exposure Time (Adult)	ET	hr/day	8	USEPA, 2014	24	USEPA, 2014
Exposure Time (Child)	ET	hr/day	-	USEPA, 2014	24	USEPA, 2014
Exposure Duration (Adult)	ED	yr	25	USEPA, 2014	20	USEPA, 2014
Exposure Duration (Child)	ED	yr	-	USEPA, 2014	6	USEPA, 2014
Averaging Time for carcinogens	ATc	yr	70	USEPA, 2014	70	USEPA, 2014
Averaging Time for noncarcinogens	ATnc	yr	25	USEPA, 2014	26	USEPA, 2014
Notes:						
hr = hour						
yr = year						
References:						
U.S. Environmental Protection Agency (USEPA). 2014. *Memorandum Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*).Office of Solid Waste and Emergency Response Directive 9200.1-120. February.						

TABLE 3-2 Toxicity Factors

Analyte	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Reference	Inhalation Reference Concentration (mg/m^3)	Reference
Tetrachloroethene	2.6E-07	IRIS	4.0E-02	IRIS
Trichloroethene	4.1E-06	IRIS	2.0E-03	IRIS
Vinyl chloride	4.4E-06	IRIS	1.0E-01	IRIS
cis-1,2-Dichloroethene				
trans-1,2-Dichloroethene				
1,4-Dioxane	5.0E-06	IRIS	3.0E-02	IRIS

Notes:

$\mu g/m^3$ = micrograms per cubic meter

IRIS = Integrated Risk Information System (http://www.epa.gov/iris/)

mg/m^3 = milligrams per cubic meter

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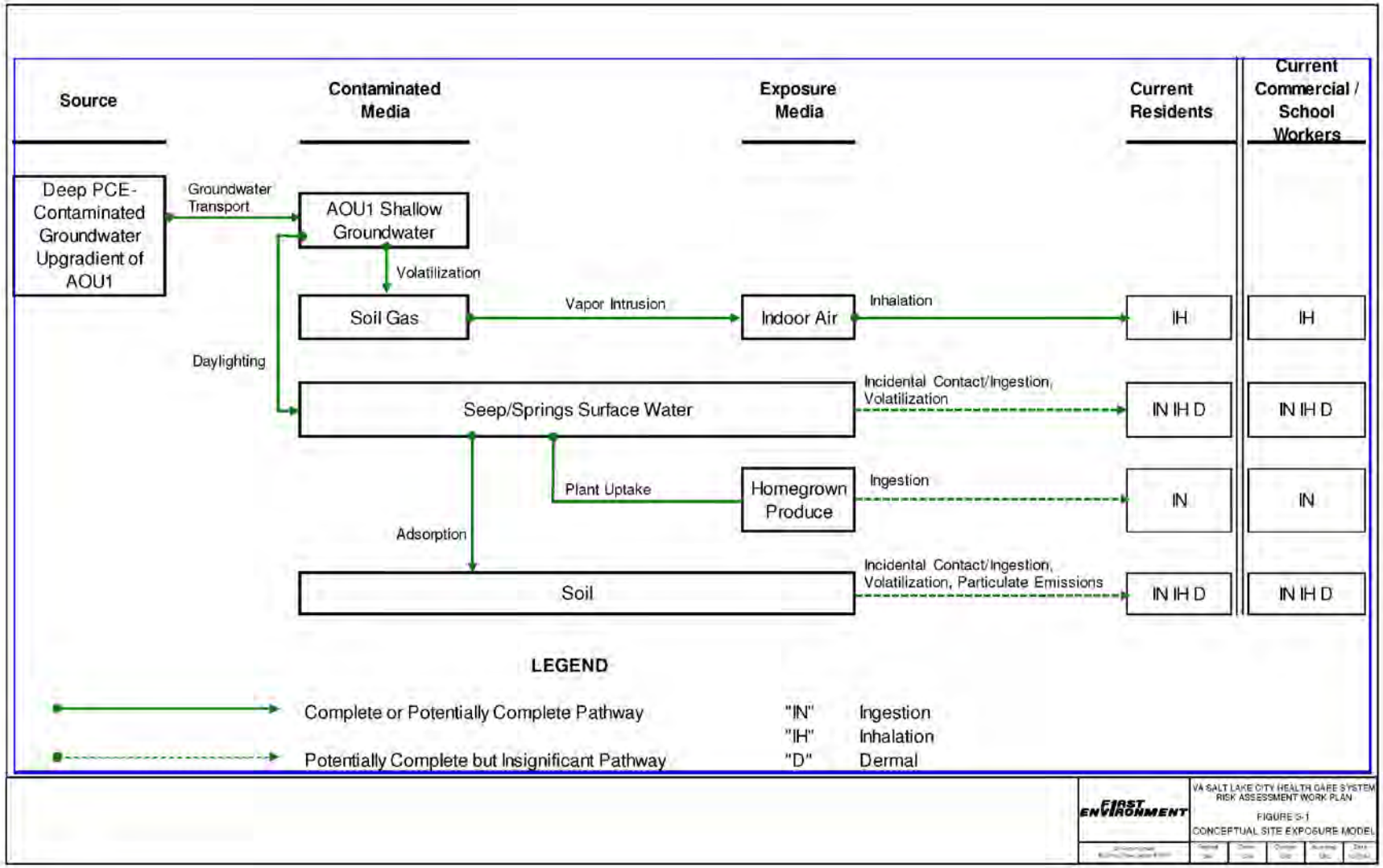
FIGURE 3-1 Conceptual Site Exposure Model



FINAL

FIGURE 3-2 Seep and Spring Photographs

FIRST ENVIRONMENT
91 Fulton Street
Boonton, New Jersey 07005

VA SALT LAKE CITY HEALTH CARE SYSTEM
RISK ASSESSMENT WORK PLAN
FIGURE 3-2
SEEP AND SPRING PHOTOGRAPHS

Revised	Drawn	Checked	Approved	Date
	SW	DPD	DPD	10/31/14

5.0 Ecological Risk Assessment

The potential risks for ecological receptors that may be exposed to target analytes (PCE, TCE, DCE, and VC) in surface water and groundwater within AOU-1 Plume were evaluated as part of this HHRA Work Plan to determine if potential exposures to ecological receptors necessitate additional evaluation in the RI. This section also present information regarding domestic dogs in response to concerns expressed by stakeholders.

A conservative ecological risk screening was conducted for surface water and groundwater samples collected within the AOU-1 Plume. These data are summarized in Table 1-1.

Ecological risk assessments are completed in a phase manner whereby each phase is more focused than the previous phase (EPA, 1998 and 2001). Sources of input parameters, screening levels, and toxicity values, as well as screening methods, are those used in full baseline ecological risk assessments.

5.1 Ecological Screening

Ecological Setting. AOU-1 lies within an urban/residential setting. Properties include residences, schools, churches, and parks. Habitat is very patchwork and includes ruderal, park, and urban/residential landscaping. Seeps and springs are found within AOU-1; however, they are seasonal and would not be available to ecological receptors year-round. Seeps/springs generally occur within the existing landscaping, but limited non-native habitat may occur around the larger seeps and springs. Overall, native habitat is highly altered and very limited and what remains is primarily attractive to those ecological receptors easily adapted to urban/residential settings (e.g., songbirds and small mammals).

It is also plausible that some PCE could reach the Jordan River located several miles west of AOU-1 through existing utility pipelines. Some of the surface water emanating as seeps and spring within AOU-1 is captured in the Salt Lake City storm drain system, which is conveyed by piping to discharge into the Jordan River. The COPC concentration shown on Table 1-1 will greatly overestimate potential the concentrations in the Jordan River due to (1) volatilization during conveyance, (2) dilution during conveyance, and (3) dilution in the river.

Exposure Assessment. Exposure pathways refer to the media and routes through which PCE and its degradation products may reach ecological receptors. Potential exposure pathways must meet specific criteria for an exposure to occur. Aside from necessary habitat for ecological receptors, a complete exposure pathway must include the following elements:

- contaminant source (e.g., chemicals in groundwater);
- mechanism for contaminant release and transport (e.g., groundwater daylighting to surface);
- exposure point (e.g., seeps/springs);
- exposure medium (e.g., surface water);
- feasible route of exposure (e.g., ingestion);
- receptor (e.g., bird, dog, or other).

Many of the seeps and springs and springs are seasonal. Wet areas observed in the spring were not visible in late summer. Thus, ecological exposures in many instances will be of short annual duration, between the spring thaw and when the seeps and springs dry up.

Exposure pathways evaluated for AOU-1 include the following:

- direct contact with water in seeps/spring by aquatic organisms (e.g., plants, invertebrates, amphibians);
- direct contact with water in seeps/spring by plants;
- incidental ingestion of water from seeps/springs by urban wildlife including small birds (American robin) and mammals (deer mouse);
- incidental ingestion of water from seeps/springs by domestic pets (dogs).

Typically, ecological risk assessments do not evaluate potential risks to domesticated species. However, given that the site is predominantly urban/residential, domesticated dogs are included in this ecological screening as they are of local concern.

Conservative exposure assumptions used in this evaluation are as follows:

- receptors are exposed to the maximum detected concentrations of target analytes;
- birds and mammals receive 100 percent of their daily intake of water from seep/springs.

These assumptions are used solely for the purpose of this initial assessment. These assumptions are highly conservative because (1) maximum concentrations area applied; (2) the seep/springs dry up later in the year in many cases; (3) birds and mammals are mobile and will obtain water from a variety of sources; and (4) the primary source of water for domesticated animals is from potable water sources unaffected by groundwater contamination.

Ecological Effects Assessment. Surface water screening levels include media benchmarks and risk-based screening levels (RBSLs), collectively referred to hereafter as surface water screening levels. Benchmarks were obtained from the literature and RBSLs were back calculated as needed for the receptors being evaluated.

Surface water benchmarks for aquatic organisms and plants were obtained from the following (note: national recommended water quality criterion were not available for the analytes of interest):

- Los Alamos National Laboratory (LANL) surface water screening levels (LANL, 2008);
- EPA Region 5 Ecological Screening Levels (EPA, 2003);
- Oak Ridge National Laboratory Tier II Chronic Surface Water Benchmarks (Suter and Tsao, 1996);
- Oak Ridge National Laboratory Toxicological Benchmarks for Terrestrial Plants (Efroymson et al., 1997).

RBSLs for birds and mammals were back-calculated using an iterative function (GoalSeek) in Excel. Species-specific exposure factors and chemical toxicity reference values are summarized on Table 4-1 and Table 4-2, respectively. RBSLs for bird and mammal receptors

were back calculated through the following set of equations. Resulting RBSLs are shown in Table 4-3:

$$[Water]\ x\ WIR = \ Water\ Ingestion\ Dose$$

$$\frac{Water\ Ingestion\ Dose}{Receptor\ TRV} = \ HQ$$

$$[Water]\ that\ results\ in\ HQ\ of\ 1\ \ = \ RBSL$$

where:

[Water]	=	Water concentration (milligrams per liter)
WIR	=	Water ingestion rate (liters/kilogram body weight per day)
Water Ingestion Dose	=	Average daily dose of water intake (milligrams/kilogram body weight per day)
TRV	=	Toxicity reference value (milligrams/kilogram body weight per day)
HQ	=	Hazard quotient
RBSL	=	Risk-based screening level (milligrams per liter)

Surface water screening levels for all receptors are summarized in Table 4-4.

Risk Screening. The maximum detected concentrations in surface water and groundwater samples collected from AOU-1 were compared to the receptor-specific water screening levels (Table 4-5). Maximum detected concentrations and/or minimum method detection limits for non-detects did not exceed surface water screening levels for any of the evaluated receptors.

Ecological Risk Conclusions. A very conservative evaluation of potential risks was conducted using the available surface water (seeps/springs) and groundwater data for AOU-1 and a range of potential receptors that may be found in a residential setting. Maximum detected concentrations of the target analytes in groundwater and surface water did not exceed chronic and/or no-effect level based surface water screening levels for aquatic invertebrates, plants, birds, wildlife, or dogs.

In addition, PCE and its degradation products (TCE, DCE, and VC) are unlikely to pose an ecological risk due to the following:

- Analytes will begin volatilizing upon exposure to the atmosphere.
- Concentrations in surface water will undergo significant dilution in stormwater and tributary flows prior to reaching the Jordan River.

5.2 Scientific Management Decision Point

Based on the available site investigation data, compared to the water screening levels, additional evaluation of potential risks to ecological receptors at AOU-1 from PCE and its daughter products (TCE, DCE, and VC) in either surface water or groundwater is unwarranted and no further evaluation for ecological receptors is recommended. As with the HHRA, the assumptions in this work plan will be revisited following the completion of the RI data collection and before preparing the risk assessment report. The assumptions, methods, and conclusions will be updated if warranted due to significant changes in the conceptual site model.

TABLE 4-1 Exposure Factors for Representative Species

Species	Representative species	Exposure Factors					
		Body Weight			Ingestion Rate - water		
		Mean (kg)	Notes	Source	(L/kgbw-d)	Notes	Source
Birds							
American robin	--	0.079	breeding males and females	Wheelwright, 1986 in USEPA, 1993	0.136	allometric estimation for "all birds" normalized to L/kgbw-d	Calder and Braun, 1983 in USEPA, 1993
Mammals							
Deer mouse	--	0.018	mean body weight from field collected specimens	Nagy, 2001	0.148	allometric estimation for "all mammals" normalized to L/kgbw-d	Calder and Braun, 1983 in USEPA, 1993
Dog - small/toy	Pomeranian	1.87	3 to 7lbs (mean 5 lbs)	AKC, 2014	0.093	allometric estimation for "all mammals" normalized to L/kgbw-d	Calder and Braun, 1983 in USEPA, 1993
Dog - medium	Labrador retriever	24.3	55 to 75 lbs (mean = 65 lbs)	AKC, 2014	0.072	allometric estimation for "all mammals" normalized to L/kgbw-d	Calder and Braun, 1983 in USEPA, 1993
Dog - large	Great dane	54.1	110 to 180 lbs (mean = 145 lbs)	AKC, 2014	0.066	allometric estimation for "all mammals" normalized to L/kgbw-d	Calder and Braun, 1983 in USEPA, 1993
Notes:							
-- not applicable							
kg = kilograms							

L/kgbw-d = liters per kilogram body weidht per day							
lbs = pounds							
Calder and Braun 1983 water intake rates --> *WI(L/kgbw/day)* = *a*(kilograms body weight)^{b} / kilograms body weight							
Group	***a***	***b***					
birds	0.059	0.67					
mammals	0.099	0.9					
Sources:							
American Kennel Club (AKC). 2014. Onlne Breed Information. www.akc.org/breeds accessed October 22, 2014							
Calder, W. A. and E. J. Braun. 1983. Scaling of osmotic regulation in mammals and birds. *Am J. Physiol.* 244:R601-R606.							
Nagy, K.A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews, Series B: *Livestock Feeds and Feeding* 71:1R-12R.							
Sample, B. E., C. M., Opresko, and G. W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision.* Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp., ES/ER/TM-86/R3.							
U.S. Environmental Protection Agency (USEPA). 1993. *Wildlife Exposure Factors Handbook*. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a. December.							
Wheelwright, N. T. 1986. The diet of American robins: an analysis of U.S. Biological Survey reports. *Auk*, 103:710-735.							

TABLE 4-2 Toxicity Reference Values for Birds and Mammals

	Bird Toxicity Reference Values				Mammal Toxicity Reference Values			
Analyte[a]	**Low Toxicity Value (mg/kgbw/d)**	**Endpoint**	**Type**	**Source**	**Low Toxicity Value (mg/kgbw/d)**	**Endpoint**	**Type**	**Source**
1,2-Dichloroethene (total)	--	--	--	--	45.2	NOAEL	Chronic	Sample et al., 1996
1,4-Dioxane	--	--	--	--	9.6	NOAEL	Chronic	USEPA, 2014
Tetrachloroethene	--	--	--	--	1.4	NOAEL	Chronic	Sample et al., 1996
Trichloroethene	--	--	--	--	0.7	NOAEL	Chronic	Sample et al., 1996
Vinyl chloride	--	--	--	--	1.7	LOAEL	Chronic	Sample et al., 1996
Notes:								
-- not available								
LOAEL = lowest observed adverse effect level								
NOAEL = no observed adverse effect level								
Sources:								
Sample, B.E., C. M. Opresko, and G. W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision.* Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp., ES/ER/TM-86/R3.								
U.S. Environmental Protection Agency (USEPA). 2014. USEPA Integrated Risk								

	Bird Toxicity Reference Values				Mammal Toxicity Reference Values			
Analyte[a]	**Low Toxicity Value (mg/kgbw/d)**	**Endpoint**	**Type**	**Source**	**Low Toxicity Value (mg/kgbw/d)**	**Endpoint**	**Type**	**Source**
Information System (IRIS) database. Accessed online: http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList								

TABLE 4-3 Risk-based Screening Levels for Ingestion of Water

Analyte	Receptor	Exposure Parameters		SLERA Area Use Factor		Uptake from Water			No Effect Level TRV (mg/kgbw-d)	Target Hazard Quotient	Surface Water RBSL (mg/L)
		Body Weight (kg)	Water Intake (L/kgbw-d)			Surface Water Concentration (mg/L)	Water Ingestion Dose (mg/kgbw-d)			No Effect Level	
1,2-Dichloroethene (total)	American robin	0.079	0.136	1		--	--		--	--	--
1,4-Dioxane	American robin	0.079	0.136	1		--	--		--	--	--
Tetrachloroethene	American robin	0.079	0.136	1		--	--		--	--	--
Trichloroethene	American robin	0.079	0.136	1		--	--		--	--	--
Vinyl chloride	American robin	0.079	0.136	1		--	--		--	--	--
1,2-Dichloroethene (total)	Deer mouse	0.018	0.148	1		305	45.2		45.2	1.0	305
1,4-Dioxane	Deer mouse	0.018	0.148	1		65	9.6		9.6	1.0	65
Tetrachloroethene	Deer mouse	0.018	0.148	1		9.5	1.4		1.4	1.0	9.5
Trichloroethene	Deer mouse	0.018	0.148	1		4.7	0.70		0.7	1.0	4.7
Vinyl chloride	Deer mouse	0.018	0.148	1		11.5	1.7		1.7	1.0	11
1,2-Dichloroethene (total)	Dog - small/toy	1.87	0.093	1		486	45.2		45.2	1.0	486
1,4-Dioxane	Dog - small/toy	1.87	0.093	1		103	9.6		9.6	1.0	103
Tetrachloroethene	Dog - small/toy	1.87	0.093	1		15	1.4		1.4	1.0	15
Trichloroethene	Dog - small/toy	1.87	0.093	1		7.5	0.70		0.7	1.0	7.5
Vinyl chloride	Dog - small/toy	1.87	0.093	1		18.3	1.7		1.7	1.0	18

Analyte	Receptor	Exposure Parameters		SLERA Area Use Factor		Uptake from Water			No Effect Level TRV (mg/kgbw-d)	Target Hazard Quotient	Surface Water RBSL (mg/L)
		Body Weight (kg)	Water Intake (L/kgbw-d)			Surface Water Concentration (mg/L)	Water Ingestion Dose (mg/kgbw-d)			No Effect Level	
1,2-Dichloroethene (total)	Dog - medium	24.3	0.072	1		628	45.2		45.2	1.0	628
1,4-Dioxane	Dog - medium	24.3	0.072	1		133	9.6		9.6	1.0	133
Tetrachloroethene	Dog - medium	24.3	0.072	1		19	1.4		1.4	1.0	19
Trichloroethene	Dog - medium	24.3	0.072	1		10	0.70		0.7	1.0	10
Vinyl chloride	Dog - medium	24.3	0.072	1		23.6	1.7		1.7	1.0	24
1,2-Dichloroethene (total)	Dog - large	54.1	0.066	1		685	45.2		45.2	1.0	685
1,4-Dioxane	Dog - large	54.1	0.066	1		145	9.6		9.6	1.0	145
Tetrachloroethene	Dog - large	54.1	0.066	1		21	1.4		1.4	1.0	21
Trichloroethene	Dog - large	54.1	0.066	1		11	0.70		0.7	1.0	11
Vinyl chloride	Dog - large	54.1	0.066	1		25.8	1.7		1.7	1.0	26
Notes:											
BAF = bioaccumulation factor											
L/kgbw-d = liters per kilogram body weidht per day											
mg/kgbw-d = liters per kilogram body weidht per day											
mg/L = milligrams per liter											
RBSL = risk-based screening level											
SLERA = Screening-Level Ecological Risk Assessment											
TRV = toxicity reference value											

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TABLE 4-4 Surface Water/Seeps/Springs Screening Levels

Analyte	Water Screening Levels (mg/L)						
	Aquatic Organisms	Plants	American Robin	Deer Mouse	Dog - Small/Toy	Dog - Medium	Dog - Large
1,2-Dichloroethene (total)	0.59	100	trv	305	486	628	685
1,4-Dioxane	22	trv	trv	65	103	133	145
Tetrachloroethene	0.12	10	trv	9.5	15	19	21
Trichloroethene	0.35	10	trv	4.7	7.5	10	11
Vinyl chloride	0.93	trv	trv	11	18	24	26

Notes:

mg/L = milligrams per liter
TRV = toxicity reference value

Sources:

Aquatic organisms -
1,2-Dichloroethene (cis/trans) - Tier II values (Suter and Tsao, 1996)
1,4-Dioxane and vinyl chloride - Region 5 ESLs (USEPA Region 5, 2003)
Tetrachloroethene and trichloroethene - No effect level ESLs (LANL, 2011)

Plants - Efroymson et al., 1997

Birds - no TRVs available to backcalculate screening levels.

Mammals - Screening levels are backcalculated.

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TABLE 4-5 Groundwater and Surface Water Screening

Analyte	Maximum Concentration (mg/L)	Ecological Screening Levels (mg/L)						
		Aquatic Organisms	Plants	American Robin	Deer Mouse	Dog - Small/Toy	Dog - Medium	Dog - Large
Groundwater								
1,2-Dichloroethene (cis-)	<0.005	0.59	100	trv	305	486	628	685
1,2-Dichloroethene (trans-)	<0.005	0.59	100	trv	305	486	628	685
1,4-Dioxane[a]	<0.1	22	trv	trv	65	103	133	145
Tetrachloroethene	0.008	0.12	10	trv	9.5	15	19	21
Trichloroethene	0.013	0.35	10	trv	4.7	7.5	10	11
Vinyl chloride	<0.005	0.93	trv	trv	11	18	24	26
Surface Water								
1,2-Dichloroethene (cis-)	<0.005	0.59	100	trv	305	486	628	685
1,2-Dichloroethene (trans-)	<0.005	0.59	100	trv	305	486	628	685
1,4-Dioxane[a]	<0.1	22	trv	trv	65	103	133	145
Tetrachloroethene	0.02	0.12	10	trv	9.5	15	19	21
Trichloroethene	0.0046	0.35	10	trv	4.7	7.5	10	11
Vinyl chloride	<0.005	0.93	trv	trv	11	18	24	26

Notes:

< (for concentration field) = indicates that analyte was not detected above the minimum method detection limit (MDL)

<1 (for HQ field) = site concentration is below screening level

mg/L = milligrams per liter

HQ =

trv = no toxicity reference value available

a. The 1,4-Dioxane were rejected (flagged "R") during data validation

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Analyte	Maximum Concentration (mg/L)	No Effect Level Hazard Quotients						
		Aquatic Organisms	Plants	American Robin	Deer Mouse	Dog - Small/Toy	Dog - Medium	Dog - Large
Groundwater								
1,2-Dichloroethene (cis-)	<0.005	<1	<1	trv	<1	<1	<1	<1
1,2-Dichloroethene (trans-)	<0.005	<1	<1	trv	<1	<1	<1	<1
1,4-Dioxane[a]	<0.1	<1	trv	trv	<1	<1	<1	<1
Tetrachloroethene	0.008	<1	<1	trv	<1	<1	<1	<1
Trichloroethene	0.013	<1	<1	trv	<1	<1	<1	<1
Vinyl chloride	<0.005	<1	trv	trv	<1	<1	<1	<1
Surface Water								
1,2-Dichloroethene (cis-)	<0.005	<1	<1	trv	<1	<1	<1	<1
1,2-Dichloroethene (trans-)	<0.005	<1	<1	trv	<1	<1	<1	<1
1,4-Dioxane[a]	<0.1	<1	trv	trv	<1	<1	<1	<1
Tetrachloroethene	0.02	<1	<1	trv	<1	<1	<1	<1
Trichloroethene	0.0046	<1	<1	trv	<1	<1	<1	<1
Vinyl chloride	<0.005	<1	trv	trv	<1	<1	<1	<1

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ATTACHMENT 1

ATTACHMENT 2

Equations used to Evaluate Dermal Exposure to Surface Water

Equations used to Evaluate Dermal Exposure to Surface Water

While doing yard work, people could be exposed directly to contaminated surface water and volatile organic compounds could be absorbed through the skin of the hands or feet (dermal contact). Screening levels were calculated for this scenario based on the U.S. Environmental Protection Agency's (EPA's) regional screening level online calculator tool. The output from these calculations are provided in the attached tables.

Site-specific exposure factors were used in the calculation of the risk-based concentrations. The skin surface area for the hands and feet were used for these calculations based on the assumption that these body part could be in contact with seeps or springs during yard work. Based on values presented in the EPA's Exposure Factors Handbook (2011), 15 percent is a conservative estimate of the hands and feet percentage of total body area. Applying this percentage to the EPA's (2014) recommended total body area for a bathing scenario, yields 957 cubic centimeters (cm^2) for the child's skin surface area and 3,135 cm^2 skin surface area for adults.

It was assumed that that contact with the seep or springs water would occur 12 times per month (roughly 3 times per week) for the 8 non-winter months of the year. Each event would last one-half hour. This is likely greater than a reasonable maximum exposure because it is unlikely a resident would spend that much time in direct contact with tetrachloroethene-impacted surface water.

The following equations are used to determine a risk-based concentration associated with dermal exposure of contaminants of potential concern (COPCs) in surface water.

For organic chemicals, if $t_{event} > t^*$:

$$SL = \frac{DA_{event} x 1000 \ \frac{cm^3}{L}}{FAxK_p x[\frac{ET}{1+B} + 2xt_{event} x \frac{1+3B+3B^2}{(1+B)^2}]}$$

SL	=	Groundwater screening level (micrograms per liter [µg/L])
DA_{event}	=	Absorbed dose per event per area of skin exposed (milligrams per square centimeters [mg/cm^2]-event)
FA	=	Fraction absorbed (unitless)
K_p	=	Skin permeability constant for chemicals in groundwater (centimeters [cm]/hour)
ET	=	Exposure time (hours/event)
B	=	Dimensionless coefficient (cm/hour)
t_{event}	=	Exposure Time (hours)

If $t_{event} \leq t^*$

$$SL = \frac{DA_{event} x 1000 \ \frac{cm^3}{L}}{2xFAxK_p \sqrt{\frac{6xt_{event}xET}{\pi}}}$$

Where:

SL	=	Surface water screening level (µg/L)
DA_{event}	=	Absorbed dose per event per area of skin exposed (mg/cm^2-event)
FA	=	Fraction absorbed (unitless)
K_p	=	Skin permeability constant for chemicals in groundwater (cm/hour)
t_{event}	=	Exposure Time (hours)

Calculation of DA_{event} for noncarcinogens:

$$DA_{event} = \frac{THQxATx1000\ \frac{cm^3}{L}xBW}{\frac{1}{RfDxGIABS}xEVxEDxEFxSA}$$

Where:

DA_{event}	=	Absorbed dose per event per area of skin exposed (mg/cm^2-event)
THQ	=	Target Hazard Quotient
BW	=	Body Weight (kilograms [kg])
RfD	=	Reference Dose (milligrams per kilogram per day [mg/kg-day])
GIABS	=	Fraction of contaminant absorbed in gastrointestinal tract (unitless)
EV	=	Exposure Event (events per day)
ED	=	Exposure Duration (years)
EF	=	Exposure Frequency (days per year)
SA	=	Skin surface area (cm^2)

Calculation of DA_{event} for carcinogens:

$$DA_{event} = \frac{TRxATx1000\ \frac{cm^3}{L}xBW}{\frac{CSF}{GIABS}xDFW}$$

DA_{event}	=	Absorbed dose per event per area of skin exposed (mg/cm^2-event)
TR	=	Target Risk
CSF	=	Cancer Slope Factor (mg/kg-day)$^{-1}$
GIABS	=	Fraction of contaminant absorbed in gastrointestinal tract (unitless)
DFW	=	Age weighted water dermal contact factor (cm^2 - event/kg)

Calculation of Age weighted water dermal contact factor:

$$DFW = \frac{(EVcxEDcxEFcxSAc)}{BWc} + \frac{(EVaxEDaxEFaxSAa)}{BWa}$$

Where:

DFW	=	Age weighted water dermal contact factor (cm^2 - event/kg)
EVc	=	Child recreator event (events per day)
EDc	=	Child exposure duration (years)
EFc	=	Child exposure frequency (days per year)
SAc	=	Child skin surface area (cm^2)
EVa	=	Adult recreator event (events per day)

EDc	=	Adult exposure duration (years)
EFa	=	Adult exposure frequency (days per year)
SAa	=	Adult skin surface area (cm^2)

Site-specific

Recreator Equation Inputs for Surface Water

Variable	Value
TR (target cancer risk) unitless	1.0E-6
ED_{recw} (exposure duration - recreator) year	26
ED_{recwa} (exposure duration - adult) year	20
ED_{recwc} (exposure duration - child) year	6
ED_{0-2} (mutagenic exposure duration) year	2
ED_{2-6} (mutagenic exposure duration) year	4
ED_{6-16} (mutagenic exposure duration) year	10
ED_{16-30} (mutagenic exposure duration) year	10
THQ (target hazard quotient) unitless	1
LT (lifetime - recreator) year	70
EF (exposure frequency) day/year	96
EF_{recwa} (adult exposure frequency) day/year	96
EF_{recwc} (child exposure frequency) day/year	96
EF_{0-2} (mutagenic exposure frequency) day/year	96
EF_{2-6} (mutagenic exposure frequency) day/year	96
EF_{6-16} (mutagenic exposure frequency) day/year	96
EF_{16-30} (mutagenic exposure frequency) day/year	96
$ET_{recw-adj}$ (age-adjusted exposure time) hour/event	0.5
$ET_{recw-madj}$ (mutagenic age-adjusted exposure time) hour/event	0.5
ET_{recwa} (adult exposure time) hour/event	0.5
ET_{recwc} (child exposure time) hour/event	0.5
$ET_{recw0-2}$ (mutagenic exposure time) hour/event	.5
$ET_{recw2-6}$ (mutagenic exposure time) hour/event	.5
$ET_{recw6-16}$ (mutagenic exposure time) hour/event	.5
$ET_{recw16-30}$ (mutagenic exposure time) hour/event	.5
EV_{recwa} (adult) events/day	1
EV_{recwc} (child) events/day	1
EV_{0-2} (mutagenic) events/day	1
EV_{2-6} (mutagenic) events/day	1
EV_{6-16} (mutagenic) events/day	1
EV_{16-30} (mutagenic) events/day	1
BW_{recwc} (body weight - child) kg	15
BW_{recwa} (body weight - adult) kg	80
BW_{0-2} (mutagenic body weight) kg	15

Site-specific

Recreator Equation Inputs for Surface Water

Variable	Value
BW_{2-6} (mutagenic body weight) kg	15
BW_{6-16} (mutagenic body weight) kg	80
BW_{16-30} (mutagenic body weight) kg	80
SA_{recwc} (skin surface area - child) cm^2	2800
SA_{recwa} (skin surface area - adult) cm^2	2800
SA_{0-2} (skin surface area - mutagenic) cm^2	2800
SA_{2-6} (skin surface area - mutagenic) cm^2	2800
SA_{6-16} (skin surface area - mutagenic) cm^2	2800
SA_{16-30} (skin surface area - mutagenic) cm^2	2800
SA_{0-2} (mutagenic skin surface area) cm^2	2800
SA_{2-6} (mutagenic skin surface area) cm^2	2800
SA_{6-16} (mutagenic skin surface area) cm^2	2800
SA_{16-30} (mutagenic skin surface area) cm^2	2800
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	1.56
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	6.32
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	174720
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	707840
IRW_{recwa} (water intake rate - adult) L/hr	0.05
IRW_{recwc} (water intake rate - child) L/hr	0.05
IRW_{0-2} (mutagenic water intake rate) L/hr	0.05
IRW_{2-6} (mutagenic water intake rate) L/hr	0.05
IRW_{6-16} (mutagenic water intake rate) L/hr	0.05
IRW_{16-30} (mutagenic water intake rate) L/hr	0.05
l_{sc} (apparent thickness of stratum corneum) cm	0.001

Site-specific

Recreator Screening Levels (RSL) for Surface Water

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL), max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat,
Smax=Soil SL exceeds ceiling limit and has been substituted with the max value (see User's Guide),
Ssat=Soil inhalation SL exceeds csat and has been substituted with the csat

Chemical	CAS Number	Mutagen?	VOC?	Chemical Type	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Chronic RfD (mg/kg-day)	RfD Ref	RAGSe GIABS (unitless)	KP	MW	FA	In EPD?
Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-		2.00E-03	I	1	0.011	96.94	1	Yes
Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-		2.00E-02	I	1	0.011	96.94	1	Yes
Dioxane, 1,4-	123-91-1	No	No	Organics	1.00E-01	I	3.00E-02	I	1	0.000332	88.11	1	Yes
Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	I	6.00E-03	I	1	0.0334	165.83	1	Yes
Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	I	5.00E-04	I	1	0.0116	131.39	1	Yes
Vinyl Chloride	75-01-4	Yes	Yes	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	1	Yes

Chemical	DAeventc	DAeventnc	DAeventna	Ingestion SL TR=1.0E-6 (µg/L)	Dermal SL TR=1.0E-6 (µg/L)	Carcinogenic SL TR=1.0E-6 (µg/L)	Ingestion SL (Child) HQ=1 (µg/L)	Dermal SL (Child) HQ=1 (µg/L)
Dichloroethylene, 1,2-cis-	-	0.0407366	0.2172619	-	-	-	4.56E+03	3.13E+03
Dichloroethylene, 1,2-trans-	-	0.4073661	2.172619	-	-	-	4.56E+04	3.13E+04
Dioxane, 1,4-	0.0014623	0.6110491	3.2589286	1.64E+02	3.94E+03	1.57E+02	6.84E+04	1.65E+06
Tetrachloroethylene	0.0696352	0.1222098	0.6517857	7.80E+03	1.13E+03	9.86E+02	1.37E+04	1.98E+03
Trichloroethylene	0.0019595	0.0101842	0.0543155	2.19E+02	1.14E+02	7.51E+01	1.14E+03	5.94E+02
Vinyl Chloride	7.1775E-6	0.0611049	0.3258929	8.04E-01	9.03E-01	4.25E-01	6.84E+03	7.69E+03

Chemical	Noncarcinogenic SL (Child) HQ=1 µ(g/L)	Ingestion SL (Adult) HQ=1 (µg/L)	Dermal SL (Adult) HQ=1 (µg/L)	Noncarcinogenic SL (Adult) HQ=1 (µg/L)	Screening Level (µg/L)
Dichloroethylene, 1,2-cis-	1.86E+03	2.43E+04	1.67E+04	9.90E+03	1.86E+03 nc
Dichloroethylene, 1,2-trans-	1.86E+04	2.43E+05	1.67E+05	9.90E+04	1.86E+04 nc
Dioxane, 1,4-	6.57E+04	3.65E+05	8.78E+06	3.50E+05	1.57E+02 ca
Tetrachloroethylene	1.73E+03	7.30E+04	1.06E+04	9.23E+03	9.86E+02 ca**
Trichloroethylene	3.91E+02	6.08E+03	3.17E+03	2.08E+03	7.51E+01 ca**
Vinyl Chloride	3.62E+03	3.65E+04	4.10E+04	1.93E+04	4.25E-01 ca

ATTACHMENT 3

Surface Water-to-Soil Pathway Calculations

Surface-Water-to-Soil Pathway Calculations

Surface soil could adsorb volatile organic compounds (VOCs) from Tetrachloroethene-containing groundwater emanating in seeps and springs within Accelerated Operable Unit (AOU) 1. Residents and workers could be exposed to VOCs in soil through incidental ingestion, dermal contact, and inhalation of VOCs in outdoor air because of volatilization and particulate emissions. The US Environmental Protection Agency's regional screening levels for soil (http://www.epa.gov/region9/superfund/prg/) are conservative, risk-based concentrations that account for combined ingestion, dermal and inhalation exposures for both residential and industrial exposure scenarios.

Since the goal was to assess whether VOCs in AOU 1 surface water could adversely impact soil, the soil RSLs were related to a surface water concentration using a linear, equilibrium soil-water partitioning model, as follows:

$$SL_{Water\text{-}to\text{-}Soil} = \frac{RSL_{Soil} \times 1000 \text{ (micrograms/milligram)}}{K_{oc} \times F_{oc}}$$

Where: $SL_{Water\text{-}to\text{-}Soil}$ = Screening level for assessing potential surface water impacts surface soil (micrograms / liter)

RSL_{Soil} = Soil regional screening level (milligrams/kilogram)

K_{oc} = Organic-carbon partitioning coefficient (liters/kilogram)

F_{oc} – Fraction of organic carbon in soil (unitless)

Table C-1 summarizes the input inputs, data sources, and results for the calculation describe herein.

TABLE C-1

Surface-Water-to-Soil Pathway Calculations

VA Salt Lake City Health Care System Risk Assessment Work Plan

Chemical Name	K_{oc} (L/kg)	F_{oc} (unitless)	Residential Soil RSL (mg/kg)	Industrial Soil RSL (mg/kg)	Residential $SL_{Water\text{-}to\text{-}Soil}$ (µg/L)	Industrial $SL_{Water\text{-}to\text{-}Soil}$ (µg/L)
Tetrachloroethene	94.940	0.002	2.4E+01	1.0E+02	1.3E+05	5.3E+05
Trichloroethene	60.700	0.002	9.4E-01	6.0E+00	7.7E+03	4.9E+04
Vinyl chloride	21.730	0.002	5.9E-02	1.7E+00	1.4E+03	3.9E+04
cis-1,2-Dichloroethene	39.600	0.002	1.6E+02	2.3E+03	2.0E+06	2.9E+07
1,4-Dioxane	2.633	0.002	5.3E+00	2.3E+01	1.0E+06	4.4E+06

Notes:

µg/L = micrograms per liter

F_{oc} – Fraction of organic carbon in soil

K_{oc} = Organic-carbon partitioning coefficient

L/kg = liters per kilogram

mg/kg = milligrams per kilogram

RSL = regional screening level

SL = screening level

RSLs, K_{oc} and F_{oc} derived from United States Environmental Agency RSL Tables and Guidance (http://www.epa.gov/region9/superfund/prg/)

ATTACHMENT 4

Home-Grown Produce Pathway Calculations

Home-Grown Produce Pathway Calculations

Garden plants irrigated with water from the seeps and springs could uptake volatile organic compounds (VOCs). This homegrown produce could then make up a portion of a resident's diet. For purposes of estimating concentrations and uptakes, the vegetables are divided into root vegetables and aboveground (or leafy) vegetables.

The total hypothetical exposure through the homegrown produce pathway is a function of the following: (1) the amount of the root vegetables and the aboveground vegetables consumed, (2) the VOC concentrations in the edible portions of plants, and (3) potential for bioaccumulation of VOCs from seeps and springs.

Exposure factors used in the homegrown produce calculations are provided in Table D-1. With the exception of the produce ingestion rates, the exposure factors are from (U.S. Environmental Protection Agency [EPA], 2014). The produce ingestion rates were derived from the Exposure Factors Handbook (EFH) (EPA, 2011), Table 13-10. Chapter 13 of the EFH provides consumer-only home-produced food intake rates for various age groups. Total intake rates of vegetables for children (ages 0 to 6 years) and adults (ages 7 to 70 years) were 49.5 g/day (3.3 g/kg bodyweight-day) and 145 g/day (1.81 g/kg bodyweight-day), respectively. It was assumed that total intake was comprised of 40% rooted vegetables and 60% above ground vegetables.

A factor of 50 percent was applied to the ingestion rates was applied to the ingestion rates to account for several the site-specific conditions, including:

1. The seeps and springs are seasonal and it is likely that municipal water would be used for irrigation during the latter part of the growing season:
2. Houses, sidewalks, parking strips, driveways and other features limit the portion of the small building lots in AOU 1 that is available for gardening.
3. The elevation and latitude of AOU 1 result in a shorter growing season than many areas included in the EFH statistics.

The ingestion rates provided are on a wet weight basis and are based on foods as brought into the household and not in the form in which they are consumed. Loss during preparation are not accounted for and would cause overestimation of the intake rates. In addition, losses of VOCs during cooking, canning or other food preparation steps are not accounted for. The homegrown produce consumption rates described above likely overestimate consumption rates for a setting such as AOU 1 where (1) the area available for food production is limited because of the small, urban residential lots and houses that consume a large fraction of the lot, and (2) the elevation and latitude result in a shorter growing season than many areas included in the EFH statistics.

Toxicity factors used in the calculations are provided in Table D-2.

Calculation of the chemical-specific root bioconcentration factors and aboveground plant bioconcentration factors are provided in Table D-3. Concentrations in the root and aboveground vegetables are calculated by multiplying the concentration in groundwater by the root concentration factor (*BCFr)* or the aboveground vegetable concentration factor (*BCFa)*. The Briggs et al. (1992) and Travis and Arms (1988) models as presented in (EPA, 2005), were used to estimate the bioconcentration factors for root vegetables (*BCFr*) and aboveground vegetables (*BCFa*), respectively.

Chemical-specific root concentration factors were calculated using the Briggs et al. (1992) models as follows:

$$BCFr = 10^{0.778\,(LogKow)-1.52} + 0.82 \;\; (for\ Log\ Kows < 2)$$

$$BCFr = 10^{0.778\,(LogKow)-1.52} \quad (for\ LogKows > 2)$$

Where:

BCF_r	=	Root concentration factor (mg chemical/kg produce per mg chemical / L water)
LogKow	=	Chemical specific octanol water partition coefficient (kg/L)

Chemical-specific aboveground vegetation concentration factors were calculated using the Travis and Arms (1988) model as follows:

$$BCFa = 10^{1.588-0.578(LogKow)}\ x\ (1-0.85) x\ Kd$$

Where:

BCF_a	=	Aboveground vegetable concentration factor (mg/kg produce per mg/L water)
LogKow	=	Chemical specific octanol water partition coefficient (kg/L)
0.85	=	Moisture content on vegetables
Kd	=	Chemical-specific soil-water partition coefficient (L/kg) where Kd = Koc x foc
Koc	-	Soil water partition coefficient
Foc	=	Fraction organic carbon (0.002) unitless

Risk-based concentrations associated with ingestion of homegrown produce grown in spring water are calculated using the following basic equations for carcinogens and noncarcinogens and are shown in Table D-4:

$$Cancer\ RBC = \frac{Target\ Riskc\ x\ ATc\ x\ BW\ x\ CF1}{SFO\ x\ EF\ x\ ED\ x\ FI\ x\ [(BCFr\ x\ IRr) = (BCFa\ x\ IRa)]}$$

$$Non\ Cancer\ RBC = \frac{Target\ Risknc\ x\ ATnc\ x\ BW\ x\ CF1\ x\ RfD}{EF\ x\ ED\ x\ FI\ x\ [(BCFr\ x\ IRr) = (BCFa\ x\ IRa)]}$$

Where:

RBC	=	Risk-based concentration (µg/L)
Target $Risk_c$	=	Target risk for carcinogens (1×10^{-6})
Target $Risk_{nc}$	=	Target risk for non-carcinogens (1)
AT_c	=	Averaging time for carcinogens (days)
AT_{nc}	=	Averaging time for noncarcinogens (days)
BW	=	Body weight (kg)
CF1	=	Conversion factor (µg/mg)
SFO	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$
RfD	=	Noncancer reference dose (mg/kg-day)

EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
FI	=	Fraction of ingested vegetables grown in contaminated water
BCF_r	=	Root bioconcentration factor (mg/kg produce per mg/L water)
IR_r	=	Ingestion rate of root vegetables (kg/day) (mg/kg produce per mg/L water)
BCF_a	=	Aboveground bioconcentration factor
IR_a	=	Ingestion rate of aboveground vegetables (kg/day)

The exposure is age-weighted for children and adults as follows:

$$IF_adj_{r\ or\ a} = \frac{EFc\ x\ EDc\ x\ IRc}{BWc} + \frac{EFa\ x\ EDa\ x\ IRa}{BWa}$$

Where:

$IF_adj_{r\ or\ a}$	=	Aboveground vegetable concentration factor (mg/kg produce per mg/L water)
EF_c	=	Child exposure frequency (days/year)
ED_c	=	Child exposure duration (years)
IR_c	=	Child ingestion rate for roots or above ground vegetables (kg/day)
BW_c	=	Child body weight (kg)
EF_a	=	Adult exposure frequency (days/year)
ED_a	=	Adult exposure duration (years)
IR_a	=	Adult ingestion rate for roots or above ground vegetables (kg/day)

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TABLE D-1

Exposure Parameters

VA Salt Lake City Health Care System Risk Assessment Work Plan

Parameter	Unit	Symbol	Adult	Symbol	Child (6 yo)	Source
Exposure frequency - home grown produce ingestion	days/year	EF_ah	350	EF_ch	350	EPA, 2014
Exposure duration	years	ED_a	20	ED_c	6	EPA, 2014
Body weight	kg	BW_a	80	BW_c	15	EPA, 2014
Averaging time (cancer)	days	AT_can_a	25550	AT_can_c	25550	EPA, 2014
Averaging time (noncancer)	days	AT_nc_a	7300	AT_nc_c	2190	EPA, 2014
Ingestion Rate - produce - roots*	kg/day	IR_r_adult	0.058	IR_r_ch	0.020	EPA, 2011
Ingestion Rate - produce -above ground plants*	kg/day	IR_a_adult	0.087	IR_a_ch	0.030	EPA, 2011
Fraction of Vegetables Irrigated with ContaminatedWater	g/g	FI	0.5		0.5	--
Bioconcentration Factor - Roots	mg chemical/kg produce per mg chemical/L water	BCF_r	Chemical specific	BCF_r	Chemical specific	--
Bioconcentration factor - Above ground plants	mg chemical/kg produce per mg chemical/L water	BCF_a	Chemical specific	BCF_a	Chemical specific	--
Conversion factor	µg/mg	CF1	1000	CF1	1000	EPA, 2014
Conversion factor	L/ml	CF2	0.001	CF2	0.001	EPA, 2014

Notes:

* Ingestion rates are provided on a wet weight basis

Ingestion rates for vegetables = age-weighted intake split between root (40%) and above ground (60%) vegetables.

µg/L = micrograms per liter

µg/mg = micrograms per milligrams

kg = kilogram

kg/day = kilograms per day

g/g = grams per gram

L/ml = liters per milliliter

TABLE D-2

Toxicity Parameters

VA Salt Lake City Health Care System Risk Assessment Work Plan

Chemical Name	CAS Number	RfD mg/kg-day	Source	SFO $(mg/kg\text{-}day)^{-1}$	Source
1,4-Dioxane	123911	3.0E-02	IRIS	1.0E-01	IRIS
cis-1,2-Dichloroethene	156592	2.0E-03	IRIS	--	--
Tetrachloroethene	127184	6.0E-03	IRIS	2.1E-03	IRIS
trans-1,2-Dichloroethene	156605	2.0E-02	IRIS	--	--
Trichloroethene	79016	5.0E-04	IRIS	4.6E-02	IRIS
Vinyl chloride	75014	3.0E-03	IRIS	7.2E-01	IRIS

Notes:

-- = not applicable

IRIS = United States Enivronmental Protection Agency (USEPA) Inegrated Risk Information System (IRIS)

mg/kg-day = milligrams per kilograms per day

RfD = reference dose

SFO = cancer slope factor

TABLE D-3

Bioconcentration Factor - Roots and Above Ground Plants

VA Salt Lake City Health Care System Risk Assessment Work Plan

Chemical Name	CAS Number	Bioconcentration Factor - Root BCF_r (mg chemical/kg produce per mg chemical/L water)	Bioconcentration Factor - Aboveground plants BCF_a (mg chemical/kg vegetable per mg chemical/L water]	Octanol-Water Partition Coefficient - Log Kow (unitless)	Source	Koc (L/kg)	Source	Kd (L/kg or ml/g)
1,4-Dioxane	123911	0.8	0.0066	-0.27	HHRAP	2.633	EPA RSL	0.01
cis-1,2-Dichloroethene	156592	1.7	0.04	1.9	HHRAP	39.6	EPA RSL	0.08
Tetrachloroethene	127184	12.5	0.01	3.4	HHRAP	94.94	EPA RSL	0.19
Trichloroethene	79016	2.1	0.03	2.4	HHRAP	60.7	EPA RSL	0.12
trans-1,2-Dichloroethene	156605	1.2	0.03	2.07	HHRAP	39.6	EPA RSL	0.08
Vinyl chloride	75014	1.2	0.04	1.4	HHRAP	21.73	EPA RSL	0.04

Notes:

Bioaccumulation factors (wet weight) calculated as follows:

$BCF_r = 10^{0.778LogKow-1.52} + 0.82$ (Log Kow <2)

$BCF_r = 10^{0.778LogKow-1.52}$ (Log Kow >2)

$BCF_a = 10^{1.588-0.578 \text{ Log Kow}} \times (1-0.85) \times Kd$

$Kd = K_{oc} \times F_{oc}$

Default fraction of organic carbon (F_{oc} = 0.002) from RSL Users Guide

Root BCF (BCF_r) model valid for LowKows -0.057 to 4.6.

Above ground BCF (BCF_a) model provides a dry weight estimate based on uptake from soil. Conversion to wet weight assumes 85% moisture. Kd used to convert to aqueous system. Model valid for LogKows 1.15 to 9.35, LogKow for 1,4-dioxane (-0.27) is outside the range so BCF_a is recalculated assuming LogKow 1.15 per HHRAP guidance.

HHRAP = Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities companion database (http://www.epa.gov/osw/hazard/tsd/td/combust/finalmact/ssra/05hhrapchemdat.mdb)

EPA RSL = US Environmental Protection Agency Regional Screening Level

L/kg = liters per kilogram

ml/g = milliters per gram

TABLE D-4

Risk-Based Concentrations - Groundwater - Ingestion Scenarios

VA Salt Lake City Health Care System Risk Assessment Work Plan

Chemical Name	IF_adj_can	IF_adj_nc	Age-adjusted - Ingestion of Home Garden produce (µg/L)	
	L/kg	L/kg-day	Cancer	Noncancer
1,4-Dioxane	3.3	0.0008	77	36,060
cis-1,2-Dichloroethene	6.9	0.0017		1,164
Tetrachloroethene	49.2	0.012	247	488
trans-1,2-Dichloroethene	4.8	0.001		16,595
Trichloroethene	8.5	0.002	65	235
Vinyl chloride	4.9	0.0012	7	2,468

Notes:

IF_adj_can = Age-adjusted ingeston rate (cancer)

IF_adj_nc = Age-adjusted ingeston rate (noncancer)

L/kg = Liters per kilogram

L/kg-day = Liters per kilogram - day

µg/L = micrograms per liter

ATTACHMENT 5

Equations Used to Calculate Inhalation Risk from TCE and Vinyl Chloride

Equations Used to Calculate Inhalation Risk from TCE and Vinyl Chloride

The carcinogenic risk calculations for trichloroethylene (TCE) and vinyl chloride differ from the other chemicals included in this work plan because of their underlying toxicity factors (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/equations.htm). The equation used to calculate inhalation risk from exposure to TCE and vinyl chloride are provided in this appendix.

Vinyl Chloride Carcinogenic Equation for Inhalation

$$CR = C_{air} x IUR + \frac{IURxEFxEDxETx\frac{1\ day}{24\ hours}}{ATc}$$

Where:

CR	= Carcinogenic risk
Cair	= Concentration in air
IUR	= Inhalation unit risk (micrograms per cubic meters [µg/m^3])$^{-1}$
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
ET	= Exposure time (hours/day)
ATc	= Averaging time (days)

TCE Carcinogenic Equation for Inhalation

TCE requires the use of different toxicity values for cancer and mutagen equations. The following equation shows the toxicity value adjustment factor for cancer (CAF) and mutagens (MAF).

$$CR = \frac{C_{air} IURx\frac{1\ day}{24\ hours} x[(EF_r xED_r xET_r xCAF_i) + ((EF_{0-2} xED_{0-2} xET_{0-2} xMAF_i x10) + (EF_{2-6} xED_{2-6} xET_{2-6} xMAF_i x3) + (EF_{6-16} xED_{6-16} xET_{6-16} xMAF_i x3) + (EF_{16-26} xED_{16-26} xET_{16-26} xMAF_i x1))]}{ATc}$$

Where:

CR	= Carcinogenic risk
Cair	= Concentration in air
IUR	= Inhalation unit risk (µg/m^3)$^{-1}$
EDr	= Exposure duration (years) (26 years)
EFr	= Residential exposure frequency (days/year) (350 days/year)
ETr	= Exposure time (hours/day) (24 hours/day)

CAFi = Cancer Adjustment Factor (0.756)
ED_{0-2} = Exposure duration (years) (2 years)
EF_{0-2} = Residential exposure frequency (days/year) (350 days/year)
ET_{0-2} = Exposure time (hours/day) (24 hours/day)
MAFi = Mutagen Adjustment Factor (0.244)
ED_{2-6} = Exposure duration (years) (4 years)
EF_{2-6} = Residential exposure frequency (days/year) (350 days/year)
ET_{2-6} = Exposure time (hours/day) (24 hours/day)
ED_{6-16} = Exposure duration (years) (10 years)
EF_{6-16} = Residential exposure frequency (days/year) (350 days/year)
ET_{6-16} = Exposure time (hours/day) (24 hours/day)
ED_{16-26} = Exposure duration (years) (10 years)
EF_{16-26} = Residential exposure frequency (days/year) (350 days/year)
ET_{16-26} = Exposure time (hours/day) (24 hours/day)
ATc = Averaging time (days) (365 days x 70 years)

APPENDIX F

FINAL

Vapor Intrusion Screening Levels and Removal Action Levels
700 South 1600 East Street PCE Plume
Salt Lake City, Utah

PREPARED FOR: D. Lynne Welsh/VA Salt Lake City Health Care System

PREPARED BY: Mike Bedan/CH2M HILL, Mike Novak/CH2M HILL

COPIES: David Waite, CH2M-Hill; Rolf Lange, Avalon; Ed Reid, First Environment, Inc.; Devin DeMarco, First Environment, Inc.

DATE: July 17, 2015

This memorandum provides the calculations and technical basis for indoor-air screening levels (SLs) and removal action levels (IRALs) to be applied during the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI) being conducted by the U.S. Department of Veterans Affairs (VA) for the 700 South 1600 East tetrachloroethylene (PCE) plume (Plume) in Salt Lake City, Utah. These SLs and RALs will be compared to measured concentrations of specific volatile organic compounds (VOCs) measured and detected in the indoor air within structures overlying a portion of the Plume identified as Accelerated Operable Unit 1 (AOU-1). Such structures have the potential of being adversely affected by the Plume through the subsurface to indoor air vapor intrusion (VI) pathway. Additional VI SLs for exterior soil gas and groundwater are also provided.

The comparison of measured VOC concentrations to the SLs and RALs will support decisions regarding the need for additional activities under CERCLA. The VI SLs are intended for screening purposes only to identify areas that may require further data collection or completion of additional data evaluation; exceedance of an investigation SL is not an indication of unacceptable risk. In addition to other requirements of the National Contingency Plan ("NCP"), RALs will be used to assess the need for implementing interim removal actions (VI mitigation, for example) in advance of selecting and implementing the CERCLA remedial action(s). These are the sole purposes of the SLs and RALs presented in this technical memorandum. The SLs and RALs do not constitute regulatory standards or cleanup goals for AOU-1.

The SLs and RALs are provided for PCE and its biodegradation breakdown products trichloroethylene (TCE), cis-1,2-dichloroethylene, and vinyl chloride. In addition, 1,4-dioxane is included at the request of the U.S. Environmental Protection Agency (EPA) because of its use historically as a stabilizer for chlorinated solvents, notably 1,1,1-trichloroethane. However, because (1) there is no knowledge of trichloroethane use associated with historical VA operations; and (2) 1,4-dioxane was not commonly used in association with PCE, the current expectation is that 1,4-dioxane will not be found in AOU-1 groundwater as a result of known VA releases.

Background

The Plume is located in Salt Lake City, Utah (the Site) near the Wasatch Mountains front in the northeastern corner of the Salt Lake Valley. The Site was first identified in the 1990s as a result of PCE detections in existing irrigation and municipal supply wells. EPA further delineated the Plume in 1998 through installation and sampling of seven groundwater monitoring wells. A sewer line originating from a former dry-cleaning facility in the VA Medical Center was subsequently identified as one potential PCE source (Bowen Collins, 2004). In 2010, in

response to an oil pipeline break near Red Butte Creek (unrelated to the VA), water samples were collected by the Salt Lake City Department of Public Utilities from Red Butte Creek and springs and seeps emanating along the Wasatch Fault scarp west of 1300 East Street. PCE was detected in several of these springs and seeps. Since 2010, additional investigations have been performed to investigate potential source areas and the nature and extent of PCE contamination (UDEQ, 2012; MWH, 2012).

In May 2013, the EPA listed the Site on the National Priorities List, making the Site eligible for comprehensive assessment and cleanup through the CERCLA, or Superfund, process (EPA, 2014a). An RI is being planned for AOU-1. A part of this investigation will consist of sampling indoor air within occupied structures overlying AOU-1 to assess if vapor has migrated from PCE-contaminated groundwater to the indoor air through VI. The SLs and RALs presented in this memorandum will support data analysis and decision making with respect to the AOU 1 indoor air data.

Indoor Air Screening Levels

The indoor air SLs are risk-based concentrations of VOCs that are compared with indoor air VOC concentrations measured in samples from a receptor's (for example, resident or worker) breathing zone. As noted above, the indoor air SLs are intended only to help identify areas that may require further data collection or evaluation; exceedance of an indoor air SL is not an indication of unacceptable risk. In addition, PCE and other VOCs can be found in indoor air as a result of indoor or outdoor background sources (in other words, not related to VI from subsurface sources). Steps will be taken when comparing measured indoor air concentrations to the SLs to account for potential background sources. These steps will be described in a forthcoming Vapor Intrusion Protocol document currently being prepared.

The indoor air SLs were calculated for residential and industrial exposure scenarios following an approach consistent with the EPA's Risk Assessment Guidance for Superfund (Part F) (EPA, 2009). The SLs were calculated based on an assumption of the magnitude of exposure, the chemical toxicity, and a target risk threshold. The exposure assumptions (exposure frequency, duration, and time) are published values for a generic, reasonable maximum exposure scenario from the EPA's Regional Screening Levels (RSL) tables (EPA, 2014b), which were recently updated based on new EPA guidance (EPA, 2014c). The toxicity values used as the basis for the calculations were also from the RSL tables (EPA, 2014b). The exposure assumptions and target risk thresholds are presented in Table 1. The toxicity values are presented in Table 2.

Separate carcinogenic and non-carcinogenic risk-based SLs were calculated for each VOC when both unit risk factors (cancer inhalation toxicity values) and reference concentrations (non-cancer inhalation toxicity values) are available. The lower calculated concentration of the cancer and non-cancer values is selected as the SL.

The target cancer risk (TCR) of 1×10^{-6} and target non-cancer hazard quotient (THQ) of 1 used to derive the indoor air SL is based on standard EPA human health risk assessment (HHRA) methodology for SLs (EPA, 2014b; EPA, 1991). Although a 1×10^{-4} to 1×10^{-6} cancer risk range is used during the risk management decision process on CERCLA projects, investigation SLs for cancer-causing chemicals are generally set to a 1×10^{-6} excess lifetime cancer risk consistent with CERCLA rules and guidance (NCP Section 300.430(e)(2)(I); EPA, 2014b, EPA, 1991).

For carcinogens, the equation for $SL_{indoor\ air}$, the indoor air risk-based SL based on cancer toxicity, is:

$$SL_{indoor\,air-c} = \frac{TCR \times AT_c \times \left(\frac{365\ days}{year}\right) \times \left(\frac{24\ hours}{day}\right)}{EF \times ED \times ET \times IUR}$$

Where:

TCR = Target cancer risk [unitless]
AT_c = Averaging time-carcinogens, residential or industrial exposure scenario [years]
EF = Exposure frequency, residential or industrial exposure scenario [days/year]
ED = Exposure duration, residential or industrial exposure scenario [years]
ET = Exposure time, residential or industrial exposure scenario [hours]
IUR = Inhalation unit risk $[\mu g/m^3]^{-1}$

For carcinogens with mutagenic mode-of-action (MMOA), which includes TCE and vinyl chloride, the SL equation for the residential receptor only is slightly modified in accordance with the RSL user's guide (EPA, 2014b).

$$SL_{indoor\,air,mut} = \frac{TCR \times AT_c \times \left(\frac{365\ days}{year}\right) \times \left(\frac{24\ hours}{day}\right)}{EF \times ED_{MMOA} \times ET \times IUR}$$

Where:

TCR = Target cancer risk [unitless]
ATc = Averaging time-carcinogens [years]
EF = Exposure frequency, residential or industrial exposure scenario [days/year]
ED_{MMOA} = Exposure duration for MMOA, residential exposure scenario [years]
ET = Exposure time, residential or industrial exposure scenario [hours]
IUR = Inhalation unit risk $[\mu g/m^3]^{-1}$

ED_{MMOA} is calculated with the equation:

$$ED_{MMOA} = (ED_{0-2} \times AF_{0-2}) + (ED_{2-6} \times AF_{2-6}) + (ED_{6-16} \times AF_{6-16}) + (ED_{16-26} \times AF_{16-26})$$

Where:

ED_{MMOA} = Exposure duration for MMOA, residential exposure scenario [years]
EDx-y = Exposure duration for the age cohort from age x to y
AFx-y = Age-dependent adjustment factor (10 for ages 0 to 2, 3 for ages 2 to 6 and 6 to 16 and 1 for ages 16 to 26

For TCE, which has mutagenic and non-mutagenic components of the IUR, two $SL_{indoor\ air}$ values are calculated using the mutagenic and non-mutagenic components of the IUR. The reciprocal of the sum of the reciprocals of those $SL_{indoor\ air}$ values is used to calculate the final $SL_{indoor\ air}$ value, in accordance with the EPA RSL guidance (EPA, 2014b).

For vinyl chloride, a slightly modified version of the equation for $SL_{indoor\ air}$ for a residential exposure scenarios is used (EPA, 2014b):

$$SL_{indoor\,air,mut,vc} = \frac{TCR}{\left(AT_c \times \frac{EF \times ED_{MMOA} \times ET \times IUR}{AT_c \times \left(\frac{365\ days}{year}\right) \times \left(\frac{24\ hours}{day}\right)} \right)}$$

For non-carcinogens, the equation for $SL_{indoor\ air\text{-}nc}$, the indoor air risk-based SL based on non-cancer toxicity, is:

$$SL_{indoor\,air-nc} = \frac{THQ \times RfC \times AT_{nc} \times \left(\frac{365\ days}{year}\right) \times \left(\frac{24\ hours}{day}\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF \times ED \times ET}$$

Where,

TCR = Target cancer risk [unitless]
ATnc = Averaging time, non-carcinogens, residential or industrial exposure scenario [years]
EF = Exposure frequency, residential or commercial/industrial exposure scenario [days/year]
ED = Exposure duration, residential or commercial/industrial exposure scenario [years]
ET = Exposure time, residential or industrial exposure scenario [hours]
THQ = Target hazard quotient (typically 1) [unitless]
RfC = Reference concentration, non-carcinogens [mg/m^3]

The lower of the cancer- and non-cancer-based $SL_{indoor\ air}$ values is chosen as $SL_{indoor\ air}$ value that satisfies both the target cancer risk level and the THQ. Table 3 summarizes the residential and industrial SLs for indoor air. The industrial SLs are applicable to school and commercial (for example, convenience store) workers as well.

Indoor Air Removal Action Levels

The indoor air RALs are risk-based concentrations used to support decisions regarding the need for implementing Removal Actions after the data from the indoor air sampling has been generated, validated and evaluated, prior to the implementation of remedial actions. Such actions may include source treatment, institutional controls, short-term mitigation measures, long-term mitigation, or a combination of these actions. The presence of indoor air concentrations above an RAL, measure with the portable field GC/MS, will not automatically result in such actions. Additional verification activities will precede a decision to implement interim actions in order to confirm that the measured indoor air concentration is valid and not an isolated occurrence, an erroneous reading, or a source unrelated to VI. Verification activities could include:

- confirmation indoor-air sampling;
- collection and evaluation of additional data and information to help ascertain whether the indoor VOC concentrations are related to VI; or
- confirmation that the indoor air samples are representative of regularly occupied spaces.

Only indoor air results from time-weighted TO-15 indoor-air samples, and not field analytical data or data collected under non-ambient conditions (that is, building depressurization), will be used in making final decisions regarding the need for a Removal Action.

The same equations, methods, and assumptions used to derive the indoor air SLs were used for the RALs with the exception of the target risk levels. Exhibit 1 summarizes the rationale for the target risk levels used to derive two tiers of RALs. Consistent with EPA guidance (EPA, 2014d, e), the two tiers of RALs were calculated to address different risk management situations:

- Tier 1 RALs were calculated using TCR level of 1×10^{-5} and a noncancer hazard quotient of 1. After confirmation that VI resulted in indoor air concentrations above the Tier 1 RALs, planning and implementation of interim action, such as a long-term mitigation, would be completed within six months.
- Tier 2 RALs were calculated using TCR level of 1×10^{-4} and a noncancer hazard quotient of 3. After confirmation that VI was resulting in indoor air concentrations above the Tier 2 RALs, implementation of a short-term mitigation action, such as installation of portable air purifiers, would be completed as soon as arrangements can be made with occupants, generally within a week. A confirmation sample will generally be collected soon after receipt of the original result and before starting the air purifier. Planning and implementation of interim action such as long-term mitigation would be completed within six months.

When indoor air concentrations fall between the indoor air screening levels and the Tier 2 RALs, additional data evaluation and/or ongoing monitoring is generally recommended.

EXHIBIT 1
Rationale for Removal Action Level (RAL) Target Risk Levels

RAL Tier	Target Caner Risk (TCR)	TCR Rationale	Target Noncancer Hazard Quotient (THQ)	THQ Rationale
Tier 1	1×10^{-5}	Taking interim action to control risks to below 1×10^{-5} will result in risks at the lower end (bottom 10%) of the target range (1×10^{-6} to 1×10^{-4}). Cumulative risks from multiple analytes, if applicable, will not exceed 1×10^{-4}. Lifetime exposures will equate to much lower risks because the removal action timeframe (a few years) is much shorter than the assumed 26-year exposure duration used to derive the RALs.	1	Taking interim action to control risks to below a THQ of 1 will result in noncancer risks below the target value.
Tier 2	1×10^{-4}	Taking action within two weeks to control risks to below 1×10^{-4} will lower calculated risks to within the target range.	3	Taking action within two weeks to control risks to below a THQ of 3 will result in noncancer risks that fall within the range of order-of-magnitude uncertainty factored into the underlying inhalation reference concentration (EPA, 2014e).

Recent guidance has also been released by several EPA regions (for example, EPA Region 9 [EPA, 2014d]) regarding the risks associated with short-term exposure to TCE in indoor air. These regulators have released interim action levels for TCE (not applicable to other Site VOCs

of concern) and recommend response action intended to be protective of sensitive populations., specifically women in the first trimester of pregnancy because of the potential for cardiac malformations to the developing fetus. TCE is detected infrequently and only at low levels in AOU-1 groundwater and surface water. TCE is not known to be associated directly with VA-related releases. Its presence at AOU 1 could be attributed to upgradient localized anaerobic biodegradation of PCE. TCE could also be related to a non-VA source.

Based on existing AOU-1 groundwater analytical data, the likelihood of site-related TCE impacts to indoor air that exceed the EPA regions' and other states' interim action levels is low. Selection of the THQ of 1 for the RAL calculation addresses this issue because the potential for fetal heart malformations was one of the endpoints considered in EPA's development of the TCE noncancer reference concentration. Based on the EPA's risk assessment and risk management framework, adverse health effects are not expected for exposure point concentrations less than or equal to an HQ of 1.

Tables 4 and 5 summarize the Tiers 1 and 2 residential and industrial indoor air RALs.

Exterior Soil Gas Investigation Screening Levels

The exterior soil gas SLs are risk-based SLs used to assess soil gas concentrations collected away from the footprint of a building that may migrate into a building to a receptor breathing zone. The soil gas SLs are intended for screening purposes only—to identify areas that may require further data collection or evaluation—an exceedance of a soil gas SL is not an indication of unacceptable risk.

The SLs for soil gas are based on the exposure equations and assumptions used to derive the indoor air SLs (described above) and the soil-gas-to-indoor-air attenuation factors for existing residential buildings. The soil-gas-to-indoor air attenuation factor (AF) is 0.03 (EPA, 2014f). AFs are conservative and generic; the AF and other assumptions used in the derivation of the gas SLs will be reassessed as site-specific empirical data become available.

The soil gas investigation screening level that corresponds to a chemical's indoor air investigation screening level is calculated by dividing the indoor air SLs by the generic soil-gas-to-indoor-air attenuation factor:

$$SL_{soil\,gas} = \frac{SL_{indoor\,air}}{AF_{ss}}$$

Where:

$SL_{soil\ gas}$ = Soil gas screening level [µg/m^3]
$SL_{indoor\ air}$ = Indoor air screening level [µg/m^3]
$AF_{soil\ gas}$ = Soil-gas-to-indoor-air attenuation factor (i.e., the ratio of indoor air concentration to soil gas concentration) [unitless]

Tables 6 and 7 summarize the residential and commercial/industrial soil gas SLs, respectively.

Groundwater Investigation Screening Levels

The groundwater SLs are risk-based SLs used to assess groundwater concentrations in proximity of a building that may volitalize and migrate through the building foundation into the receptor breathing zone. Groundwater SLs are intended for screening purposes only—to identify

areas that may require further data collection or evaluation—and exceedance of a groundwater SL is not an indication of unacceptable risk.

The groundwater SL corresponding to a chemical's target indoor air concentration is calculated by dividing the indoor air SL by an AF of 0.001 (EPA, 2014f, g) and then converting the vapor concentration to an equivalent groundwater concentration, assuming equilibrium between the aqueous and vapor phases at the water table. The equilibrium partitioning is assumed to obey Henry's Law so that:

$$SL_{groundwater} = \frac{SL_{indoor\ air}}{HLC \times AF_{gw} \times \left(\frac{1000\ L}{m^3}\right)}$$

Where:

$SL_{groundwater}$ = Groundwater screening level [µg/L]
$SL_{indoor\ air}$ = Indoor air screening level [µg/m^3]
HLC = Henry's Law Constant, at 25 degrees Celsius [unitless] (EPA, 2014g)
AF_{gw} = Soil-gas-to-indoor-air attenuation factor for an existing residential exposure scenario (i.e., the ratio of indoor air concentration to groundwater concentration) [unitless]

AFs are conservative and generic; the AF and other assumptions used in the derivation of the groundwater SLs will be reassessed as site-specific empirical data become available.

Tables 8 and 9 summarize the residential and commercial/industrial groundwater SLs, respectively.

Summary

The technical basis and rationale for calculating and employing site-specifc SLs and indoor air RALs for the proposed VI investigation are presented in this technical memorandum. The risk-based SLs and RALs were calculated for residential and industrial exposure scenarios following an approach consistent with the EPA Guidance. The SLs will be used to identify areas, including homes and other structures, that may require further data collection or evaluation. Decisions to implement Removal Actions will be based on RAL exceedances, but only following further verification, validation, and decision making.

Exterior soil gas and groundwater SLs for a current residential exposure scenario are summarized in Table 10. A summary of the proposed indoor air RALs for existing residential land use are also provided in Table 10. The decision matrix for comparing measured concentrations against the SL and RALs is provided in Table 11.

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TABLES

TABLE 1
Vapor Inrusion Investigation Screening Levels and Action Levels Exposure Assumptions
700 South 1600 East PCE Plume
Salt Lake City, Utah

Scenario	Parameter	Symbol	Value	Units	Source
General parameters	Target cancer risk - Investigaiton Screening Level	TR	1E-06	unitless	EPA, 2014a
	Target Hazard Quotient - Investigation Screening Level	THQ	1	unitless	EPA, 2014a
	Target cancer risk - Removal Action Level - Tier 1	TR_removal	1E-05	unitless	Site-specific
	Target Hazard Quotient - Removal Action Level -Tier 1	THQ_removal	1	unitless	EPA, 2014b; DTSC, 2014
	Target cancer risk - Removal Action Level - Tier 2	TR_removal	1E-04	unitless	Site-specific
	Target Hazard Quotient - Removal Action Level -Tier 2	THQ_removal	3	unitless	EPA, 2014b; DTSC, 2014
	Averaging time, carcinogenic	AT_C	70	years	EPA, 2014a
Residential	Averaging time, non-carcinogenic	AT_Nr	26	years	EPA, 2014a
	Exposure duration	ED_res	26	year	EPA, 2014a
	Exposure frequency	EF_res	350	day/year	EPA, 2014a
	Exposure Time (per day)	ET_res	24	hours	EPA, 2014a
Existing Residential Building	Near-Source Exterior Soil Gas-to-Indoor Air Attenuation Factor	AF_res_ex_source	0.03	unitless	EPA, 2014d
	Groundwater-to-Indoor Air Attenuation Factor	AF_res_gw	0.001	unitless	EPA, 2014c; EPA, 2014d
Industrial/Commercial	Averaging time, non-carcinogenic	AT_Nic	25	years	EPA, 2014a
	Exposure duration	ED_ic	25	year	EPA, 2014a
	Exposure frequency	EF_ic	250	day/year	EPA, 2014a
	Exposure Time (per day)	ET_ic	8	hours	EPA, 2014a
Existing Commercial Building	Near-Source Exterior Soil Gas-to-Indoor Air Attenuation Factor	AF_ic_ex_source	0.03	unitless	EPA, 2014d
	Groundwater-to-Indoor Air Attenuation Factor	AF_ic_gw	0.001	unitless	EPA, 2014c; EPA, 2014d

Notes:

DTSC, 2014. Department of Toxic Substances Control (DTSC) UMAN HEALTH RISK ASSESSMENT (HHRA) NOTE. HERO HHRA NOTE NUMBER 5: Health-based Indoor Air Screening Criteria for Trichloroethylene (TCE). August 21.

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TABLE 2
Toxicity Factors used in the Calculation of the California Human Health Screening Levels - Vapor Intrusion Pathways
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	USEPA Inhalation Unit Risk Factor (IUR) $(ug/m^3)^{-1}$	IUR Source	USEPA Non-Cancer Reference Concentration (RfC) (ug/m^3)	RfC Source
75354	1,1-Dichloroethylene			200	IRIS[a]
123911	1,4-Dioxane	5.0E-06	IRIS[a]	30	IRIS[a]
156592	cis-1,2-Dichloroethylene				
127184	Tetrachloroethylene	2.6E-07	IRIS[a]	40	IRIS[a]
79016	Trichloroethylene	4.1E-06	IRIS[a]	2	IRIS[a]
75014	Vinyl chloride (chloroethene)	4.4E-06	IRIS[a]	100	IRIS[a]

Notes:
USEPA: United States Environmental Protection Agency
References:

a: USEPA, 2014. Regional Screening Level - Toxicity Information. URL: http://www.epa.gov/region9/superfund/prg/index.html. May.

TABLE 3
Summary Table of Indoor Air Screening Levels
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air - C RBSL[a]	Residential Indoor Air - NC RBSL[a]	Residential Indoor Air - Investigation SL[b]	Commercial/ Industrial Indoor Air - C RBSL[a]	Commercial/ Industrial Indoor Air - NC RBSL[a]	Commercial/ Industrial Indoor Air - SL[b]
75354	1,1-Dichloroethylene		210	210		880	880
123911	1,4-Dioxane	0.56	31	0.56	2.5	130	2.5
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	11	41	11	47	180	47
79016	Trichloroethylene	0.48	2.1	0.48	3	8.8	3
75014	Vinyl chloride (chloroethene)	0.17	100	0.17	2.8	440	2.8

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.

The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.

The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.

b : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.

Final investigation screening levels are rounded to nearest 2 significant figures.

Notes:

C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
$\mu g/m^3$: micrograms per cubic meter
EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

EPA, 2014b. Vapor Intrusion Screening Levels. http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6

TABLE 4
Summary Table of Tier 1 Indoor Air Removal Action Levels
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air - C RAL[b]	Residential Indoor Air - NC RAL[b]	Residential Indoor Air RAL[c]	Commercial/ Industrial Indoor Air - C RAL[b]	Commercial/ Industrial Indoor Air - NC RAL[b]	Commercial/ Industrial Indoor Air RAL[c]
		(ug/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)
75354	1,1-Dichloroethylene		210	210		880	880
123911	1,4-Dioxane	5.6	31	5.6	25	130	25
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	110	41	41	470	180	180
79016	Trichloroethylene	4.8	2.1	2.1	30	9	8.8
75014	Vinyl chloride (chloroethene)	1.7	100	1.7	28	440	28

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b: The C RAL values were derived using a target cancer risk level (TRL) of 1E-05.
The NC RAL values were derived using a target noncancer hazard quotient (THQ) of 1.
c : The vapor intrusion removal action level (RAL) is the lowest value between carcinogenic and non-carcinogenic RALs.
The RALs are rounded to nearest 2 significant figures.

Notes:
RAL : removal action level
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter
EPA : United States Environment Protection Agency.
EPA, 2014a Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA, 2014b Vapor Intrusion Screening Levels. http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6

TABLE 5
Summary Table of Tier 2 Indoor Air Removal Action Levels
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air - C RAL[b]	Residential Indoor Air - NC RAL[b]	Residential Indoor Air RAL[c]	Commercial/ Industrial Indoor Air - C RAL[b]	Commercial/ Industrial Indoor Air - NC RAL[b]	Commercial/ Industrial Indoor Air RAL[c]
		(ug/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)
75354	1,1-Dichloroethylene		630	630		2,640	2,600
123911	1,4-Dioxane	56	93	56	250	390	250
156592	cis-1,2-Dichloroethylene						
127184	Tetrachloroethylene	1,100	123	120	4,700	540	540
79016	Trichloroethylene	48	6.3	6.3	300	26.4	26
75014	Vinyl chloride (chloroethene)	17	300	17	280	1,320	280

a: The indoor air Regional Screening Levels (EPA, 2014a) are used as the indoor air risk-based screening level (RBSL) based on the exposure assumptions and equations in Table 1 using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b: The C RAL values were derived using a target cancer risk level (TRL) of 1E-04.
The NC RAL values were derived using a target noncancer hazard quotient (THQ) of 3.
c : The vapor intrusion removal action level (RAL) is the lowest value between carcinogenic and non-carcinogenic RALs.
The RALs are rounded to nearest 2 significant figures.

Notes:
RAL : removal action level
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter
EPA : United States Environment Protection Agency.
EPA, 2014a Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

TABLE 6
Exterior Soil Gas Vapor Intrusion Investigation Screening Levels - Existing and Future Residential
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air - C RBSL[a]	Residential Indoor Air - NC RBSL[a]	Existing Residential Near-Source-Exterior-Soil-Gas-to-Indoor-Air Attenuation Factor[b]	Existing Residential Soil Gas - C RBSL[c]	Existing Residential Soil Gas - NC RBSL[c]	Existing Residential Soil Gas SL[d]
		(ug/m^3)	(µg/m^3)	(--)	(µg/m^3)	(µg/m^3)	(µg/m^3)
75354	1,1-Dichloroethylene		210	0.03		7,000	7,000
123911	1,4-Dioxane	0.56	31	0.03	18.7	1,030	19
156592	cis-1,2-Dichloroethylene			0.03			
127184	Tetrachloroethylene	11	41	0.03	367	1,370	370
79016	Trichloroethylene	0.48	2.1	0.03	16	70	16
75014	Vinyl chloride (chloroethene)	0.17	100	0.03	5.67	3,330	5.7

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b : Residential "near source" exterior-soil-gas-to-indoor-air RBSLs are based on the EPA (2014b) soil gas-to-indoor air attenuation factor of 0.03.
c : The RBSLs is calculated dividing the associated indoor air RBSL by the soil gas-to-indoor air attenuation factor.
d : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.
Final investigation screening levels are rounded to nearest 2 significant figures.

Notes:
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter

EPA : United States Environment Protection Agency.

EPA, 2014a Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

EPA, 2014b DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

TABLE 7
Exterior Soil Gas Vapor Intrusion Screening Levels - Commercial/Industrial
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Commercial/ Industrial Indoor Air - C RBSL[a]	Commercial/ Industrial Indoor Air - NC RBSL[a]	Existing Commercial /Industrial Near-Source-Exterior-Soil-Gas-to-Indoor-Air Attenuation Factor[b]	Existing Commercial/ Industrial Soil Gas - C RBSL[c]	Existing Commercial/ Industrial Soil Gas - NC RBSL[c]	Existing Commercial/ Industrial Soil Gas SL[d]
		(µg/m^3)	(µg/m^3)	(--)	(µg/m^3)	(µg/m^3)	(µg/m^3)
75354	1,1-Dichloroethylene		880	0.03		29,300	29,000
123911	1,4-Dioxane	2.5	130	0.03	83.3	4,330	83
156592	cis-1,2-Dichloroethylene			0.03			
127184	Tetrachloroethylene	47	180	0.03	1,570	6,000	1,600
79016	Trichloroethylene	3	8.8	0.03	100	293	100
75014	Vinyl chloride (chloroethene)	2.8	440	0.03	93.3	14,700	93

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b : Commercial/Industrial "near source" exterior soil gas-to-indoor-air RBSLs are based on the EPA (2014b) soil-gas-to-indoor attenuation factor of 0.03.
c : The RBSLs is calculated dividing the associated indoor air RBSL by the subslab-to-indoor-air attenuation factor.
d : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.
Final investigation screening levels are rounded to nearest 2 significant figures.
Notes:
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter
EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA, 2014b. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

TABLE 8
Groundwater Vapor Intrusion Screening Levels - Existing and Future Residential
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air - C RBSL[a]	Residential Indoor Air - NC RBSL[a]	Henry's Law Constant[b]	Residential Groundwater-to-Indoor-Air Attenuation Factor[c]	Residential Groundwater - C RBSL[d]	Residential Groundwater - NC RBSL[d]	Residential Groundwater Investigation SL[e]
		(µg/m^3)	(µg/m^3)	(--)	(--)	(µg/L)	(µg/L)	(µg/L)
75354	1,1-Dichloroethylene		210	1.07E+00	0.001		197	200
123911	1,4-Dioxane	0.56	31	1.96E-04	0.001	2,850	158,000	2,900
156592	cis-1,2-Dichloroethylene			1.67E-01	0.001			
127184	Tetrachloroethylene	11	41	7.24E-01	0.001	15.2	56.7	15
79016	Trichloroethylene	0.48	2.1	4.03E-01	0.001	1.19	5.21	1.2
75014	Vinyl chloride (chloroethen	0.17	100	1.14E+00	0.001	0.15	88	0.15

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b : Henry's Law Constant (HLC) values are taken from USEPA (2014a). HLCs are assumes at 25 degree Celsius.
c : Residential groundwater-to-indoor-air RBSLs are based on the EPA (2014b, c) groundwater-to-indoor attenuation factor of 0.001.
d : The RBSLs is calculated dividing the associated indoor air RBSL by the Henry's Law Constant, the groundwater-to-indoor-air attenuation factor, and a conversion factor of 1000 liters per cubic meter.
e : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.
Notes:
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter
EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA, 2014b. Vapor Intrusion Screening Levels. http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6
EPA, 2014c. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

TABLE 9
Groundwater Vapor Intrusion Screening Levels - Existing and Future Commercial/Industrial Buildings
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Commercial/ Industrial Indoor Air RBSL[a] - C	Commercial/ Industrial Indoor Air RBSL[a] - NC	Henry's Law Constant[b]	Commercial/ Industrial Groundwater-to-Indoor-Air Attenuation Factor[c]	Commercial/ Industrial Groundwater - C RBSL[d]	Commercial/ Industrial Groundwater - NC RBSL[d]	Commercial/ Industrial Groundwater Investigation SL[e]
		(µg/m^3)	(µg/m^3)	(--)	(--)	(µg/L)	(µg/L)	(µg/L)
75354	1,1-Dichloroethylene		880	1.07E+00	0.001		825	830
123911	1,4-Dioxane	2.5	130	1.96E-04	0.001	12,700	663,000	13,000
156592	cis-1,2-Dichloroethylene			1.67E-01	0.001			
127184	Tetrachloroethylene	47	180	7.24E-01	0.001	65	249	65
79016	Trichloroethylene	3	8.8	4.03E-01	0.001	7.45	21.9	7.5
75014	Vinyl chloride (chloroethene)	2.8	440	1.14E+00	0.001	2.46	387	2.5

a: Indoor air risk-based screening level (RBSL) based on USEPA (2014a) exposure assumptions and equations (Table 1) using toxicity values in Table 2.
The C RBSL values were derived using a target cancer risk level (TRL) of 1E-06.
The NC RBSL values were derived using a target noncancer hazard quotient (THQ) of 1.
b : Henry's Law Constant (HLC) values are taken from USEPA (2014a). HLCs are assumes at 25 degree Celsius.
c : Commercial/industrial groundwater-to-indoor-air RBSLs are based on the EPA (2014b, c) groundwater-to-indoor attenuation factor of 0.001.
d : The RBSLs is calculated dividing the associated indoor air RBSL by the Henry's Law Constant, the groundwater-to-indoor-air attenuation factor, and a conversion factor of 1,000 liters per cubic meter.
e : The vapor intrusion screening level is the lowest value between carcinogenic and non-carcinogenic RBSLs.
Notes:
C : carcinogenic (cancer-causing)
NC : non-carcinogenic (non-cancer-causing)
CASRN : chemical abstract service registry number
µg/m^3 : micrograms per cubic meter
EPA : United States Environment Protection Agency.

EPA, 2014a. Regional Screening Levels for Residential Soil. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm
EPA, 2014b. Vapor Intrusion Screening Levels. http://www.epa.gov/oswer/vaporintrusion/guidance.html#Item6
EPA, 2014c. DRAFT OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE SOURCES TO INDOOR AIR. September 4.

TABLE 10
Summary of Screening Levels and Removal Action Levels
700 South 1600 East PCE Plume
Salt Lake City, Utah

CASRN	Chemical	Residential Indoor Air SL	Residential Indoor Air Tier 1 RAL	Residential Indoor Air Tier 2 RAL	Residential Soil Gas SL	Residential Groundwater SL	Commercial/ Industrial Indoor Air SL	Commercial/ Industrial Indoor Air Tier 1 RAL	Commercial/ Industrial Indoor Air Tier 2 RAL	Commercial/ Industrial Soil Gas SL	Commercial/ Industrial Groundwater SL
		(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/L)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/L)
75354	1,1-Dichloroethylene	210	210	630	7,000	200	880	880	2,640	29,000	830
123911	1,4-Dioxane	0.56	5.6	56	19	2,900	2.5	130	390	83	13,000
156592	cis-1,2-Dichloroethylene										
127184	Tetrachloroethylene	11	41	120	370	15	47	180	540	1,600	65
79016	Trichloroethylene	0.48	2.1	6.3	16	1.2	3	8.8	26	100	7.5
75014	Vinyl chloride (chloroethene)	0.17	1.7	17	5.7	0.15	2.8	440	1,320	93	2.5

Notes:
SL : screening level
RAL : removal action level

TABLE 11
Site Management Decision Matrix
700 South 1600 East PCE Plume
Salt Lake City, Utah

Indoor Air SL/RAL Comparison Result	Site Management Decision	Possible Actions
Indoor Air <= SL	No further evaluation or actions	None
SL < Indoor air <= Tier 1 RAL	Monitoring and Further Evaluation	Additional Data Collection
		Periodic Monitoring
		Additional Data Evaluation
Tier 1 RAL < Indoor Air <= Tier 2	Further Evaluation, Mitigation, Monitoring	Additional Data Collection
		Long-term Mitigation
		Periodic Monitoring
		Additional Data Evaluation
Indoor Air >= Tier 2 RAL	Response Action Needed	Additional Data Collection
		Short-term Mitigation (e.g., portable filtration)
		Long-term Mitigation
		Periodic Monitoring
		Additional Data Evaluation

Notes:
SL : investigation screening level
RAL : removal action level

APPENDIX G

Community Involvement Plan
700 South 1600 East Street PCE Plume
Salt Lake City, Utah

July 17, 2015

Prepared by: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

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List of Acronyms

ATSDR - Agency for Toxic Substances & Disease Registry

CAG - Community Advisory Group

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act of 1980, commonly called Superfund

CIP - Community Involvement Plan

EPA - United States Environmental Protect Agency

HRS - Hazard Ranking System

MCL - Maximum Contaminant Level

NPL - National Priorities List

OU - Operable Unit

PCE - **P**er**c**hloro**e**thylene or Tetrachloroethylene

PA/SI - Preliminary Assessment/Site Investigation

PRP - Potentially Responsible Party

ROD - Record of Decision

RD/RA - Remedial Design/Remedial Action

RI/FS - Remedial Investigation/Feasibility Study

SARA - Superfund Amendments and Reauthorization Act 1986

TAG - Technical Assistance Grant

TASC - Technical Assistance Services for Communities

TCE - Trichloroethylene

UDEQ - Utah Department of Environmental Quality

VA - United States Department of Veterans Affairs

VAMC - VA Medical Center

VHA – Veterans Health Administration, one of the three agencies in the Department of Veterans Affairs that administers the Salt Lake City Health Care System

VOC - Volatile Organic Compound

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1.0 Overview of Community Involvement Plan

The U.S. Department of Veterans Affairs (VA), in consultation with the U.S. Environmental Protection Agency (EPA) Region 8 and Utah Department of Environmental Quality (UDEQ), developed this Community Involvement Plan (CIP) for the 700 South 1600 East PCE Plume Superfund site (the Site) in Salt Lake City, Utah. The CIP will provide a framework to facilitate communication among community members and the VA and its partner agencies to encourage community involvement in site activities. The VA will use the community involvement activities outlined in this plan to ensure that residents are continuously informed and provided ample opportunities to be involved. Acronyms used in this CIP can be found preceding this section.

The VA drew upon several information sources to develop this plan including community interviews, site files, U.S. Census Bureau demographic information provided by the EPA, and informal meetings with stakeholders and information sessions.

2.0 Capsule Site Description

2.1 Site History

On May 24, 2013, the EPA added the 700 South 1600 East PCE Plume site to its National Priorities List (NPL) of Superfund sites. The listing became final on June 24, 2013. A former dry-cleaning facility at the nearby Salt Lake City VA Medical Center (VAMC) currently is the only identified source in the area for groundwater beneath the Site that is contaminated with tetrachloroethylene, commonly known as PCE. PCE levels at the Site are in excess of Federal drinking water standards, but drinking water for the community, which comes from the Salt Lake City public water supply, is not impacted. Salt Lake City routinely tests its drinking water pursuant to Federal standards. In addition, the artesian fountains at Liberty Park and at 800 South and 500 East are routinely tested and no PCE has been detected. As the only known PCE source, the VA is responsible for leading the cleanup under the Superfund program. The addition of the Site to the NPL requires the VA to pay for and manage the cleanup. Placement on the NPL guarantees the public the opportunity to participate in the cleanup process from its early stages, which includes a detailed site assessment and investigation.

2.2 Site Description and Location

The Site is located on the East Bench in Salt Lake City, Utah. The plume is located generally within the area bounded by 500 South and Michigan Avenue and between Guardsman Way and 1100 East. Figure 1 in Appendix A shows the area of investigation. At the time of publication of this CIP, the extent of the plume has not been defined. Upcoming studies will help establish the boundaries of the plume.

2.3 Site Investigation and Activities

PCE contamination was first detected in this area in the 1990s during routine sampling of the Mount Olivet Cemetery irrigation well. This detection led to the discovery of the Site, formerly known as the Mount Olivet Cemetery Plume, and several subsequent investigations.

The EPA first associated the Salt Lake City VA Medical Center (VAMC) with the Site in 1995 as the result of a State of Utah report. This State report was unable to determine where the PCE contaminating the Site originated but pointed out that the VAMC operated a dry-cleaning facility on site in the late 1970s. The EPA first became interested in the Site for listing on the NPL in 2003-2004 when a site investigation detected PCE in a Salt Lake City municipal drinking water well at a concentration of 2.23 µg/L. The national drinking water standard for PCE is 5.0 µg/L. But, as a precautionary measure, Salt Lake City Public Utilities removed the well from service even though the drinking water was defined as safe.

The EPA notified the VA in 2006 that it would defer listing the Site on the NPL while local city officials sought money from Congress to address the issue. Previous UDEQ and EPA investigations indicated that while PCE was found in deep groundwater, no PCE was detected in surface water springs in the City. At that time there did not appear to be any means for people in the community to come in contact with PCE in the relatively deep groundwater.

In 2010, PCE was discovered again in several residential springs located downgrade from the plume. A Preliminary Assessment/Site Investigation (PA/SI) completed in 2011 by UDEQ confirmed the presence of PCE in the springs and shallow groundwater and concluded that the contamination is likely connected to the 700 South 1600 East PCE Plume.

The EPA and UDEQ concluded from their 2011 preliminary investigation that PCE from the VA impacted the groundwater. The EPA and UDEQ were unable to identify other potentially responsible parties other than the VA that may have contributed to the contamination.

The full extent of the plume has not been delineated; however, initial groundwater computer modeling indicates that the plume is approximately 300 acres in size. Figure 1, attached, depicts the general location of the plume. Note than in 2010 it was discovered that the springs along the Wasatch Fault were impacted by PCE. Left uncontrolled, the plume could continue to migrate.

Both the City and State supported the proposed listing of the Site on the NPL on September 18, 2012 as mitigation funding efforts failed locally and site conditions and PCE exposure pathways were better defined. Final listing of the Site on the NPL occurred in May 2013.

2.4 Site Risk

PCE is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal degreasing. Exposure to PCE could pose a threat to human health and the environment. The U.S. Department of Health and Human Services has determined that PCE may reasonably be anticipated to be a carcinogen.

In addition to drinking water concerns at the Site, PCE in groundwater evaporates easily, allowing vapors to move through the soil and into buildings through basement foundations. Because buildings are not airtight, vapors may enter through cracks in the foundation, gaps around pipes, and other openings. In extreme cases, the vapors may accumulate in homes and buildings to levels that may pose health effects (i.e., nausea) or aesthetic problems (odors). Typically, however, chemical concentrations are low or, depending on site-specific conditions, vapors may not be present at detectable concentrations. In residences with low concentrations, chemical exposures over many years may raise the lifetime risk of cancer or chronic disease.

Symptoms of respiratory exposure to PCE include irritation, dizziness, headaches, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Initial symptoms of PCE exposure include respiratory irritation at or around an inhalation concentration of 200 ppm. As a comparison, the known maximum concentration of PCE in the groundwater is 0.320 ppm identified during an investigation in November 1998.

Trichloroethylene (TCE) was also detected in the groundwater during the investigation of the PCE plume at concentrations of 0.012 and 0.013 ppm. TCE is another widely used chemical used mainly as a solvent to remove grease from metal parts. The detected TCE may be a breakdown product of PCE or be the result of an unknown source of groundwater contamination. The EPA reasonably anticipates TCE to be a human carcinogen and has reported a wide-range of human health effects from TCE exposure. The EPA's Maximum Contaminant Level (MCL) for TCE in drinking water is 0.005 ppm.

The Agency for Toxic Substances and Disease Registry (ATSDR) and the Utah Department of Health are planning to conduct a Public Health Assessment for the Site. The assessment will review available information about hazardous substances at the Site and evaluate whether exposure to those substances may be hazardous to people.

Most recently, information about potential health impacts from exposure to environmental contaminants in the area comes from the Red Butte Creek Oil Spill of June 2010. The Utah Department of Health's Environmental Epidemiology Program has partnered with the Salt Lake Valley Health Department and Salt Lake City to determine possible health issues relating to crude oil exposure from the Red Butte Creek Chevron Oil Spill.

Results were published in a public health assessment and a subsequent health consultation, both produced through a cooperative agreement with the ATSDR. The public health assessment evaluated the potential for long-term health impacts in the community from exposure to components of crude oil. It also addressed the crude oil contaminants, and water and air that were impacted during the spill. Based on the review of available data, the oil spill is not associated with any immediate health hazards to the community.

A subsequent health consultation addressed specific community concerns regarding exposures to chemicals from the crude oil (called polycyclic aromatic hydrocarbons, or PAHs) that had affected the water and creek soil sediment. Based upon the available data regarding water and soil contamination of Red Butte Creek, the Environmental Epidemiology Program found no apparent health hazard to the community because of PAH exposure.

The studies found no incidence of cancer clusters.

Complete results of the Red Butte Creek health studies can be found on the Utah Department of Health's website at:
http://www.health.utah.gov/enviroepi/appletree/redbuttecreekoilspill/frontpage.htm

While the chemicals from the Chevron oil spill are not the same as PCE, they are in the same family of chemicals and exposure pathways would be comparable.

3.0 Regulatory Framework

3.1 CERCLA (Superfund) Process Overview

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, known as CERCLA or Superfund, provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through CERCLA, the EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup. The Superfund Amendments and Reauthorization Act (SARA) of 1986 reauthorized CERCLA and provided additional opportunities for affected residents to participate in the decisions for cleanup.

The EPA obtains private party cleanup through orders, consent decrees, and other small-party settlements. The EPA also recovers costs from financially viable individuals and entities once a response action has been completed. Its authority may be applied against government agencies in the same way through federal facilities agreements (FFA).

The Superfund process involves:

1. Preliminary Assessment/Site Inspection (PA/SI)- reports on the initial/current state of a site.
2. Hazard Ranking System (HRS) Scoring determines if the site should be on the National Priorities List (NPL).
3. NPL Site Listing Process prioritizes the most serious sites.
4. Remedial Investigation/Feasibility Study (RI/FS) studies the degree of site contamination, evaluates potential remedies and selects a preferred remedy.
5. Proposed Plan presents the preferred remedy in a plan to the public for comment.
6. Record of Decision (ROD) - explains which cleanup alternatives will be used to clean up a Superfund site. The ROD for sites listed on the NPL is created from information generated during the RI/FS.
7. Remedial Design/Remedial Action (RD/RA) plans and implements the selected remedy.
8. Operation and Maintenance ensures long-term protection for the community and the environment when construction is complete.
9. Deletion from the NPL when no further response is required to protect human health or the environment.

3.2 Status of Superfund Work at the 700 South 1600 East Plume Site

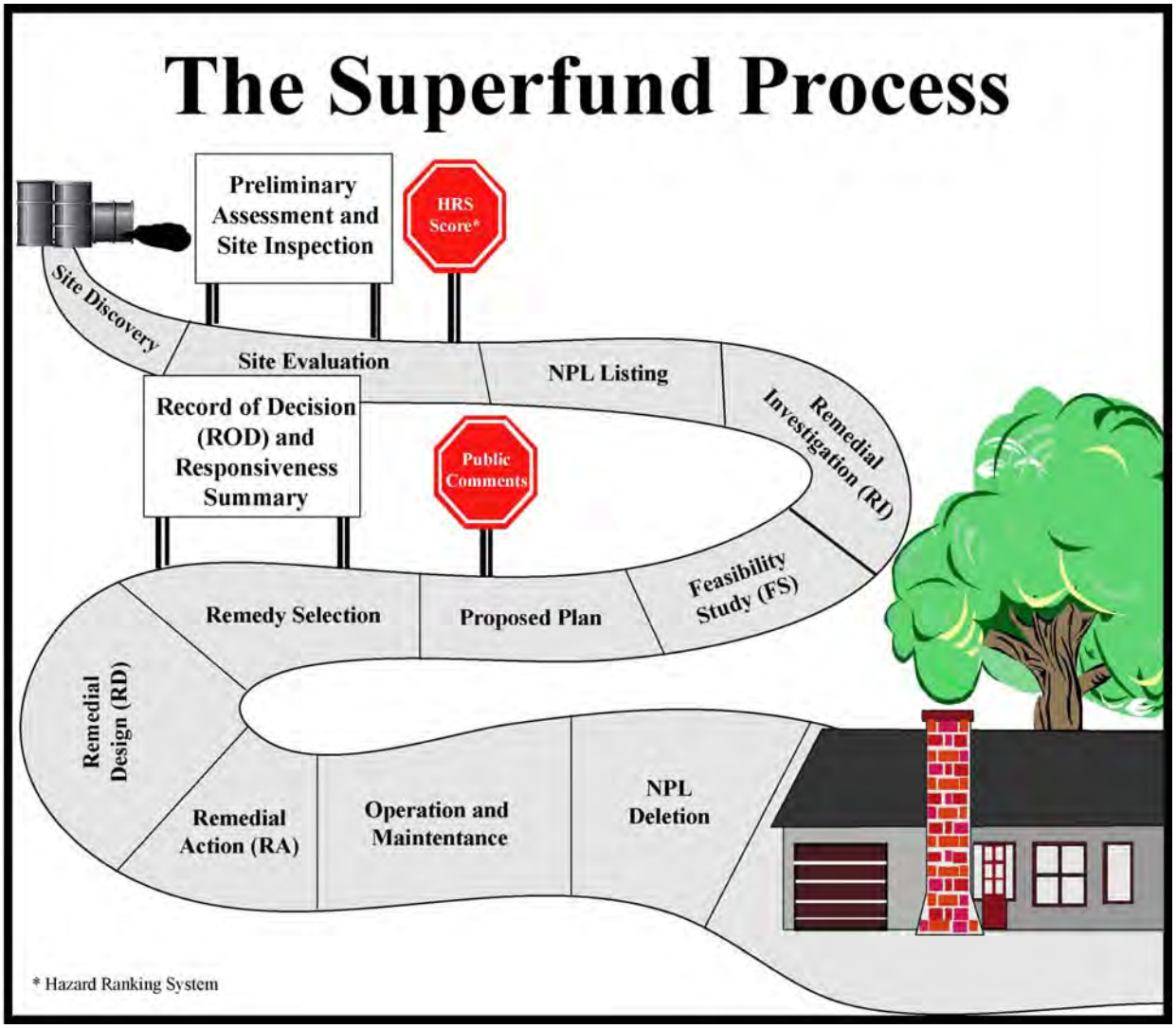
The 700 South 1600 East PCE Plume site was formally listed on the NPL in May 2013, and the VA is currently the only known responsible party. Listing of the Site on the NPL is a preliminary step toward the investigation and remediation of a CERLCA Site. Listing also launches the preparation of numerous documents that outline how the VA will manage the Site investigation (Site Management Plan), how the VA will inform the local community (this Community Involvement Plan), and a Conceptual Model of how the contamination is believed to have occurred and how it may be migrating in the subsurface. In addition, the VA must develop a series of documents, collectively known as a Remedial Investigation Work Plan (RIWP), that define the specific investigation plans for the Site including quality assurance requirements,

health and safety requirements for investigators and the public, and field sampling methods required to characterize the site and determine the nature and extent of contamination in groundwater, surface water, soil, and air. The EPA and UDEQ must then approve these plans before active investigation of the Site can begin.

The VA has identified two specific “Operable Units” or OUs to focus on during the Plume investigation. The AOU-1 (the “A” designates the term “Accelerated”) area consists of the East Side Springs area where PCE is discharging to surface water via springs and seeps and has a higher potential to impact the public. Investigation of AOU-1, particularly for potential human health impacts will be conducted as soon as the CERCLA process allows. The AOU-1 investigation, because it will take place in residential neighborhoods, will be highly visible to residents, and the VA will communicate with residents regarding the processes, sampling, and progress of the investigation as it proceeds.

OU-2 covers the area of the plume contained in deep groundwater beneath and near the VA property where the contamination may have migrated to affect water supply wells, and the potential exists for soil contamination on VA property. The OU-2 investigation, while planned to be conducted almost simultaneously with the AOU-1 investigation, will proceed at a slower rate since the deep location of the contaminants make them much more isolated from human contact. The VA will also continue to inform the community as the work proceeds; however, the targeted area is less residential in nature and will likely be less intrusive to the community.

The illustration below shows the Superfund process from beginning to the conclusion of a cleanup.



3.3 Government Agencies and Roles

The cleanup of the Site will require collaboration among several Federal, State and local governments. A brief description of each and its role in the process follows.

3.3.1 U.S. Department of Veterans Affairs

VA provides health care and other benefits for many of the country's veterans. A former dry-cleaning operation at its George A. Wahlen VA Medical Center in Salt Lake City currently has been identified as the source of the PCE contamination at the 700 South 1600 East PCE Plume Site. Therefore, the VA is responsible for leading and financing the cleanup of the Site.

3.3.2 U.S. Environmental Protection Agency

The EPA protects Americans from significant risks to human health and the environment. Superfund is the federal government's program to clean up the nation's uncontrolled hazardous waste sites. The EPA must enforce the Superfund law against government agencies just as it would any other entity. It will oversee the cleanup under a Federal Facilities Agreement and must agree to the proposed remedy.

3.3.3 Utah Department of Environmental Quality

The Department of Environmental Quality is charged with safeguarding public health and quality of life by protecting and enhancing the environment. It implements State and Federal environmental laws and works with individuals, community groups, and businesses to protect the quality of air, land, and water throughout Utah. The Department of Environmental Quality also will oversee the cleanup under a Federal Facilities Agreement and must agree to the proposed remedy.

3.3.4 Salt Lake City

Salt Lake City is the capital and largest city in Utah with a population of approximately 190,000 in the city and 1.2 million in the metropolitan area. As a precautionary measure, Salt Lake City Public Utilities has removed from service one well threatened by the groundwater contamination suspected as resulting from the 700 South 1600 East PCE Plume.

4.0 Community Background

4.1 Community Profile

The Site is located near the George E. Wahlen Department of Veterans Affairs Medical Center (VAMC) on the east side of Salt Lake City. The preliminary area of investigation is generally bounded on the west side by 900 East, on the north by 500 South, on the east by 1600 East, and on the south by Yale Avenue. The investigation area is defined by the limited amount of existing data collected over a number of years that includes results from groundwater sampling on and immediately adjacent to the VA property, and spring and groundwater sampling to the west-southwest of the VAMC at the East Side Springs. The ultimate investigation area for the Plume will be refined as more data are collected during the Remedial Investigation process.

The north and eastern portion of the Site is mostly a mix of parkland (Sunnyside Park), public recreation and convention facilities, a large cemetery, schools and school athletic fields, and VA property, with a limited number of residences and businesses. The western and southern sides of the Site are predominantly residential but include several businesses and schools, including East High. Figure 1.0 in Appendix A contains a map showing the locations of various buildings, streets, and residential areas relative to the Site. According to U.S. Census Bureau data provided on EPA's EJ View website, approximately 40,138 people live within a 1.5 mile radius of the Site. Approximately 16 percent of the population is minority. Per capita income is $32,268 per year and 29 percent of the households have incomes of more than $75,000 per year.

4.2 History of Community Involvement

A variety of activities have taken place prior to engaging the community in the cleanup process at the Site:

- In the 1990s, PCE was first detected in the Salt Lake City area during the City's routine monitoring of the Mount Olivet Cemetery irrigation well. The detection of PCE in the cemetery well led to the discovery of the Site.
- A subsequent investigation of the Site in 2004 detected PCE in a Salt Lake City municipal drinking water well at a concentration of 0.00223 ppm. The investigation was conducted jointly by the Utah Department of Environmental Quality and the EPA. As a precautionary measure, the Salt Lake City Public Utilities removed the well from service.
- Based on the 2004 investigation, the UDEQ and the EPA returned to the Site in 2005 to collect groundwater samples to prepare a Hazardous Ranking System (HRS) package to propose the Site to the NPL.
- In 2010, as part of a review to assess the impact of the Red Butte Creek Chevron Oil Spill, the Salt Lake City Department of Public Utilities detected PCE again in multiple residential springs located downgradient of the plume on the east bench of Salt Lake City. This discovery lead to the portion of the Site referred to as "East Side Springs."
- A Site Inspection Analytical Results Report was prepared in 2012 for the East Side Springs by the UDEQ concerning the Site's PCE soil exposure pathway, groundwater migration pathway, surface water migration pathway, and air migration pathway.
- The EPA published a public notice inviting public comment concerning its intent to list the Site on the NPL in May 2012 and a Fact Sheet and press release announcing its proposal in August 2012.

- The EPA added the Site to the NPL in May 2013.
- Beginning in December 2013 and continuing through February 2014, the VA, EPA, and UDEQ conducted approximately 20 community interviews. The interviewees included three elected city officials, five school staff, six local community council members, a Utah Department of Public Health member, and several area residents to determine citizen awareness and concerns about the Site. The results of these interviews are summarized in the section on community concerns. The interview questions can be found in Appendix B. Community council districts affected by the 700 South 1600 East PCE Plume Site can be found in Appendix C.
- The VA, with support from the EPA and UDEQ and the East Central Community Council, held an open house and public meeting at the McGillis School on March 13, 2014. Approximately 75 community members attended the meeting and 45 people signed up to receive more information about having their properties tested for contaminants during the Remedial Investigation and Feasibility Study. An additional request for testing was received by phone after the community meeting.
- The VA conducted two briefings for Salt Lake City, Salt Lake County, and other local officials about the upcoming RI/FS and other Site activities on February 28, 2014 and March 13, 2014.
- A local Information Repository containing Site documents and public comment has been established on the third floor of the Salt Lake City Main Library, 210 E. 400 South. The EPA also maintains an Information Repository for this Site at its Denver headquarters.

4.3 Key Community Concerns

As stated, community interviews conducted from December 2013 through February 2014 included residents and representatives from community councils, school officials, and Salt Lake City Council. The results of these community interviews and feedback obtained from participants in the March 2013 open house and community meeting identified the following community members' concerns about groundwater contamination and the RI/FS:

Vapor intrusion – Public safety, especially for children who attend the McGillis School, Rowland Hall, and East High School, was a high priority for community members. Concerns were raised concerning previous testing and what kind of testing will be done for those schools in the future. Also, how much of the area will be tested and will the equipment be placed in locations where children would be unable to tamper with them. Homeowners requesting testing on their property stated that they will need adequate prior notice.

Community members who participated in the interviews and the open house were concerned more about risks associated with potential vapor intrusion than with drinking water. Drinking water provided by Salt Lake City is not sourced from groundwater that is the focus of these studies.

To address concerns regarding vapor intrusion, the VA will conduct indoor air quality reviews of potentially affected residences and structures to determine if mitigation actions on a case-by-case basis are necessary.

Cancer clusters – Some concern exists that higher than normal incidences of cancer are occurring in the community. The Public Health Assessment to be conducted jointly by the ASTDR and Utah Department of Environmental Quality will address this concern.

Impacts to vegetable gardens – Gardening is popular in the area and a number of community members asked if groundwater contamination could affect home-grown vegetables. The McGillis School is planning on planting various gardens on school property and staff members want to know how contamination, testing, and clean-up efforts might affect their gardens. The Public Health Assessment to be conducted jointly by the ASTDR and Utah Department of Environmental Quality will address this concern.

Property values and Superfund status – Residents expressed concern that the Superfund designation might negatively affect property values, and they are uncertain if a property owner must disclose Superfund status when selling a home in the area. One resident asked if the Site would no longer be a Superfund site once cleanup is complete.

Water Quality – One interviewee for this plan asked whether the surface water at Miller Park is safe. Another was concerned about the springs along 1300 East and the status of the artesian well water at the park. Salt Lake City tests the public drinking water supplies, including Miller and Liberty Park, to ensure their safety.

Scope and duration of site investigations – Interviewees want the VA to establish the official boundaries of the Site and to evaluate if contamination is migrating. They also want to learn about the investigation process and how long it will take. To address these concerns, the VA will continue to investigate the Site to better clarify the boundaries of the plume.

Communication and agency cooperation – Interviewees expressed the hope that local, State and Federal agencies involved in the RI/FS are effectively collaborating and communicating. The VA is striving to ensure that all stakeholders are provided updates to the site investigation and outcomes of the review and will hold the necessary meetings to achieve this goal.

Impact on funding Superfund Project on VA's budget – Funding the CERCLA/Superfund Project will have an impact on the Rocky Mountain Veterans Health Administration's operating budget for several years, but the VA is continuously working with all parties to mitigate this impact and to ensure our Veterans continue to receive care second to none.

University of Utah secondary water – In the past, the University of Utah converted potable water wells to secondary use, such as for irrigation. Some concern exists that increased pumping of these wells in the future could affect the movement of PCE in the groundwater and result in impact to the school's irrigation supply well. The VA will address this concern as part of its planned remedial investigation at the Site.

4.4 Response to Community Concerns

In response to community concerns discovered during community interviews, the March open house and community meeting, and in briefings with local officials, the VA is accelerating its remedial investigation plan for the AOU-1 East Side Springs area and will test properties where there is a reasonable likelihood that vapors might be present prior to completely defining the PCE plume boundaries. The VA, in cooperation with the EPA and UDEQ, also will conduct additional community meetings and briefings about Site activities for residents, local officials, and other stakeholders. The VA will develop a web site to publish new information and alert the community about upcoming meetings. Additionally, the VA will provide opportunities for the public to review and comment on the Proposed Plan to address groundwater contamination and its impacts. Section 5 contains detailed information about the VA's community outreach and involvement program.

The ATSDR will help address community health concerns by conducting a Public Health Assessment. The assessment will consider:

- what are the levels (or "concentrations") of hazardous substances;
- potential routes of exposure (i.e., exposure pathways) to PCE such as inhalation, dermal contact, etc.;
- what harm, if any, the substances might cause to people and their pets (or the contaminants' "toxicity").

More information on Public Health Assessments can be found at the ATSDR's website http://www.atsdr.cdc.gov/com/pha.html

5.0 Community Outreach and Involvement Program

The goal of the community involvement program for the 700 South 1600 East PCE Plume Site is to promote effective communication between Salt Lake City residents and the VA, EPA, and UDEQ, and to provide opportunities for meaningful and active involvement by the community in the groundwater cleanup process.

Community involvement is encouraged and is legally required to fulfill the intent of the Superfund law. Involvement by the community supports the core values behind the legislation, which include:

- people have a say in decisions that affect them;
- public participation includes the promise that input from the community will be thoughtfully considered;
- the process should communicate the interests and meet the needs of all participants;
- agencies will seek and facilitate involvement from those affected by contaminants;
- citizens can define how they participate;
- citizens will be provided with the information they need to participate; and
- communication to citizens will explain how their input was or was not used in the decision-making process.

5.1 Communications Techniques

The VA, in conjunction with the EPA and UDEQ, will employ the following diverse communication techniques to meet the VA's community involvement goal:

- The VA will develop and arrange for publication of public notices in the *Salt Lake Tribune* and *Deseret News* announcing the formal public comment period for the Proposed Plan, and other documents, if needed. Public notices will be placed at least five days prior to any public meetings. Electronic and broadcast news outlets will also be engaged to help solicit public comments. The VA will provide local news media with press releases to announce important news about project activities. Appendix D contains a list of local news media and recent news media coverage about the Site.
- News about Site activities and progress will be posted regularly on appropriate websites, such as websites hosted by the EPA, UDEQ, the City, public health agencies, and local community councils.
- The VA will develop a website that will contain timely information about the status of project activities and will be maintained by the VA. This website will complement other websites already established to inform community members about the Site (see Appendix E).
- Information repositories will be maintained at the following locations:
  Salt Lake City Main Library
  Third Floor
  210 E. 400 South
  Salt Lake City, UT 84111
  801-524-8200

U.S. Environmental Protection Agency
Region 8 Headquarters
Technical Library, 2nd Floor
1595 Wynkoop Street
Denver, CO 80202
Hours: 8 a.m. – 4 p.m. Mon. – Thur.

- The VA will develop fact sheets, FAQs, flyers, postcards, and other materials, as needed, to keep the community informed about Site activities.
- The public will be invited to public meetings, including a formal public meeting for the Proposed Plan, and small-group meetings. Notification of public meetings and formal public comment periods associated with the cleanup will be published in the *Salt Lake City Tribune* and *Deseret News* and be included on websites and Salt Lake City's community notice board.
- Periodic briefings will be held for Federal, State and local elected officials and other government agency staff.
- All public information will include contact information for key project team members (see Appendix F for contact information for the VA, EPA, and UDEQ).
- An e-mail list will be maintained as part of this CIP by the VA. Persons requesting to be placed on the list will receive announcements of upcoming public meetings and the availability of new site-specific information at the Information Repository at the Salt Lake City Main Library.
- Local community councils, schools, businesses and other community members who have a vested interest in the cleanup of the site will be engaged and encouraged to participate in community involvement activities. (See Appendices G -J)

6.0 EPA Technical Assistance for the Community

The EPA can serve the residents of Salt Lake City by providing direct resources and technical assistance to the community so that it better understands the science and regulation concerning the Site investigation and cleanup. EPA offers this assistance in multiple ways, including the Technical Assistance Services for Communities (TASC) program and Technical Assistance Grants (TAG).

The TASP program is a national initiative that seeks to improve community knowledge and participation in local environmental issues and EPA actions. Specific offerings that the TASC provides, include

- community training;
- educational presentations;
- technical assistance needs assessments;
- reviewing and explaining technical information;
- helping communities form Community Advisory Groups (CAG);
- facilitating community meetings; and
- developing information materials for communities.

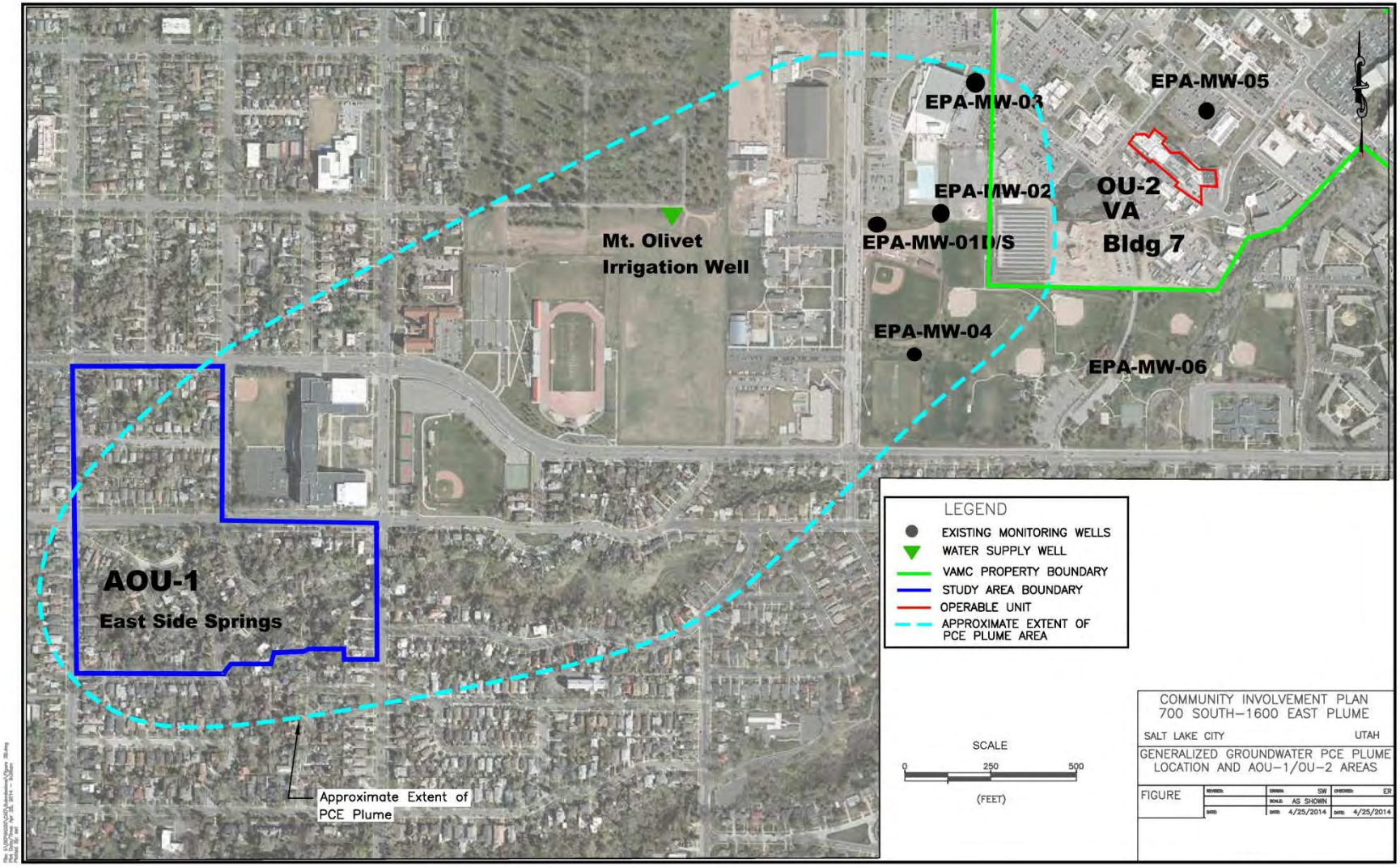
A CAG can be formed by members of the Salt Lake City community with assistance from the TASC and can serve as the focal point for the exchange of information among the local community and EPA, the State regulatory agency, and other pertinent Federal agencies involved in cleanup of the Superfund site.

The EPA also makes available Technical Assistance Grants (TAG) to qualified community groups to facilitate participation in decision making at eligible Superfund sites. An initial grant up to $50,000 is available to qualified groups so they can access independent advisors to interpret and help the community understand technical information about the Site.

If a TAG is awarded and/or a CAG is formed for the Site, these groups will help keep the VA, EPA, and UDEQ informed about questions or concerns on behalf of the community and help disseminate information about Site activities and progress.

Additional information about the TASC program and TAG can be obtained by contacting the EPA Regional TASC Project Coordinator at (303) 312-6695 or coursen.robin@epa.gov.

ATTACHMENT 1
Figure 1- Site Location and Description



ATTACHMENT 2
Community Interview Questions

Questions:

1. How long have you lived in the area?

2. What do you know about the PCE Plume? When did you first become aware of the Site?

3. Do you have any health/environmental concerns regarding the plume?

4. Do you have any questions or concerns regarding the remedial investigation and feasibility study and the sampling and investigations that will start soon?

5. Have you every utilized or do you plan to utilize the PCE Plume information repository that's been established at the main Salt Lake City Library?

6. What is the best way to get information to you and in your opinion, to the community? For instance, Salt Lake Tribune, local radio stations, direct mailing, and/or PSA's?

7. Are you interested in receiving specific information on a regular basis about the cleanup developments at the Site? If so, would your preference be to receive information through the mail or email?

8. Are you familiar with EPA's website? If EPA were to establish a Facebook page or Twitter page to provide updates in regards to the Standard Mine, would you find this way of communicating more useful than the EPA website?

9. Now that you're aware of the PCE Plume, are there other people, civic or public groups, that we should contact for an interview?

10. Is there anything else you would like to add or do you have any questions?

ATTACHMENT 3
Community Council Districts in the Affected Area of the 700 South 1600 East Plume

City Council District 4

East Central Community Council
Esther Hunter Chair
Nate Salazar Co-Chair
606 Trolley Square
Salt Lake City, Utah 84102
Website: http://eastcentralcc.org/
Email: ecchair@live.com

City Council District 5

East Liberty Park Community Council
Michael Cohn
P.O. Box 520123
Salt Lake City, Utah 84125
Phone: 801-521-9450
Fax: 801-770-2040
Website: http://www.elpco.org/
Email: Macohn9@comcast.net

City Council District 6

Yalecrest Community Council
Kelly White
1068 South 1700 East
Salt Lake City, Utah 84108
Phone: 801-582-0445
Website: http://www.ycccslc.com/
Email: Kellym.white@comcast.net

ATTACHMENT 4
News Media Contacts and Recent News Media Coverage

News Media Contacts

- KUTV, (CBS Affiliate): newsdesk@kutv.com: reporter varies
- KSL, (NBC Affiliate) KSL Radio and the Deseret News: assignment.desk@ksl.com: reporter Jed Boal (possible)
- KTVX, (ABC Affiliate): news@abc4news.com: reporter varies
- KSTU, (FOX Affiliate): news@kstutv13.com: reporter varies
- KUER (NPR): news@keur.org: reporter varies
- Salt Lake Tribune: newsroom@sltrib.com: reporter Kristen Moulton
- Deseret News: newstips@desnews.com: reporter Amy Joi O'Donoghue
- KUED (local University of Utah Public Broadcast Channel) Community Outreach (801) 585-3523 or main number: (801)-581-7777

Recent News Coverage

Salt Lake Tribune

Investigators take on east side Superfund groundwater site

Cleanup • Officials to address residents Thursday evening on mitigation effort.

By Christopher Smart

Published: March 12, 2014 12:09PM

Updated: March 11, 2014 10:27PM

Federal and state agencies are moving forward with the assessment and cleanup of a contaminated groundwater plume on Salt Lake City's east side that was added to the Superfund cleanup list last year.

Environmental officials will meet Thursday evening with residents concerned about groundwater contaminated by tetrachloroethylene (PCE), a man-made chemical commonly used in dry cleaning.

The plume is believed to be about 300 acres in size and generally located between Guardsman Way and 1100 East downslope from the Veterans Administration Hospital. Concentrations of PCE were found to be 60 times the limit for drinking water. In high concentrations, the chemical can cause dizziness and headaches, nausea, motor difficulties, and even death.

Investigators hired by the VA are beginning to formulate a "remedial investigation work plan" and will make a presentation and hold a question-and-answer session with residents Thursday at 6:30 p.m. at the McGillis School, 668 E. 1300 South.

The meeting is being hosted by the East Central Community Council, according to Chairwoman Esther Hunter. It is open to all Salt Lake City residents and property owners.

"We're grateful the V.A. is taking responsibility and we're fortunate they are leading the cleanup," she said.

The work plan is the first step toward more accurately defining the plume and seeking ways to mitigate its impacts, said D. Lynne Welsh, the remedial manager for the Department of Veteran's Affairs in Salt Lake City.

The VA has taken responsibility for the contamination and cleanup, she said. The chemical has "vapor intrusive impacts" and can seep into homes.

"PCE is a volatile compound," Welsh said. "We want to make sure it doesn't get into people's basements."

Investigators will inspect residential housing with the permission of owners or tenants, Welsh said. Residents can sign up for inspections at Thursday's meeting.

The inquiry will look at various aspects of groundwater in the area and must also take into account housing foundations. Because foundations vary from structure to structure it's important that investigators evaluate as many as possible, Welsh said.

The probe will be followed by a feasibility study that will lead eventually to a mitigation plan.

"The fact that the VA is moving forward is good news," said Tom Daniels, remedial project manager for the Utah Department of Environmental Quality.

The state will provide support and oversight on the project, he said. "It's our job to look out for the concerns of the state and its residents," he said.

The federal Environmental Protection Agency also is involved in the project.

The contamination was discovered in the 1990s near the irrigation well for Mount Olivet Cemetery. In 2004, Salt Lake City removed a drinking-water well from service when trace amounts of PCE were discovered there.

csmart@sltrib.com

ATTACHMENT 5
Project Web Links

www.saltlakecity.va.gov

http://www.epa.gov/region8/superfund/ut/700southpce/index.html

www.deq.utah.gov

ATTACHMENT 6
700 South 1600 East Project Contacts

VA Salt Lake City Health Care System

George E. Wahlen Department of Veterans Affairs Medical Center
500 Foothill Drive
Salt Lake City, UT 84148
801-582-1565

Jill Atwood, Chief Communications Officer, 801-584-1252, cell 801-330-1198, jill.atwood@va.gov
D Lynne Welsh: Remedial Project Manager; 801-582-1565, ext. 2021, dlynne.welsh@va.gov

Veterans Health Administration
Dan Bruneau, HQ Office of Communications, 805-985-4739, cell 202-615-0641 (based CA), dan.bruneau@va.gov

Environmental Protection Agency (EPA)

U.S. EPA Region 8
1595 Wynkoop Street, Denver, CO 80202-1129

John Dalton, Community Involvement Coordinator, 303-312-6633, dalton.john@epa.gov
Mark Aguilar, Project Manager, 303-312-6251, aguilar.mark@epa.gov
Vera Moritz, Project Manager, 303-312-6981, moritz.vera@epa.gov

Utah Department of Environmental Quality (UDEQ)

Dave Allison, Community Involvement Coordinator, 801-536-4479, dallison@utah.gov
Tom Daniels, Project Manager, 801-536-4090, tdaniels@utah.gov

ATTACHMENT 7
Local Contacts

Local Agencies Involved in Cleanup				
NAME	**TITLE, ORGANIZATION**	**PHONE No.**	**ADDRESS**	**E-MAIL**
Vicki Bennett	Senior Environmental Advisor, Salt Lake City	801-535-6540	P.O. Box 145467 Salt Lake City UT 84114-5467	vickibennett@slcgov.com
Teresa Gray	Bureau Manager, Water Quality & Hazardous Waste, Salt Lake Valley Health Dept.	801-313-6713	2001 South State Street, Salt Lake City, Utah 84190-3050	Tgray@slco.org
Royal DeLegge	Director, Environmental Health, Salt Lake City Health Dept.	801-313-6602	788 East Woodoak Ln. Murray, UT 84107	rdelegge@slco.org
Jeff Niermeyer	Director of Public Utilities, SLC Corp.	801-483-6785	P.O. Box 145528 Salt Lake City UT 84115	jeff.niermeyer@slcgov.com
Jesse Stewart	Water Resources Manager Public Utilities, SLC Corp.	801-483-6864	P.O. Box 145528 Salt Lake City UT 84115	jesse.stewart@slcgov.com

Local Elected Officials and Community Leaders				
NAME	**TITLE, ORGANIZATION**	**PHONE No.**	**ADDRESS**	**E-MAIL**
Ralph Becker	Mayor, Salt Lake City	801-535-7704	451 S. State St, Rm 306 Salt Lake City, Utah 84111	mayor@slcgov.com
Ben McAdams	Mayor, Salt Lake County	385-468-7025	2001 S State St, Salt Lake City, UT 84190	mayor@slco.org
Charlie Luke	SL Council District 6 (primary councilperson)	801-535-7784	451 S. State Street, Salt Lake City Utah 84114	charlie.luke@slcgov.com
Luke Garrott	SL Council District No. 4 (neighboring district)	801-535-7782	451 S. State Street, Salt Lake City Utah 84114	luke.garrott@slcgov.com
Erin Mendenhall	SL Council District 5 (neighboring district)	801-535-7786	451 S. State Street, Salt Lake City Utah 84114	erin.mendenhall@slcgov.com
RandyHoriuchi	SL County Council At Large “A”	385-468-7451	2001 South State Street N2200 Salt Lake City, UT 84114-4575	rhoriuchi@slco.org
Richard Snelgrove	SL County Council At Large “B”	385-468-7452	2001 South State Street N2200 Salt Lake City, UT 84114-4575	rsnelgrove@slco.org
Jim Bradley	SL County Council At Large “C”	385-468-7453	2001 South State Street N2200 Salt Lake City, UT 84114-4575	jbradley@slco.org

ATTACHMENT 8

Utah Federal Contacts

NAME	TITLE, ORGANIZATION	PHONE No.	ADDRESS	E-MAIL
The Honorable Chris Stewart	United States Representative Congressional Dist. 2	801-364-5550	323 Cannon House Office Building, Washington, DC 20515-4402	Dell.smith@mail.house.gov
Orin Hatch	U.S. Senator	801-524-4380	8402 Federal Bld. 125 S State St. SLC, UT 84138	Zenock_bishop@hatch.senate.gov
Mike Lee	U.S. Senator	801-524-5983	Wallace F. Bennet FB 125 S State St. SLC. UT 84138	Wendy_johnson@lee.senate.gov

Utah State Contacts

NAME	TITLE, ORGANIZATION	PHONE No.	ADDRESS	E-MAIL
Herbert, Gary	Governor	801-538-1000	350 North State Street Suite 200 SLC, UT 84114-2210	garyherbert@utah.gov
Ross Romero	Utah State Senator	801-844-2212-O	1150 South 1400 East, SLC, UT 84105	ross@rossromero.net
Brian King	Utah State Representative	801-583-5464-H 801-532-1739-C	1855 Michigan Ave., SLC, UT 84108	briansking@le.utah.gov
Joel Briscoe	Utah State Representative	801-583-2281-H 801-946-9791-C	1124 E 600 S, SLC, UR 84102	jbriscoe@le.utah.gov

ATTACHMENT 9
Tribal Groups

Battle Mountain Band Council Joseph Holly, Chairman 37 Mountain View Drive, #C Battle Mountain, NV 98920 Ph: 775-635-2004 Fx: 775-635-8016	Las Vegas Paiute Tribe Benny Tso, Chairman 1 Paiute Drive Las Vegas, NV 89030 Ph: 702-386-3926 Fx: 702-383-4019 Website: www.lvpaiutetribe.com	Walker River Paiute Tribe Carl W. Johnson, Chairman P.O. Box 220 Schurz, NV 89427 Ph: 775-773-2306 Fx: 775-773-2585 Website: www.wrpt.us
Carson Colony Community Council W. Gary Nevers, Chairman 2900 South Curry St. Carson City, NV 89703 Ph: 775-883-6459 Fx: 775-883-6467	Lovelock Paiute Tribe Victor Mann, Chairman P.O. Box 878 Lovelock, NV 89419 Ph: 775-273-7861-Fx: 775-273-5151	Washoe Tribe of Nevada & California Darrel Kizer, Chairman 919 Highway 395 South Gardnerville, NV 89410 Ph: 775-265-4191 Fx: 775-265-6240 Website: www.washoetribe.us
Dresslerville Community Council Julie Barr, Chairperson' 1585 Watasheamu Gardnerville, NV 89460 Ph: 775-265-4564	Moapa Band of Paiutes Aletha Tom, Chairperson P.O. Box 340 Moapa, NV 89025 Ph: 702-865-2787 Fx: 702-865-2875 Website: www.moapapaiutes.com	Wells Band Council Michelle Cure, Chairperson P.O. Box 809 Wells, NV 89835 Ph: 775-345-3089 Fx: 775-752-2179
Duck Valley Shoshone-Paiute Tribe Dennis Smith Sr., Chairman P.O. Box 219 Owyhee, NV 89832 Ph: 208-759-3100 Fx: 208-759-3103 Website: www.shopaitribes.org	Pyramid Lake Paiute Tribe Elwood Lowery, Chairman P.O. Box 256 Nixon, NV 8942 Ph: 775-574-1000 Fx: 775-574-1008 Website: www.pyramidlake.us	Winnemucca Colony Council Thomas Wasson, Chairman P.O. Box 1370 Winnemucca, NV 89446 Ph: 775-623-0888 Fx: 775-623-0888
Duckwater Shoshone Tribe Virginia Sanchez, Chairperson P.O. Box 140068 Duckwater, NV 89314 Ph: 775-863-0227 Fx: 775-863-0301 Website: www.duckwatertribe.org	Reno-Sparks Indiann Colony Arlan Melendez, Chairman 98 Colony Road Reno, NV 89502 Ph: 775-329-2936 Fx: 775-329-8710 Website: www.rsic.org	Woodfords Community Council Vacant, Chairman 96A Washoe Blvd. Markleeville, CA 96120 Ph: 530-694-2170 Fx: 530-694-1890
Elko Band Council Gerald Temoke, Chairman 1745 Silver Eagle DriveP.O. Box 140068 Elko, NV 89801 Ph: 775-738-8889 Fx: 775-753-5439 Website: www.elkobandcouncil.org	South Fork Band Council Alice Tybo, Chairperson HC 30 Box B-13 Spring Creek, NV 89815 Ph: 775-744-4273 Fx: 775-744-4523	Yerington Paiute Tribe Linda Howard, Chairperson 171 Campbell Lane Yerington, NV 89447 Ph: 775-463-3301 Fx: 775-463-2416

Ely Shoshone Tribe Alvin S. Marques, Chairman 16 Shoshone Circle Ely, NV 89301 Ph: 775-289-3013 Fx: 775-289-3156 Website: www.elyshoshonetribe-nsn.gov	Stewart Community Council David Tom, Chairman 465 Clear Creek Carson City, NV 89701 Ph: 775-883-7794	Yomba Shoshone Tribe James Birchim Jr., Chairman HC61 Box 6275 Austin, NV 89310 Ph: 775-964-2463 Fx: 775-964-2443 Website: www.yombatribe.org
Fallon Paiute Shoshone Tribe Len George, Chairman 565 Rio Vista Dr. Fallon, NV 89406 Ph: 775-423-6075 Fx: 775-423-5202 Website: www.fpst.org	Summit Lake Paiute Tribe Randi DeSoto, Chairperson 1708 H Street Sparks, NV 89431 Ph: 775-827-9670 Fx: 775-827-9678 Websitye: www.summitlaketribe.com	Inter-Tribal Council of Nevada Daryl Crawford, Executive Director 680 Greenbrae Drive Sparks, NV 89431 Ph: 775-355-0600 Fx: 775-355-0648 Website: www.itcn.org
Ft. McDermitt Paiute-Shoshone Tribe Tildon Smart, Chairman P.O. Box 457 McDermitt, NV 89421 Ph: 775-532-8259 Fx: 775-532-8487	Te-Moak Tribe of Western Shoshone David Gonzales, Chairman 525 Sunset Street Elko, NV 89801 Ph: 775-738-9251 Fx: 775-738-2345 Website: www.temoaktribe.com	Las Vegas Indian Center, Inc. Debra Reed, Executive Director 2300 W. Bonanza Road Las Vegas, NV 89107 Ph: 702-647-5842 Fx: 702-647-4497 Website: www.lasvegasindiancenter.org
Confederated Tribes of Goshute Madeline Greymountain, Chairperson P.O. Box 6104 Ibapah, UT 84034 Ph: 435-234-1138 Fx: 435-234-1162 Website: www.goshutetribe.com	Timbisha Shoshone Tribe George Gholson,, Chairman 1349 Rocking W. Dr. Bishop, CA 93514 Ph: 760-872-3614 Fx: 760-690-4486 Website: www.timbisha.org	Nevada Indian Commission Sherry L. Rupert, Executive Director 5366 Snyder Ave. Carson City, NV 89701 Ph: 775-687-8333 Fx: 775-687-8330 Website: www.nic.nv.gov
		Nevada Urban Indians, Inc. Janet Reeves, Executive Director 745 W. Moana Lane, Suite 375 Reno, NV 89509 Ph: 75-788-7600 Fx: 775-788-7611 Website: www.nevadaurbanindians.org

APPENDIX H

FINAL

Protocol for Performing Indoor Air and Near-slab Soil Gas Assessments
700 South 1600 East PCE Plume Superfund Site
Salt Lake City, Utah

PREPARED FOR: D. Lynne Welsh/VA Salt Lake City Health Care System

PREPARED BY: Scott Beckman and Ed Reid, First Environment, Inc.

COPIES: David Waite, CH2M-Hill; Rolf Lange, Avalon; Devin DeMarco, First Environment, Inc.

DATE: July 17, 2015

1.0 Introduction

This document provides a protocol for the use of real-time on-site gas chromatography/mass spectrometry (GC/MS) analysis to screen for indoor sources, identify potential points for vapor intrusion, screen for the presence of volatile organic compounds in soil gas and indoor air, and direct 24-hour SUMMA canister sampling at selected locations (with TO-15 analyses) to evaluate the potential for vapor intrusion in structures associated with the Accelerated Operable Unit-1 (AOU-1) portion of the 700 South 1600 East PCE Plume (Plume).

The AOU-1 Remedial Investigation will involve an assessment structure including residential, commercial, and public buildings within the Study Area. The objectives of the investigation are several-fold:

- Determine, using real-time indoor air sampling via portable laboratory equipment and confirmatory EPA TO-15 analyses for volatile organic compounds (VOCs), if there is an immediate threat to human health in structures associated with the Plume.
- Expedite the indoor air assessment using real-time data from a field-portable GC/MS to identify indoor sources and identify potential vapor intrusion points during negative depressurization followed by positive pressurization of the entire structure or key discrete portions, as determined practical in the field.
- Collect indoor and near-slab soil vapor data as part of a collaborative data-set that will support the overall remedial investigation of both the groundwater plume and vapor intrusion potential, development of a periodic indoor air monitoring program for AOU-1, future risk assessment, and refinement of the conceptual site model.
- Determine the relationship between a subset of co-located TO-15 grab samples and field-portable GC/MS air sample results for determining the comparability of the field instrument to provide acceptable and usable real-time data.

This vapor intrusion investigational approach was adopted from an Environmental Security Technology Certification Program (ESTCP) Project No. ER- 201119-Final Report (GSI, 2013) and ER-201119-GD- Standard Protocol (GSI, 2014) and provides an alternative to the conventional investigation method of indoor air and sub-slab testing. The project-specific Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP) (including Standard Operating Procedures (SOPs) for HAPSITE preparation and general operation) were

also used as references for this Protocol, as well as the Infinicon HAPSITE Smart Plus™ and HAPSITE-ER™ Operating Manuals.

The Protocol relies on the use of on-site data acquisition of indoor air volatile organic contaminants and near-slab soil gas using field portable gas chromatography/mass spectrometry (GC/MS) for real-time assessment of structures. The protocol also provides a methodology for locating and quantifying sources of indoor air contamination should indoor air contaminants be identified during the assessment process. For this study, the field portable instrument will be the HAPSITE Smart Plus™ or HAPSITE ER Chemical Identification System™ (HAPSITE). Indoor air constituents detected above initial action screening levels proposed by the Department of Veterans Affairs (VA) will be confirmed by conventional 24-hour SUMMA canister sampling. The SUMMA canister samples will be analyzed using Environmental Protection Agency (EPA) Method TO-15 Select Ion Monitoring (SIM) and TO-15 laboratory analyses by a National Environmental Laboratory Accreditation Program (NELAP)-certified off-site laboratory.

The following activities will be performed as part of the Protocol. Real-time assessment using the HAPSITE™ will determine the nature and applicability of specific activities. For AOU-1, the decision criteria are contained in the technical memorandum: Vapor Intrusion Screening Levels and Removal Action Levels 700 South 1600 East PCE Plume, Salt Lake City, Utah dated 10/17/2014.

- Selection of Structures for Vapor Intrusion Assessment (Section 3.0) – selection of structures to be included in the Remedial Investigation.
- Pre-Assessment Activities (Section 4.0) – confirmation of access agreements/ permissions, schedules, and address for testing; property owner/occupant review of questionnaire for locating potential indoor air background sources; and building condition assessment for sampling locations.
- HAPSITE™ Use, Calibration and QC Checks (Section 5.0) – use and operation, initial calibration; continuing calibration and tuning checks, overnight storage, and regular maintenance.
- Outdoor (upwind) Real-time Qualitative Sampling (Section 6.0) - conduct ambient outdoor (background) testing at an upwind location adjacent to the structure using the HAPSITE ™ in analyze mode to identify presence of target VOCs.
- Initial (upon entry) Survey of indoor VOC Concentrations/Identification of Interior Background Sources (Section 7.0) – room-by-room (or groups of room openly connected) walk through of the structure using the HAPSITE™ in survey mode to identify the presence of any elevated VOC concentrations, followed by localized (sub-areas of rooms) assessments as indicated by initial results to identify and record locations of interior background sources.
- Survey of Potential Vapor Intrusion Entry Points (Section 8.0) – areas identified during initial building condition assessment inspection to assess for vapor entry points using HAPSITE™ in survey mode.
- Initial Real-Time Quantitative Sampling (Section 9.0) – under ambient conditions, interior floor-by-floor and (if necessary) room-by-room quantitative assessment of target chlorinated VOCs: Tetrachloroethylene (PCE); Trichloroethylene (TCE); cis-1,2-Dichloroethylene **(**cis-1-2-DCE); and, Vinyl Chloride (VC).

- Negative Pressure Real-Time Quantitative Sampling (Section 10.0) – place the building interior, or if the structure is divided into discrete areas, the portion of the building interior identified as having the greatest potential for vapor intrusion, under negative pressure, and conduct continuous (repeated samples at a central location) quantitative sampling for target chlorinated VOCs during initial depressurization and air exchange, followed by quantitative sampling using the HAPSITE™ on all other floors while building is under negative pressure.
- Positive Pressure Real Time Quantitative Sampling (Section 11.0) – place the building interior, or if the structure is divided into discrete areas, the same portion of the interior where depressurization was previously performed, under positive pressure and conduct continuous (repeated samples at a central location) quantitative sampling in the same locations and sampling procedures as used during the negative depressurization.
- SUMMA Canister Sampling (Section 12.0) – SUMMA™ canisters (24-hour samples) deployed after interior background source are identified and after quantitative HAPSITE™ sampling under ambient and negative pressure, if data indicates exceedances of the established risk action screening levels for any analyte.
- Near-Slab Real-Time Soil Gas Sampling (Section 13.0) – perform real-time, near-slab soil gas quantitative evaluation of contaminants of interest using the HAPSITE™ in analytical mode. Collect SUMMA canister samples at selected sampling probe locations adjacent to structures where indoor SUMMA™ canisters were collected, plus at least two soil gas locations without detectable COCs in soil gas.
- Data Management and Distribution (Section 14.0) – data management and distribution to project participants.

2.0 Problem Definition

A PCE plume (Plume) has been detected in the vicinity of the George E. Wahlen VA Medical Center (VAMC or Facility). The Plume underlies the neighborhoods surrounding the intersection of 700 South and 1600 East in Salt Lake City, Utah, a blended commercial and residential area of approximately 300 acres. PCE was detected at parts per billion (ppb) levels in one of Salt Lake City's secondary drinking water wells (removed from service in 2004) and the Mt. Olivet Cemetery irrigation well. PCE has also been detected at ppb levels in shallow and deep groundwater, surface water springs, and in storm sewers in this area.

VA subsequently designated the primarily residential area on and just below the Wasatch Fault Scarp as AOU-1, also known as the East Side Springs area. This area is characterized by numerous small seeps and springs, some of which discharge PCE-containing groundwater to the land surface near the suspected downgradient margin of the PCE plume. The residential areas just to the north of AOU-1 and a dry gulch just to the east of AOU-1 are included in AOU-1. The northernmost and easternmost portions of AOU-1 are not currently known to contain springs or seeps, and the depth-to-groundwater beneath the surface is not known. However, the proximity of these areas to the groundwater table and springs containing PCE warrant further study to determine whether any subsurface contaminants related to the Site extend to those areas and pose risks to human health and/or the environment.

The primary public health concern within AOU-1 is the potential for vapor intrusion of chlorinated volatile organic compounds, associated with the Plume, into surrounding homes, schools, and other structures in the East Side Springs area. The potential public health threat is the accumulation of volatilized PCE and its degradation by-products from contaminated

groundwater into proximal occupied structures above regional screening levels; thus creating an inhalation exposure hazard. The potential pathways for PCE (and associated degradation products) into indoor air may include the surrounding or underlying soil gas, surface water springs, and shallow groundwater in the vicinity of the structure or dwelling.

This protocol outlines performing real-time and conventional indoor-air assessment of structures associated with the East Side Springs in order to rapidly assess excess risk associated with contaminated indoor air resultant of VI and to obtain legally defensible data for future mitigation decisions.

3.0 Selection of Structures for Remedial Investigation Initial VI Assessment

Prior to field-activities, the VA and technical team will coordinate the solicitation of property owners for voluntary testing of their property for VI assessment. VA plans to approach the 50 or so property owners that have already indicated a willingness to allow testing and pending access permission, structures on these properties will constitute the initial group of buildings to be tested for potential vapor intrusion. VA's goal is to identify a sufficient number of structures within the known location of the Plume and outside the Plume that may exhibit a full-spectrum of indoor air vapor concentrations for the contaminants of interest. Of the 50 or so properties to date where owners have volunteered for testing, some are located within the approximate known areas of the Plume where PCE detections in the surface springs were encountered, some are above the Plume in areas where groundwater is at least 30 to 50 feet below the surface, some are located over shallow groundwater that is outside the Plume, and some are located a considerable distance from the known Plume extent and well above the groundwater table.

The rationale for testing a range of locations within the Remedial Investigation Area is to: (1) maximize the probability of encountering structures with a spectrum of measurable concentrations of the contaminants of interest in the known impact areas; and (2) maximize the probability of encountering some structures with no or minimal levels of the contaminants. The combined data-set will be used as an early guide to recruit additional sampling locations and prioritize the recruitment based on potential for vapor intrusion.

4.0 Pre-Assessment Activities

Pre-assessment activities include the following: (1) confirming that an access agreement/permission of the property owner is in place, confirming the schedule for the investigation, and the structure's address; (2) reviewing questionnaire responses in order to evaluate potential indoor air background sources; (3) identifying indoor air sampling locations and evaluating the structural conditions that may affect vapor intrusion; and (4) noting the locations of background sources (to the extent possible) of materials containing chlorinated volatile organics. The activities noted for 1, 2, and 3, above, may be done in advance of the arrival of the sampling team whenever possible. Removal of significant background sources, including non-target sources such as gasoline or paint thinners that are likely to potentially overwhelm the field instruments, will be discussed with owner upon arrival and removed from the structure with their permission to the extent possible. For this effort, the assessment team will consist of two individuals, at least one of which is trained and certified by the equipment vendor on the use of the HAPSITE.

4.1 Confirmation of Access Agreements, Schedules, and Addresses

Prior to arriving at the testing site, the assessment team will confirm with the VA that permission for access is in place, the scheduled date and address are correct, and a responsible party will be at the building to grant access and provide pertinent information. For the day of the assessment, upon arrival of the sampling team, the property owner will be asked to close all windows, exterior and interior doors, and shut off any forced air climate control equipment for the duration of each sampling task that requires no air circulation (i.e., indoor source survey and entry point survey, negative depressurization). Between sampling tasks and during personnel breaks or lunchtimes, forced air climate controls can be restarted to maintain indoor temperatures. Homes with baseboard electric heat or hot-water radiator heat do not require systems to be turned off.

4.2 Review of Building Questionnaire Responses

A questionnaire will be filled out by the property owner or building occupant prior to on-site assessment and reviewed by the assessment team. The questionnaire will include information regarding the layout of the structure (e.g., number of floors, approximate square-footage, rooms on each floor, attached structures); and the type and location of potential background sources (dry cleaning, glues, solvents, fuels, cleaning products). This information will be used to (1) identify initial sampling locations; and (2) locate and document any potential background sources prior to conducting any screening or sample collection.

4.3 Building Survey

Upon arrival at the building, if the structure was not able to be inspected and the layout obtained prior to the sampling date, the assessment team will perform a walk-through to confirm the layout of the structure. The assessment team will sketch a floor plan layout showing each room on each level with approximate dimensions of each room. Any obvious interior background sources identified from the questionnaire or during the walk-through will be documented as to the type of product and its location within the structure. Unless the source is creating high concentrations of indoor VOCs that will overwhelm the HAPSITE™, all identified background sources will be left in place. The potential source and location will be recorded on the sampling record, as well as the presence of any fixed sources that cannot be removed such as new carpet, freshly painted surfaces, etc. From the building survey, initial quantitative sampling locations will be marked on the layout sketch. These initial locations shall be, at a minimum, on every level and generally centered within the level.

5.0 HAPSITE™ Use, Calibration, and QC Checks

5.1 HAPSITE™ Use

The HAPSITE™ will be operated by a KD Analytical Trained and Certified assessment team member. The trained assessment team member will be familiar with the general use of the instrument, as well as with the project specific measurements and QC requirements.

The HAPSITE™ will be used in two modes - Quantitative Analyze and Qualitative Survey. In Quantitative Analyze mode the instrument will detect and quantify the target chlorinated VOCs: PCE, TCE, cis-1,2-DCE, and VC. The sensitivity of the HAPSITE™ for chlorinated VOCs in Analyze Mode is 0.1 to 0.5 µg/m3, which is below the characterization criteria (EPA RSLs; in parentheses) for PCE, but close to the criteria for the other selected target analytes: PCE (11.0 µg/m3, TCE (0.48 µg/m3), VC (0.17 µg/m3), and cis-1,2-DCE (no value established by EPA). In Qualitative Survey Mode the instrument will be used as a screening tool for the

continuous-reading of the target analytes. The sensitivity of the HAPSITE ™ for the target analytes in Survey Mode is in the low mg/m3 range. Survey mode will be used to assess the location of background sources from indoor products and materials, as well as determine potential entry points for subsurface vapor contaminants.

For the Analyze Mode, a project-specific sample intake and analysis method has been developed for the HAPSITE™ by the operator focusing on the target analytes: PCE, TCE, cis 1,2-DCE, and VC. The selective ion monitoring (SIM) mode will be used to increase the detector sensitivity for the target analytes. The customized method for the HAPSITE™ will include selecting the characteristic ions for each compound targeted, the temperature settings, GC temperature profiles, including ramp times and rates, and the timing and mass measurements associated with each scan set in the method. The equipment vendor is providing the method programming pre-installed as a selection option on the HAPSITE™. These parameters can also be modified or reset according to manufacturer instructions provided in the HAPSITE™ Operations Manual (included as an attachment to the SAP). The method will be designed for low concentration samples (i.e., 0.1 – 10 ppbV range). However, if high concentrations are encountered (e.g., 100 – 1,000 ppbv), the method can be modified simply by reducing the sampling duration – effectively diluting the sample and raising the lower quantification limit for any lower concentration VOCs.

In the Survey Mode, the HAPSITE™ by-passes the GC column and sends a continuous sample directly to the mass spectrometer detector. Survey mode for this project will be used to continuously search for indoor background generating materials and for screening potential entry points for subsurface vapors. For the Survey Mode, the HAPSITE™ is carried from room to room and the concentrator probe placed near a suspected source or near potential vapor intrusion points (e.g., foundation cracks) to identify concentrations of VOCs, as further discussed below.

5.2 Calibration and QC Checks

For the Analyze Mode, tuning, initial calibration, continuing calibrations, and QC checks will be performed to assure that the instrument meets the data quality objectives specified in the Quality Assurance Project Plan.

Prior to the analyses of any samples, blanks, or calibration standards in Analyze Mode, the instrument performance check (tuning check) will be performed to establish that the HAPSITE™ meets the mass spectral ion abundance criteria. The instrument tuning check (also known as the continuing calibration verification; CCV) gas will be analyzed initially following the calibration of the HAPSITE™ and once per 24-hour time period of operation. In the event the instrument performance check standard does not meet criteria, the HAPSITE™ will not be used in Analyze mode until corrections (including recalibration) are made in accordance with the Operators Manual, however, the Survey Mode may be used to look for the selected ions of the chemicals of interest.

The HAPSITE™ will be calibrated using a minimum of five chemical concentrations that span the monitoring range of interest (0.1 ppbv to 100 ppmv) in an initial calibration sequence to determine instrument sensitivity and the linearity of GC/MS response for the target compounds (PCE, TCE, cis-1,2-DCE, and VC). QA criteria for calibration curve acceptability are: Relative Standard Deviation (RSD) <20%; RSD of RF < 30%; and curve fit R-Squared (R^2) ≥ 0.98, where the RSD % is the measure of the linearity of the concentration levels (ion counts) in the calibration curve for each compound; and the Relative Standard Deviation of the Response Factor (RSD of RF %) is the measure of the linearity of the response factors for each

compound in the calibration curve, where the response factor is a measure of the relative response (ion count) of an analyte compared to that of an internal standard. Calibration will be conducted in accordance with the procedures described in detail within the HAPSITE™ Operation Manual attached to the SAP. R^2 is the coefficient of determination or correlation coefficient squared and measures variation in the y variable attributable to the x variable. In the case of instrument calibration, this is the instrument reading relative to the known concentration of a calibration standard.

Prior to the daily analysis of samples and blanks, but after tuning criteria and initial calibration have been met, the initial calibration of the GC/MS system must be routinely checked by analyzing a continuing calibration verification (CCV) standard to ensure that the instrument continues to remain within control limits. The CCV standard will be performed once every 24 hours.

The initial equipment checks and QA analyses will be performed using a project-specific method and calibration library provided onboard the instrument. If the QA results fall outside of the desired performance goals, the instrument will be recalibrated.

In the event a sample concentration overwhelms the HAPSITE™ (i.e., concentrations completely saturate the detector as indicated by analytical results), the instrument will require purging of the analytical system with nitrogen in accordance with the Operators Manual to clean the detector before the next sample can be analyzed. Purging shall continue until the instrument results (blanks) indicate the no carry-over concentrations remain.

5.3 Storage and Routine Maintenance

The HAPSITE should be stored in a climate-controlled, dry location where it can be plugged into a stable power outlet and left in “Stand-by” mode – even over weekends. The use of Stand-by mode maintains the system temperature and carrier gas pumps and preserves the system calibration so that daily startup times are considerably shorter. A properly stored HAPSITE in standby mode can maintain its reliability and calibration for up to a month.

The routine maintenance schedule of the HAPSITE is described in the QAPP and in the Operators Manual. Key maintenance includes switching tuning standard cylinders and performing self-test programs before beginning sampling. The internal power source (battery) for the HAPSITE™ provides only two to three hours of operation time and, except when using the instrument in Survey Mode, the HAPSITE should be placed on the floor or on a cart and connected to external electrical 110 Volt AC power.

6.0 Outdoor Real-time Qualitative Sampling

After confirming that the HAPSITE™ meets tuning and continuing calibration requirements, and upon arrival at a testing site, the HAPSITE™ shall be operated in Analyze Mode to collect an ambient outdoor background sample. The sample is acquired in order to define the ambient (outdoor) concentration of the target VOCs.

The outdoor quantitative sampling should be conducted upwind, but within 10 to 30 feet of the structure to be assessed. The sample is collected upwind of the building at a height of approximately three to five feet above the ground surface (approximating the breathing zone). Outside weather conditions shall be recorded including temperature, barometric pressure, wind direction, and an estimate of wind velocity (categorical).

7.0 Identification of Interior Background Sources

Consumer products and household items are commonly found to be significant sources of chlorinated VOCs in indoor air (see Table below).

CHEMICAL[1]	GENERAL CATEGORIES
1,2-DCA	Molded plastic products, air fresheners
Carbon Tetrachloride	Aerosol cans, refrigerants, dry cleaned clothes, varnish
Chloroform	Dry cleaned clothes, fire extinguishers, adhesive remover, chlorinated drinking water
PCE	Dry cleaned clothes, automotive brake cleaners, metal degreasers, hobby craft glue
TCE	Self-defense pepper spray, degreaser, rug-cleaners
Trans-1,2-DCE	Taxidermy foam, refrigerants, cleaning solutions
1,1,1-TCA	Cleaners, adhesives, aerosol cans

1) Data sources: U.S. Department of Health and Human Services. Household Products Database. 2012.

After collecting a quantitative outdoor ambient background sample, the HAPSITE™ shall be switched to operate in Survey Mode inside the building to identify the presence of any elevated VOC concentrations. The initial indoor survey should be conducted by walking through the structure room-by-room (or groups of openly connected rooms) while holding the HAPSITE™ probe at waist level and observing instrument responses (ion count). The initial room to room survey will be followed by localized (sub-areas of rooms) assessments as indicated by initial results to identify and record locations of interior background sources.

The indoor source identification procedure involves using a combination of continuous-read qualitative analysis in survey mode, visual inspection, and isolation. In continuous-reading survey mode, the instrument is used to scan potential sources for the specific target analytes. In survey mode, scan near storage units (e.g., cabinets, closets, storage containers, etc.) and product containers found in the room(s) with the highest concentration of the target VOCs detected during the initial survey and quantitative testing. As the potential source area is approached, the ion counts on the instrument will increase. If an instrument response is observed for a storage unit such as a cabinet or drawer, with permission of the property representative, examine the unit for products or materials. Examine the product labels to see if the target VOC is identified on the label and note the type of product on the sampling record. Do not remove the products, return the unit to its as found condition, and proceed with the assessment. If permission is not granted to inspect a storage unit, the area will be noted as a possible source of background contamination.

Locations of identified indoor sources will be recorded on the electronic sampling forms and rooms with elevated VOCs not tied to an indoor source shall be noted for further investigation for vapor intrusion points.

8.0 Survey of Potential Vapor Intrusion Entry Points

Areas identified in the initial VI assessment inspection and during the initial walk-through of the structure for potential vapor intrusion entry points will be assessed using the HAPSITE™ in survey mode. The vapor intrusion entry survey will be concurrent with the indoor source survey to the extent practical.

The instrument will be used to scan potential vapor entry points such as sumps, floor drains, expansion joints, plumbing penetrations, or foundation cracks. The sampling port is placed near the potential vapor entry point. If the ion counts increase in the vicinity of the entry point, then there is evidence that there is a vapor intrusion problem. In addition, any VOCs identified by type by the instrument will be recorded. The particular room (or rooms) shall be further evaluated in quantitative mode under depressurization conditions.

9.0 Initial Real-time Quantitative Sampling

After the initial Survey for indoor background and vapor intrusion points for target VOCs has been completed, the HAPSITE™ shall be switched to Analyze Mode to conduct real-time quantitative indoor air sampling and analysis (under ambient pressure conditions). Based on the structural assessment, floor plan of the structure, and Survey Mode results, an initial indoor sample for quantitative analysis will be collected from the three to five foot high breathing zone interval in each major floor level within the building; for example, the basement, main floor, and second floor of the structure. Additional samples may be collected from potential indoor source areas such as an attached garage and from specific rooms where the initial survey indicated evidence of elevated VOCs.

If the concentration of the target VOCs in all areas is below detection limits or below the screening action level concentrations, then it can be concluded that there are no significant background sources of indoor air contamination. The assessment then proceeds to performing an indoor air assessment under negative pressure conditions (Section 10.0). If target VOCs in one or more major areas are detected above screening levels, then a more detailed quantitative assessment is performed to determine the specific rooms associated with the areas exhibiting the highest concentrations. For example, if the VOC concentrations from the first round of sampling were highest in the basement, each room in the basement would be sampled in quantitative mode.

10.0 Negative Pressure Real-Time Quantitative Sampling

Building depressurization (negative pressure) can exacerbate a vapor intrusion problem and may be a conservative means of detecting vapor intrusion within a structure. The structure will be placed under a stable differential pressure of -5 pascals using a variable speed louvered air door installed in a doorway located at the lowest possible level at the structure. A recording digital manometer will be used to measure the indoor versus outdoor pressure differential and the structure will be maintained under negative differential pressurization for 30 minutes (or until at least 2.5 air exchanges have occurred) before initiating sampling. The louvered air door to be employed in the depressurization will be capable of exhausting up to 6,000 cubic feet per minute of air; however, depending on construction tightness of the structure, particularly in homes built prior to the 1970s, air leakage into the home may not allow attaining of the -5.0 pascal target depressurization level. In this case, testing will proceed as long as any differential depressurization can be achieved. In the event the structure does not achieve a one pascal depressurization relative to the outdoors, this will be taken as an indicator that the structure

construction is so leaky with respect to outdoor air that depressurization does not naturally occur and will be noted on the sampling forms, and the sampling will continue to verify that no increases in concentrations occurred..

The HAPSITE™ will be deployed in Analyze Mode in a high-risk location (defined as the lowest living or occupied level of a structure and where vapor intrusion is most likely to occur) immediately prior to the start and operated continuously (one sample every eight minutes or as often as instrument cycling allows) during negative pressurization until the 2.5 air exchanges have been attained. Upon achieving conditions stated above, additional quantitative sampling will be performed on every level of the structure, in the same locations used during the ambient characterization. If the previous entry point screening using the HAPSITE™ in Survey mode identified an area of probable vapor intrusion, then a quantitative measurement will be performed in that room while it is under negative depressurization.

It is important to note that the residences and structures to be tested range in size from single floor dwellings to large public buildings and range in age from 30 to over 100 years. In the event that an entire structure cannot effectively be placed under negative pressure due to size, floor plan layout, or extreme air leakage, the blower door will be located to depressurize the lowest level of the structure where vapor intrusion is most likely to occur, as indicated by the previous testing results. The final decision will be made by the field team leader, and the decision rationale noted in the electronic field record.

11.0 Positive Pressure Real Time Quantitative Sampling

Building pressurization (positive pressure) can assist in the differentiation of indoor background sources and actual vapor intrusion. The structure will be placed under a stable differential pressure of +5 pascals using a variable speed louvered air door installed at the same location as used for the negative depressurization discussed in Section 10.0. In addition, if the initial indoor source survey and ambient quantitative analysis results suggest an indoor source on an upper level, the pressurization test will be conducted with the blower door installed on that level. A recording digital manometer will be used to measure the indoor versus outdoor pressure differential and the structure will be maintained under positive differential pressurization for 30 minutes (or until at least 2.5 air exchanges have occurred) before initiating sampling. Testing will proceed as long as any differential pressurization can be achieved. In the event the structure does not achieve pressurization relative to the outdoors, the building will be assumed to be too leaky to pressurize and any reduction in vapor concentrations is the result of fresh air dilution.

The HAPSITE™ will be deployed in Analyze Mode in a high-risk location (defined as the lowest living or occupied level of a structure and where vapor intrusion is most likely to occur) immediately prior to the start and operated continuously (one sample every eight minutes or as often as instrument cycling allows) once positive pressurization is achieved until the 2.5 air exchanges have been attained. Upon achieving conditions stated above, additional quantitative sampling, at a minimum, will be performed on every level of the structure, in the same locations used during the ambient characterization. If the previous entry point screening using the HAPSITE™ in Survey mode identified an area of probable vapor intrusion, then a quantitative measurement will be performed in that room while it is under positive pressurization.

It is important to note that the residences and structures to be tested range in size from single floor dwellings to large public buildings and range in age from 30 to over 100 years. In the event that an entire structure cannot effectively be placed under positive pressure due to

building size, floor plan layout, or extreme air leakage, the blower door will be located to pressurize the lowest level of the structure where vapor intrusion is most likely to occur, as indicated by the previous testing results, and secondly, in the area noted as most likely containing indoor source materials. The final decision will be made by the field team leader, and the decision rationale noted in the electronic field record.

12.0 SUMMA™ Canister Sampling

Laboratory confirmation samples will be collected from structures where any quantitative HAPSITE ambient indoor or quantitative HAPSITE™ depressurization analyses exceed the screening action levels for any target VOC. Sample collection will use a 24-hour composite sample from a SUMMA™ canister and will be analyzed by Method TO-15.

For residences or other occupied buildings meeting this criteria, at least one indoor air sample for lab analysis will be collected per building. This sample will typically be collected in the lowest regularly occupied level of the home (either a finished basement or first floor) in contact with the ground. If the specific construction or configuration of a residence suggests one indoor sample will not be representative, or field-based detections of any contaminant of interest are detected in widely separated multiple locations, then a second indoor air sample may be collected from another living space, working space, or an unfinished basement room, as indicated by HAPSITE™ characterization results. A house or dwelling's heating and cooling systems can be used during the SUMMA™ Canister sampling.

Non-residential structures such as school buildings and businesses will be screened for indoor air sources, vapor entry points, and negative/positive pressurization as described above, and SUMMA™ canister sample locations will be selected based on the uses of the lower levels of the structure or where VI is most likely to occur. In particular, basement level classrooms in school buildings may be tested with SUMMA canisters for lab analysis regardless of the HAPSITE™ results.

In addition, at least three structures that exhibit concentrations below screening levels (including at least one location with no HAPSITE™ detection of target VOCs) will be sampled using 24-hour SUMMA canisters.

The indoor air samples for full laboratory analysis will be collected into laboratory-supplied six-liter SUMMA™ canisters over a 24-hour period, as detailed below:

- A clean and inerted six-liter Summa canister under a 25 in. Hg vacuum equipped with a flow regulator will be placed at a height of three to five feet above the floor in the center of the space to be sampled.
- The flow regulator will be set to collect a 24-hour time weighted sample (approximately 4 ml/min).
- Sampling will be stopped (i.e., the valves closed and the canister disconnected) after about 24 hours once the vacuum reaches about 5 in. Hg).
- The sampling crew will record the sample name, initial and final vacuums, initial and final sampling times, canister and flow controller serial numbers, and other pertinent information on the field sampling summary and laboratory Chain of Custody (CoC) forms.
- Canisters will be packed in a rigid wall shipping container, such as a cooler or heavy-duty cardboard box (ice is not required), if shipping is required.

- A custody seal will be placed over the openings to the shipping container.
- The shipping container will be shipped or delivered immediately to the laboratory for analysis.
- All samples will be accompanied by the CoC as described in the QAPP.

SUMMA™ Canister sampling will be conducted in accordance with the SOPs provided in the SAP.

As an additional confirmation on the accuracy and precision of the HAPSITE™, up to six instantaneous SUMMA™ grab samples will be collected and analyzed for TO-15 parameters in residences where VOCs are detected during the HAPSITE quantitative sampling. The grab samples will be co-located with the HAPSITE™ sample probe and collected by opening the SUMMA™ canister valve to allow the canister to fill concurrently with the HAPSITE sample intake process. The results will represent the VOC concentrations present at a given location at the time of collection and can be correlated compared directly to HAPSITE quantitative results similar to a duplicate sample analysis.

13.0 Near-Slab Real-Time Soil Gas Sampling and Analysis

The near-slab soil gas characterization approach will be implemented concurrent with the indoor air characterization to identify and characterize target VOCs present in soils adjacent to tested structures. The purpose of the soil gas sampling is two-fold (1) provide soil gas concentrations near structure foundations for support of the AOU-1 Vapor Intrusion Risk Assessment pathway evaluation process; and (2) provide information to help define the potential extents of the underlying groundwater VOC plume.

Near-slab soil gas characterization will be performed adjacent (within five feet) to all structures screened and assessed for indoor vapor intrusion. Soil vapor probes will be driven adjacent to the structure's foundation to a depth approximately six inches below the base of the foundation or to the top of the water table, whichever occurs first. Samples will be collected with a peristaltic pump and Tedlar® bags, field screened with a PID and multi-gas meter, then a second sample collected in the same manner and field-screened in real-time with the portable GC/MS in analyze mode to identify and quantify any target VOCs present in soil pore space adjacent to structures. At locations where groundwater is not encountered at the base of the foundation, after sampling, the probe rod will be driven another five feet, if soil conditions allow, and the sampling process repeated to obtain vertical delineation data for soil gas. If groundwater is encountered, the approximate depth-to-water will be measured and recorded, the probe re-installed to just above the water table, and a soil gas sample collected just above the water level.

Soil gas samples will also be collected in SUMMA™ canisters and analyzed for full volatile organics (TO-15) analysis for any near-slab characterization sample where indoor SUMMA™ canisters are collected. In addition, three selected locations throughout AOU-1 where the field portable GC/MS did not detect target VOCs in soil gas above screening levels will be sampled. Sampling for laboratory analyses will be accomplished using SUMMA™ canisters equipped with flow regulators to collect 24-hour time-averaged samples from the soil vapor probes.

In addition to confirmatory VOC analyses, five percent of the soil gas sampling locations within the PCE plume area will be selected for additional Semi-Volatile Organic Compound (SVOC) analyses using method TO-13A. Method TO-13A employs laboratory-supplied sorbent tubes

attached inline between the vapor probe and a vacuum pump set at a flow rate of 5 L/min for 480 minutes (8 hours). SVOC samples are for informational purposes to support full characterization of the plume nature and extent, and possible future risk assessment of the Site.

The procedures for emplacing the soil gas probes, testing the integrity of the seal, and for collecting and analyzing samples both for the HAPSITE™ and the TO-15 Method and TO-13A Method are described in the QAPP (Section 2.3.2) and the SAP (Section 5.4).

14.0 Data Management and Distribution

14.1 Data Management

Information that will be included in the project data record relative to the indoor air study include field log books, sample collection and handling records, operational records, GPS data, chain-of-custody forms sample receipt records, and shipping documentation. Field log books may be kept electronically via hand-held tablets.

The project field team leader will be required to maintain a field logbook of daily activities. A separate logbook of suitable material that will be bound with consecutively numbered pages will be used for this project. All entries will be legibly written in black ink. Any entry errors are corrected by drawing one solid line through the incorrect entry followed by the user's initials and date. The bottom of each page is signed and dated by the individual making the entries. Factual and objective language will be used. All entries will be complete and accurate enough to allow reconstruction of each field activity. Activities should be recorded contemporaneously.

The field logbook cover will include the following information:

- job name, contract, and delivery order numbers,
- site activity name,
- start date,
- end date of last logbook entry.

Daily entries of the following minimum information will be recorded in the logbook as follows:

- date and time, expressed in 24-hour (military) format;
- sampling start/stop times;
- weather conditions;
- personnel present;
- field observations;
- site identification and building layout (visual sketches where appropriate);
- location of sampling points (GPS coordinates and/or visual sketches where appropriate);
- description of sample;
- sample identification number;
- number of samples taken;
- time of sample collection;
- number of Quality Assurance/Quality Control (QA/QC) samples taken;
- type and mode of field instrumentation;
- names of people collecting samples;
  all calibrations done;
- any other field instruments;

- any general observations or notes;
- any deviations from the sampling plan.

Sample custody will be documented on standardized CoC records, an example of which is included in Attachment 3 of the QAPP. The CoC record establishes the documentation necessary to trace sample possession from time of collection through sample analysis and final disposition. A sample is in the custody of a person if any of the following criteria are met:

- the sample is in a person's physical possession;
- the sample is in a person's view after being in his or her physical possession;
- the sample was in a person's physical possession and was then locked up or sealed to prevent tampering; and/or
- the sample is kept in a secured area.

Field forms including soil gas sampling data sheet, indoor air sampling data sheets, HAPSITE calibration, and QC information will be used during field work. Examples of these forms can be found in Attachment D of the QAPP.

Photographs will be taken in the field to document sampling locations and conditions. Digital camera photographs will be taken with the date/time record turned on. Photographs of all sampling locations will be taken with the sample number. A photographic log will be kept in which the date, location, photographer's name, and direction the photographer is facing (if appropriate) will be recorded. Photographs will be labeled, placed in a binder or stored electronically, and submitted at the end of the field work. Selected photographs will be used in reports as deemed necessary or appropriate.

14.2 Data Distribution

Data distribution, in the form of reports and memos, are described in the QAPP (Section 4.2) and are summarized below:

- *Weekly Field Status Reports* – Communicates to VA Remedial Project Manager (RPM) weekly progress and any significant preliminary findings, QA/QC issues, and changes to the field schedule.
- *Progress Reports* – Communicates the progress made by VA and its consultants on a monthly basis regarding site investigation, community involvement, achievement of project milestones, and the myriad of actions that encompass the investigation of AOU-1.
- *Environmental Media Reports* – Communicates in brief the conclusions of individual investigation events (Indoor Air, Soil Gas, Surface Water, and Groundwater) for AOU-1 and any laboratory analysis associated with the event. These reports will be written by the Program Manager and submitted to the VA RPM, EPA, and Utah Department of Environmental Quality (UDEQ).
- *Nonconformance Reports* – Identifies any deviations of planned or expected scope-of-work activities relating to the investigation of AOU-1. Reports may pertain to field data collection, health and safety events, etc. These reports will be written by the FET Program Manager or QA Manager. The reports will be submitted to the VA RPM and Quality Assurance Manager, and if needed, the EPA and UDEQ.

- *Laboratory Audits/Corrective Action Reports* – Communicates the result of any third-party audit or review of the analytical laboratory that is supporting the FET investigation activities. This report will be written by the CLP (soil and water media results) and ALS Global Labs (soil gas and air) laboratory designated personnel. The reports will be submitted to the FET Program Manager, VA RPM and Quality Assurance Manager, UDEQ RPM and the EPA RPMs.
- *Remedial Project Managers (RPM) Debriefings* – Weekly conference calls between VA, EPA, UDEQ and other key stakeholders to discuss previous week's field efforts and investigation.
- *Data Validation Reports* – Communicates the results of laboratory data validation for each media (indoor air, soil gas, surface water, and groundwater) to VA, EPA, and UDEQ. Each report will provide a summary of the data validation process, a list of analytes having changed data qualifiers, a list of analytes rejected during validation, and a determination of the usability of the data. The data validation reports will be prepared by the FET lead data validator and the QA/QC Manager.
- *Remedial Investigation Report (RI Report)* – Communicates the conclusions of all investigation events for AOU-1 and any laboratory analysis associated with the event. The RI Report will also contain summaries of data validation reports and deviations from the SAP and QAPP.

15.0 References

ESTCP (2013). *Use of GC/MS Analysis to Distinguish Between Vapor Intrusion and Indoor Sources of VOCs –Final Report* - ESTCP Project ER-201119, November 2013.

ESTCP (2014). *Use of GC/MS Analysis to Distinguish Between Vapor Intrusion and Indoor Sources of VOCs – Standardized Protocol for On-Site Evaluation of Vapor Intrusion* - ESTCP Project ER-201119, July 2014.

Quality Assurance Project Plan (QAPP), 700 South and 1600 East Street PCE Plume, AOU-1: East Side Springs, Salt Lake City, Utah – October 1, 2014.

Sampling and Analysis Plan (SAP), 700 South and 1600 East Street PCE Plume, AOU-1: East Side Springs, Salt Lake City, Utah – October 1, 2014.

INFICON (2006). *Operation Manual for the HAPSITE Smart Plus – 074-472-P1C*.

APPENDIX I

FINAL

Project Communications Plan for Contractor Field Staff

AOU-1 East Side Springs
700 South 1600 East PCE Plume
Salt Lake City, Utah

BPA No. VA259-14-A-0021
TO No. VA259-14-5-4311

July 17, 2015

Prepared for: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

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ATTACHMENTS

1 Residential Sampling Letter
2 Non-Residential Sampling Letter
3 Occupied Dwelling VI Questionnaire Form
4 Commercial-Industrial Building VI Questionnaire Form
5 Permission to Sample Letter
6 VA EPA UDEQ Contacts
7 Stakeholder Contact Card
8 Stakeholder Contact Log
9 FAQs
10 SLC Study Brochure
11 Letter Template to Communicate Sampling Results

1.0 Introduction

This Project Communications Plan (PCP) is a tool to help VA and its contractors, in conjunction with EPA and UDEQ effectively communicate with residents, news media, and other stakeholders during the Remedial Investigation of the East Side Springs area (Accelerated Operable Unit 1, or AOU-1) which includes groundwater evaluations and indoor air sampling.

VA is conducting this project in a densely populated urban area, and anticipates that community members will be concerned about potential noise, traffic, and safety issues – especially when this work is near schools and playgrounds. Community members who have agreed to have indoor air sampling conducted at their residences may have concerns about disruption to their personal schedules and their property, the storage of source items during sampling, and when and how they will receive sampling results. Team members must be aware of the public scrutiny of this project and the importance of good community relations and effective communication.

Local news media have done stories about VA's work at this Site, the agency has held two community meetings and is maintaining ongoing communication with local residents, community groups, and local government officials. We can expect that many residents will be at least partially informed about what we are doing.

For purposes of this PCP, community members may include:

- residents,
- neighborhood association members and other community group representatives,
- local elected officials,
- agency officials (Salt Lake City health department, for example), and
- news media.

2.0 Communication Process for the Remedial Investigation

2.1 Phase 1 – Communication before Field Activities Begin

Continuous communication with stakeholders will be a key factor in the successful completion of the Remedial Investigation. VA will engage community members early in the process and provide frequent opportunities for meaningful and active involvement in the groundwater cleanup process. Activities VA is conducting before field work begins include the following:

- In November 2014, VA sent letters to residents and organizations, including commercial buildings and schools, that had agreed to participate in the sampling effort. The letters described the activities VA and its contractors will undertake to evaluate indoor air for potential vapor intrusion and soil and groundwater outside structures for the presence of the solvent tetrachloroethylene, commonly known as PCE. The letters included a questionnaire residential and non-residential property owners were asked to complete to help identify potential sources of PCE in indoor air that may prove unrelated to groundwater contamination.
- Property owners received a second letter in December 2014 that authorized VA and its contractors to collect environmental samples on their properties. Attachments 1 through 5 contain the initial letters to property owners, questionnaires, and the sampling authorization letter.
- From December 8 to December 19, 2014, VA and contractors visited property owners to identify and address, if possible, any concerns they might have and answer their questions before work begins.
- Beginning in January 12, 2015, VA contractors will conduct VI surveys and inspections in preparation for sampling activities.

2.2 Phase 2 – Communication during Remedial Investigation Field Activities

VA and its contractors will maintain high technical standards while being polite and courteous when working with members of the community. D. Lynne Welsh, Remedial Project Manager, and Jill Atwood, Chief Communications Officer, are the key VA contacts for communicating with the public during all phases of the Remedial Investigation. Their contact information, along with that of U.S. EPA and UDEQ staff involved in this project, can be found in Attachment 6.

2.2.1 Communications Guidelines for Contractors Working in the Field

At no time should contractors present themselves as employees of VA. If someone asks what you are doing, give a very basic response (examples below) and refer him/her to Jill Atwood, VA Chief Communications Officer or Lynne Welsh, VA Remedial Project Manager. Their contact information is provided on the business cards that accompany this PCP (Attachment 7).

A VA representative will be stationed in the investigation area to field questions from media and stakeholders other than residents whose houses are being evaluated. Contact t VA representative in the field, if available, and provide the stakeholder's contact information for immediate follow up. Log all contacts with stakeholders in the field on the contact log provided in this PCP (Attachment 8). If the VA representative is unavailable, provide stakeholders with a

comprehensive list of frequently asked questions (FAQs) to explain details about the entire project, the brochure on indoor air sampling, and/or the contact card, and have them call VA if they have additional questions. The PCP will be updated when VA issues new brochures or other outreach material. The FAQs and brochure are included in this PCP as Attachment 9and Attachment 10, respectively.

As noted above, questions from non-residents or detailed technical or policy questions should be directed to VA. However, contractor field personnel are expected to be prepared to answer basic questions from residents that pertain to the field work. The following are examples of basic responses to questions or concerns that stakeholders might have once field activities are underway.

Question/Concern: What are you doing?

Response: We are drilling wells to learn more about groundwater in the area, which is contaminated with dry-cleaning solvents. We are also studying indoor air to see if chemicals from the groundwater are present in indoor air.

Question/Concern: Why are you doing this work?

Response: In 2010, PCE was detected in seeps and springs located along the Wasatch fault and in this general area. These seeps and springs suggest groundwater is near the ground surface, and this has raised concerns about the potential of vapor intrusion of PCE into homes and businesses. The PCE-contaminated springs are called the “East Side Springs.” The work we are doing is to support the first phase of a study called a Remedial Investigation that is required under CERCLA, or Superfund. This work is the first phase of a site-wide investigation and evaluation program to learn more about groundwater contamination in the area and develop remedies to correct the problem.

Question/Concern: How long is this going to take?

Response: This phase of the project is expected to take about 12 months. There will be follow-on work, but we do not know the schedule for that work yet.

Question/Concern: I’m concerned your drilling will tear up my yard.

Response: We will make every effort to disturb as little of your yard as possible, and we will repair your yard before we leave. We will replace, at no cost to you, any damaged sod with the same or similar grass, or fix any sprinkler lines that have been damaged.

Question/Concern: When will I get my indoor air sampling results? How will VA provide me with results?

Response: It generally takes at least six weeks for the tests to be analyzed. VA will contact you verbally with the results within 45 days after receipt of the results and will also provide you with paper copies of the test results.

Question/Concern: My neighbor had his indoor air sampled. How do I get my house sampled?

Response: We have one person coordinating all of the testing. Here is Jill Atwood’s contact information. Please contact her to discuss indoor air sampling.

Question/Concern: I have an access agreement to get my indoor air sampled, but I don't understand it. Who can I talk to?

Response: Please call the VA contact, Jill Atwood. Give them the contact information card which also includes EPA and UDEQ contacts.

2.2.2 Questions from the News Media

If a news reporter asks you questions, you should

- Politely state that you are there working as a contractor for VA.
- If asked, say who you are and the name of your company.
- Provide the brief description of the project.
- Give him/her a brochure, a copy of the FAQs, and the contact card. Contact the VA field representatives immediately by phone to report the contact by the reporter and document the encounter in the contact log (Attachment 8).

Beyond providing this basic information, do not answer questions from the news media. Do not give reporters on-the-record statements regarding the clean up or participate in on-camera interviews. Have them contact Jill Atwood if they need information for official attribution or want to conduct an on-camera interview. Do not elaborate or speculate on future activities. Do not give any information on specific homes that are tested or any other information that may be considered confidential.

2.3 Dealing with Complaints During Field Activities

Receiving few complaints from the public is a critical success factor for this project. Complaints cannot be avoided completely, but community members can be satisfied by addressing their concerns quickly and efficiently. Use the contact log (Attachment 8) to record complaints from community members and track communication from receipt of the initial complaint through resolution of the issue.

2.3.1 Complaints about project-specific activities

Members of the field crew should refer stakeholders with complaints about project activities to the Field Team Leader if the field crew member first approached about the problem is not able or authorized to fix it. Complaints that cannot be successfully addressed in the field should be referred to an on-site VA representative for assistance in developing an approach to solve the problem. Problem resolution may involve a phone call, written response, and/or personal contact from a VA representative.

2.3.2 Complaints about issues unrelated to project activities

Instruct stakeholders who needs assistance with issues unrelated to the project (water quality issues, trash removal, traffic control issues not caused by field activities, etc.) that your company works for VA on this specific issue and they will have to contact the appropriate city organization and log the contact and resolution.

2.4 Phase 3 – Communication of Results and Path Forward

VA will share the results of soil, groundwater, and indoor air testing with property owners and anticipates having the results within six weeks after the completion of field work in the East Side

Springs area. Property owners will receive a letter containing the results of sampling on their properties and a follow-up visit from a VA representative and contractor to discuss sampling results. Sampling results will be communicated to property owners using the letter template included as Attachment 11. Based on sampling results, VA will recommend additional sampling or installation of an indoor air mitigation system as an interim measure to address VI while long-term remedies are developed.

ATTACHMENT 1

GEORGE E. WAHLEN
DEPARTMENT OF VETERANS AFFAIRS MEDICAL CENTER
VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, UT 84148

November 14, 2014

Dear Resident:

Thank you for your willingness to participate in the sampling program the Department of Veterans Affairs Salt Lake City Health Care System is planning for the 700 South 1600 East PCE Plume Site. We understand your concerns and need for timely answers and that's why we are taking an expedited investigational approach in your area particularly focusing on vapor intrusion (VI).

Understanding citizens' concerns voiced at our informational meetings, VA will first address vapor intrusion in as many houses and structures as possible in the target area, then VA will proceed with an incremental sampling approach that will test properties where previous groundwater contamination was identified. After that, VA will test adjacent areas to define the limits of the groundwater contamination and if needed test additional properties' indoor air quality. Not all properties may require testing, if no groundwater contamination is found, your indoor air will not need to be tested. The investigation of the East Side Springs area will take between four to six weeks.

A former dry cleaning facility at the nearby George E. Wahlen VA Medical Center has been identified as a likely source of the solvent tetrachloroethylene, commonly known as PCE, which has contaminated groundwater in the area. The Remedial Investigation (RI) is planned to begin in fall 2014 and will refine the limits of groundwater contamination identified by Salt Lake City, the state and EPA and evaluate the potential vapor issues associated with that contamination. The VI sampling is part of the RI that VA is undertaking in conjunction with the Utah Department of Environmental Quality (UDEQ) and the US Environmental Protection Agency (EPA). After indoor air testing our next step is to evaluate the extent of the groundwater and soil-gas contamination in the East Side Springs area. If your property is tested, sampling will be conducted by VA contractors in two phases:

1. First, VA contractors will screen your property's indoor air for any item that may contain the same or similar chemicals. Once those items are temporarily removed, a small fan will be turned on to vent your structure so the contractors can characterized any vapors that may be intruding through foundation or wall openings. This will take approximately half a day per structure.
2. If the screening of a property indicates a potential of vapor intrusion during venting then VA will request you allow us to conduct a longer test using a Summa canister and pump. The canister collects periodic air samples over a 24-hr period of time during normal activities. This longer test will allow VA to better determine if vapors are entering the structure and what the concentration are of the vapors. We will need to visit your home twice within a twenty-four hour period, once to place the canister and once to pick it up.

Concurrent with indoor air sampling, VA contractors will also be conducting tests on soil and the groundwater in your yard. These tests will consist of collecting air and water samples that are typically collected using a small tractor mounted 'GeoProbe' to insert a probe in the ground to the surface of the groundwater and sample using hand held sampling tools. Sampling could also require VA to drive metal probes deeper into the ground to extract groundwater.

Indoor air can contain contamination from other sources (for example, some cleaning products and pesticides) and can frequently result in inaccurate results. If we determine the need to test indoors, the VA contractors will work with you to identify any products that may affect our tests and help you temporarily relocate them. Your property may not require indoor air testing, but to be prepared in the event VA would like to test the air in your basement, please read and complete the enclosed residential air sampling questionnaire and return it in the postage-paid envelope. If indoor air sampling is needed, this information will help us better understand what activities might affect our sampling results of the air in your home.

VA will share the results of soil, groundwater and indoor air testing with you and anticipates having the results within six weeks after the completion of our field work in the East Side Springs area. These results will also be included in our report to the UDEQ and EPA. Additionally, in consultation with UDEQ and EPA, VA will follow up with you regarding our evaluation of your test results and discuss our recommendations. These recommendations may include additional sampling or indoor air mitigation.

We understand your frustrations with what seems like a lengthy process, but please understand the need to be thorough and systematic in defining and subsequently cleaning up the contamination.

If you have any questions or concerns about VA's planned sampling effort, please contact me at (801) 582-1565 ext. 4094 or by email at Jill.Atwood@va.gov. Again, thank you very much for your time and understanding.

Sincerely,

Jill Atwood
Chief Communication Officer
Department of Veterans Affairs
VA Salt Lake City Health Care System

Enclosures: VI Questionnaire Form
Postage-Paid return envelope

ATTACHMENT 2

GEORGE E. WAHLEN
DEPARTMENT OF VETERANS AFFAIRS MEDICAL CENTER
VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, UT 84148

November 14, 2014

Dear Property Owner:

You are receiving this letter because you have either already communicated your organization's willingness to participate in the sampling program the Department of Veterans Affairs Salt Lake City Health Care System is planning for the 700 South 1600 East PCE Plume Site, or we have determined that your proximity to the area warrants this correspondence. We understand your concerns and need for timely answers and that's why we are taking an expedited investigational approach in your area particularly focusing on vapor intrusion (VI).

Understanding citizens' concerns voiced at our informational meetings, VA will first address vapor intrusion in as many houses and structures as possible in the target area, then VA will proceed with an incremental sampling approach that will test properties where previous groundwater contamination was identified. After that, VA will test adjacent areas to define the limits of the groundwater contamination and if needed test additional properties' indoor air quality. Not all properties may require testing, if no groundwater contamination is found, your indoor air will not need to be tested. The investigation of the East Side Springs area will take between four to six weeks.

A former dry cleaning facility at the nearby George E. Wahlen VA Medical Center has been identified as a likely source of the solvent tetrachloroethylene, commonly known as PCE, which has contaminated groundwater in the area. The Remedial Investigation (RI) is planned to begin in fall 2014 and will refine the limits of groundwater contamination identified by Salt Lake City, the state and EPA and evaluate the potential vapor issues associated with that contamination. The VI sampling is part of the RI that VA is undertaking in conjunction with the Utah Department of Environmental Quality (UDEQ) and the US Environmental Protection Agency (EPA). After indoor air testing our next step is to evaluate the extent of the groundwater and soil-gas contamination in the East Side Springs area. If your property is tested, sampling will be conducted by VA contractors in two phases:

1. First, VA contractors will screen your property's indoor air for any item that may contain the same or similar chemicals. Once those items are temporarily removed, a small fan will be turned on to vent your structure so the contractors can characterized any vapors that may be intruding through foundation or wall openings. This will take approximately half a day per structure.
2. If the screening of a property indicates a potential of vapor intrusion during venting then VA will request you allow us to conduct a longer test using a Summa canister and pump. The canister collects periodic air samples over a 24-hr period of time during normal activities. This longer test will allow VA to better determine if vapors are entering the structure and what the concentration are of the vapors. We will need to visit your property twice within a twenty-four hour period, once to place the canister and once to pick it up.

Concurrent with indoor air sampling, VA contractors will also be conducting tests on soil and the groundwater outside the structures on your organization's property. These tests will consist of collecting air and water samples that are typically collected using a small tractor mounted 'GeoProbe' to insert a probe in the ground to the surface of the groundwater and sample using hand held sampling tools. Sampling could also require VA to drive metal probes deeper into the ground to extract groundwater.

Indoor air can contain contamination from other sources (for example, some cleaning products and pesticides) and can frequently result in inaccurate results. If we determine the need to test indoors, the VA contractors will work with you to identify any products that may affect our tests and help you temporarily relocate them. Your property may not require indoor air testing, but to be prepared in the event VA would like to test the air in your basement, please read and complete the enclosed Commercial/Industrial Building Questionnaire and return it in the postage-paid envelope. If indoor air sampling is needed, this information will help us better understand what activities might affect our sampling results of the air in your building(s).

VA will share the results of soil, groundwater and indoor air testing with you and anticipates having the results within six weeks after the completion of our field work in the East Side Springs area. These results will also be included in our report to the UDEQ and EPA. Additionally, in consultation with UDEQ and EPA, VA will follow up with you regarding our evaluation of your test results and discuss our recommendations. These recommendations may include additional sampling or indoor air mitigation.

We understand your frustrations with what seems like a lengthy process, but please understand the need to be thorough and systematic in defining and subsequently cleaning up the contamination.

If you have any questions or concerns about VA's planned sampling effort, please contact me at (801) 582-1565 ext. 4094 or by email at Jill.Atwood@va.gov. Again, thank you very much for your time and understanding.

Sincerely,

Jill Atwood
Chief Communication Officer
Department of Veterans Affairs
VA Salt Lake City Health Care System

Enclosures: VI Questionnaire Form
Postage-Paid return envelope

ATTACHMENT 3

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

OCCUPIED DWELLING QUESTIONAIRE

Indoor Air Assessment Survey

Date: _____

1. Name:_____
   Address:
   _____
   _____
   Home Phone:_____ Work Phone:_____
2. What is the best time to call to speak with you?_____At: Work ☐ or Home ☐ ?
3. Are you the Owner ☐, Renter ☐, Other ☐ (please specify)_____of this Home/Structure? If you are not the owner, please provide owner contact Information
   _____
   _____
4. Total number of occupants/persons at this location?_____
   Number of Children_____Ages_____
5. How long have you lived at this location?_____

General Home Description

6. Type of Home/Structure (check only one): Single Family Home ☐, Duplex ☐, Apartment ☐, Townhouse ☐ Other _____
7. Home/Structure Description:
   Number of floors:_____
   Basement ☐
   Crawlspace ☐
   Partial crawlspace/basement ☐ % of each _____
   Slab on grade ☐
   Other ☐_____
8. Age of Home/Structure:_____years, Not sure/Unknown ☐
9. General Above-Ground Home/Structure construction (check all that apply):
   Wood ☐, Brick ☐, Concrete ☐, Cement block ☐, Other ☐ _____
10. Foundation Construction (check all that apply):
    Concrete Slab ☐
    Fieldstone ☐
    Concrete block ☐
    Elevated above ground/grade ☐
    Other ☐ _____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

11. Do you have private well ☐ or cistern ☐ ?
If yes, please describe location, use and current condition_____
_____
_____

12. Do you have a septic system? Yes ☐ No ☐ Not used ☐ Unknown ☐
If yes, what is construction type?_____
Where is it located? _____
When was the last time it was serviced?_____
Do you (or have you ever) use (d) any degreaser for your septic system? Yes ☐ No ☐

13. Do you have standing water outside of your home? (pond, ditch, etc.) Yes ☐ No ☐

Basement Description (please check all boxes that apply):

14. Is the basement finished ☐ or unfinished ☐ ?

15. If finished, how many rooms are in the basement? _____
What are rooms used for? Bedrooms ☐ Family room ☐ Storage ☐
Other_____

16. If not finished, do you plan on finishing in the future? Yes ☐ No ☐

17. Is the basement floor (check all that apply) concrete ☐, tile ☐, carpeted ☐, dirt ☐,
other ☐ _____

18. Are the basement walls poured concrete ☐, cement block ☐ , stone ☐ , wood ☐ ,
Brick ☐ , other ☐ _____

19. Does the basement have a moisture problem?
Yes, frequently (3 or more times/year) ☐
Yes, occasionally (1-2 times/year) ☐
Yes, rarely (less that 1 time/year) ☐
No ☐

Describe the moisture problem_____
_____
_____

20. .Does the basement ever flood?
Yes, frequently (3 or more times/year) ☐
Yes, occasionally (1-2 times/year) ☐
Yes, rarely (less than 1 time/year) ☐
No ☐

21. Does the basement have any of the following? Floor cracks ☐ , Wall cracks ☐, Sump ☐ ,
Floor drain ☐, Other hole/opening in floor ☐
describe_____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

22. Are any of the following used or stored in the basement (check all that apply):
Paint ☐ Paint Stripper/remover ☐ Paint thinner ☐ Metal degreaser/cleaner ☐
Gasoline ☐ Diesel fuel ☐ Solvents ☐ Glue ☐ Laundry spot removers ☐ Drain cleaners
☐ Pesticides ☐ Other equipment with fuel tanks (chain saw, lawn mower, snow blower,etc.,)

23. Have you recently (within the last six months) done any painting or remodeling in your home?
Yes ☐ No ☐
If yes, specify what was done, where in the home, and what month:
_____
_____

24. Have you installed new carpeting in your home within the last year? Yes ☐ No ☐
If yes, when and where?_____

25. Do you regularly use or work in a dry cleaning service?
Yes, use dry-cleaning regularly (at least weekly) ☐
Yes, use dry-cleaning infrequently (monthly or less) ☐
Yes, work at a dry cleaning service ☐
No ☐

26. Does anyone in your home use solvents at work?
Yes ☐ If yes, how many persons?
No ☐ If no, go to question 28

27. If yes for question 26, are the work clothes washed at home? Yes ☐ No ☐

28. Where is the washer/dryer located?
Basement ☐
Upstairs utility room ☐
Kitchen ☐
Garage ☐
Use a Laundromat ☐
Other, please specify ☐ _____

29. If you have a dryer, is it vented to the outdoors? Yes ☐ No ☐

30. What type (s) of home heating do you have (check all that apply)
Fuel type: Gas ☐, Oil ☐, Electric ☐, Wood ☐, Coal ☐,
Other ☐_____

Heat conveyance system:
Forced hot air ☐
Forced hot water ☐
Steam ☐
Radiant floor heat ☐
Wood Stove ☐
Coal furnace ☐
Fireplace ☐
Other ☐ _____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

31. Does your home have (or had in the past) a storage tank for storage of: gasoline ☐ fuel oil ☐ propane ☐
If yes, where is/was it located? _____
_____
How is/was the tank filled?_____
_____
Is there staining near the tank? Yes ☐ No ☐

32. Do you have air conditioning? Yes ☐ No ☐
Central air conditioning ☐
Window air conditioning unit (s) ☐
Other (please specify) _____

33. Do you use any of the following? Room fans ☐, Ceiling fans ☐ , Attic fan ☐

34. Do you ventilate using the fan-only mode of your central air conditioning or forced air heating system? Yes ☐ No ☐

35. Has your home had termite or other pesticide treatment? Yes ☐ No ☐ Unknown ☐
If yes, please specify type of pest controlled _____
And approximate date of service_____

36. Water heater type: Gas ☐, Electric ☐, by Furnace ☐,
Other (please describe)_____

37. Water heater location: Basement ☐, Upstairs utility room ☐, Garage ☐,
Other (please specify) _____

38. What type of cooking appliance do you have? Electric ☐, Gas ☐
Other (please describe) _____

39. Is there a stove exhaust hood present? Yes ☐ No ☐
Does it vent to the outdoors? Yes ☐ No ☐

40. Smoking in Home:
None ☐, Rare (only guests) ☐, Moderate (residents, light smokers) ☐,
Heavy (at least one heavy smoker in household) ☐

41. If yes to question 40, what do they smoke?
Cigarettes ☐ Cigars ☐
Pipe ☐ Other ☐

42. Do you regularly use air fresheners? Yes ☐ No ☐

43. Does anyone in the home have indoor home hobbies or crafts involving:
Heating ☐, soldering ☐, welding ☐, model glues ☐, paints ☐
Spray paint ☐, wood finishing ☐, Other ☐ _____
_____
_____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

44. General family/home use of consumer products (please circle appropriate). Assume that: Never = never used, Hardly ever = less that once/month, Occasionally = about once/month, Regularly = about once/week, and Often = more that once/week.

Product	Frequency of Use				
Spray-on deodorant	Never	Hardly ever	Occasionally	Regularly	Often
Aerosol deodorizers	Never	Hardly ever	Occasionally	Regularly	Often
Insecticides	Never	Hardly ever	Occasionally	Regularly	Often
Disinfectants	Never	Hardly ever	Occasionally	Regularly	Often
Window cleaners	Never	Hardly ever	Occasionally	Regularly	Often
Nail polish remover	Never	Hardly ever	Occasionally	Regularly	Often
Hair sprays	Never	Hardly ever	Occasionally	Regularly	Often
Candles	Never	Hardly ever	Occasionally	Regularly	Often
Incense	Never	Hardly ever	Occasionally	Regularly	Often

45. Please check weekly household cleaning practices:

Dusting ☐

Dry sweeping ☐

Vacuuming ☐

Polishing (furniture, etc.) ☐

Washing/waxing floors ☐

Other (describe) ☐_____

46. Other comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

47. Chemical Inventory/Summary

Chemical/Chemical Product (consumer name)	Amount present in home
a)	
b)	
c)	
d)	
e)	
f)	
g)	
h)	
i)	
j)	
k)	
l)	
m)	
n)	
o)	

ATTACHMENT 4

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

ACADEMIC/COMMERCIAL/INDUSTRIAL BUILDING QUESTIONNAIRE

Indoor Air Assessment Survey

Date: _____Survey / questionnaire completed by:_____

1. Contact Name:_____

_ Address:_____City:_____State:_____Zip:_____

Phone 1:_____Phone 2:_____Cell Phone: _____

2. What is the best time to call to speak with you? _____

3. Are you the Owner ☐, Renter ☐, Other ☐ (please specify)_____of this Building/Structure? If you are not the owner, please provide owner contact information

Owner Name:_____

Address:_____City:_____State:_____Zip:_____

Phone 1:_____Phone 2:_____Cell Phone: _____

4. Total number of occupants/persons at this location?

Number of Children_____Ages_____

5. How long have you occupied this location? _____

How many days per week is building occupied?_____

How many hours per day is building occupied?_____

General Building / Structure Description

6. Type of Building/Structure (check only one): Single Business ☐, Multiple Businesses ☐

Other _____

7. Building/Structure Description:
Number of floors: _____ Area /square footage of main or ground floor:_____ square feet
Basement ☐ Area /square footage of Basement:_____square feet
Crawlspace ☐ Area /square footage of Crawlspace:_____ square feet
Partial crawlspace/basement ☐ % of each _____
Slab on grade ☐ Area /square footage of Slab on grade:_____ square feet
Other ☐ _____

8. Age of Building/Structure:_____years, Not sure/Unknown ☐

9. General Above-Ground Building/Structure construction (check all that apply):
Wood ☐, Brick ☐, Concrete ☐, Cement block ☐, Other ☐ _____

10. Foundation Construction (check all that apply):
Concrete Slab ☐
Fieldstone ☐
Concrete block ☐
Elevated above ground/grade ☐

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

Other ☐ _____

11. Do you have private well ☐ or cistern ☐ ?
If yes, please describe location, use and current condition_____
_____
_____

12. Do you have a septic system? Yes ☐ No ☐ Not used ☐ Unknown ☐
If yes, what is construction type?_____
Where is it located? _____
When was the last time it was serviced?_____
Do you (or have you ever) use(d) any degreaser for your septic system? Yes ☐ No ☐

13. Do you have standing water outside of your Building? (pond, ditch, etc.) Yes ☐ No ☐

Basement Description (please check all boxes that apply):

14. Is the basement finished ☐ or unfinished ☐ ?

15. If finished, how many rooms are in the basement? _____

What are rooms used for? Office ☐ Shop ☐ Storage ☐

Other_____

16. If not finished, do you plan on finishing in the future? Yes ☐ No ☐

17. Is the basement finished ☐ or unfinished ☐ ?

18. If finished, how many rooms are in the basement? _____

19. What are rooms used for? Office ☐ Shop ☐ Storage ☐

Other_____

20. If not finished, do you plan on finishing in the future? Yes ☐ No ☐

21. Is the basement floor (check all that apply) Concrete ☐ Tile ☐ Carpeted ☐ Dirt ☐

22. Other ☐ _____

23. Are the basement walls poured Concrete ☐ , Cement block ☐ , Stone ☐ , Wood ☐ ,
Brick ☐ , Other ☐ _____

24. Does the basement have a moisture problem?
Yes, frequently (3 or more times/year) ☐
Yes, occasionally (1-2 times/year) ☐
Yes, rarely (less than 1 time/year) ☐
No ☐
Describe the moisture problem_____
_____
_____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

25. Does the basement ever flood?
Yes, frequently (3 or more times/year) ☐
Yes, occasionally (1-2 times/year) ☐
Yes, rarely (less than 1 time/year) ☐
No ☐

26.
27. Does the basement have any of the following? Floor cracks ☐ Wall cracks ☐ Sump ☐
Floor drain ☐ Other hole/opening in floor ☐
describe_____

28. Are any of the following used or stored in the basement (check all that apply):
Paint ☐ Paint Stripper/remover ☐ Paint thinner ☐ Metal degreaser/cleaner ☐
Gasoline ☐ Diesel fuel ☐ Solvents ☐ Glue ☐ Laundry spot removers ☐
Drain cleaners ☐ Pesticides ☐ Other equipment with fuel tanks (chain saw, lawn mower, snow blower, etc.) ☐ Other products with/containing Volatile Organic Compounds, describe:
_____
_____

29. Has the Building / structure recently (within the last six months) had any painting or remodeling?
Yes ☐ No ☐
If yes, specify what was done, where in the Building, and what month:
_____
_____

30. Has new carpeting been installed in the Building / structure within the last year? Yes ☐ No ☐
If yes, when and where?_____

31. Do any occupants / employees regularly conduct or work in beauty / hair-dressing business?
Yes, work at a beauty / hair-dressing business ☐
Yes, store supplies for beauty / hair-dressing business ☐ Distance to sample point:_____
Yes, building contains beauty / hair-dressing business ☐ Distance to sample point: _____
Yes, building is near beauty / hair-dressing business ☐ Distance to sample point: _____
No ☐

32. Do any occupants / employees / anyone regularly use or work or conduct a dry cleaning service?
Yes, use dry-cleaning regularly (at least weekly) ☐
Yes, use dry-cleaning infrequently (monthly or less) ☐
Yes, work at a dry cleaning service ☐
Yes, building contains or is near dry cleaning service ☐ Distance to sample point: _____
No ☐

33. Do any occupants / employees / anyone in the Building / structure use solvents at work?
Yes ☐ If yes, how many persons?
No ☐ If no, go to question 28

34. If yes for question 26, are the work clothes washed at Building? Yes ☐ No ☐

35. Does Building / Structure contain a washer/dryer? Yes ☐ No ☐
Where are they located?
Basement ☐
Upstairs ☐
Ground floor ☐
Garage ☐
Other, please specify ☐ _____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

36. If Building / Structure contains a dryer, is it vented to the outdoors? Yes ☐ No ☐

37. What type (s) of Building heating do you have (check all that apply)
Fuel type: Gas ☐ Oil ☐ Electric ☐, Wood ☐ Coal ☐
Other ☐ _____

Heat conveyance system: Forced hot air ☐ Forced hot water ☐ Steam ☐
Radiant floor heat ☐ Wood Stove ☐ Coal furnace ☐ Fireplace ☐
Other ☐ _____

38. Does Building/Structure have (or had in the past) a storage tank for storage of gasoline ☐
fuel oil ☐, propane ☐

If yes, where is/was it located? _____
_____

How is/was the tank filled? _____

_____
Is there staining near the tank? Yes ☐ No ☐

39. Does Building/Structure have air conditioning? Yes ☐ No ☐
Central air conditioning ☐
Window air conditioning unit (s) ☐
Other (please specify) _____

40. Does Building / Structure have any: Room fans ☐ Ceiling fans ☐, Attic fan ☐

41. Does Building / Structure ventilate using the fan-only mode of your central air conditioning or forced air heating system? Yes ☐ No ☐

42. Has Building / Structure had termite or other pesticide treatment? Yes ☐ No ☐ Unknown ☐
If yes, please specify type of pest controlled _____
and approximate date of service_____

43. Water heater type: Gas ☐ Electric ☐ by Furnace ☐,
Other (please describe) _____

44. Water heater location: Basement ☐ Upstairs ☐ Ground Floor ☐ Attic ☐
Other _____

45. Does Building/Structure have any cooking appliances? Electric ☐ Gas ☐
Other _____

46. Is there a stove exhaust hood present? Yes ☐ No ☐
Does it vent to the outdoors? Yes ☐ No ☐

47. Smoking in Building/Structure:
None ☐ Rare (only guests) ☐ Moderate (occupants, light smokers) ☐
Heavy (at least one heavy smoker in Building/Structure) ☐

48. If yes to question 40, what do they smoke?
Cigarettes ☐ Cigars ☐ Pipe ☐ Other ☐

49. Does Building/Structure regularly contain/use air fresheners? Yes ☐ No ☐

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

50. Does anyone in the Building have indoor Building hobbies or crafts involving:
Heating ☐ soldering ☐, welding ☐ model glues ☐ paints ☐ spray paint ☐
wood finishing ☐ Other ☐_____

_____

_____

51. General Building / Structure use of industrial / office /consumer products (circle as appropriate).
Assume that: Never = never used, Hardly ever = less that once/month,
Occasionally = about once/month,
Regularly = about once/week, and
Often = more than once/week.

Product	**Frequency of Use**				
Solvents	Never	Hardly ever	Occasionally	Regularl	Often
Aerosol deodorizers	Never	Hardly ever	Occasionally	Regularl	Often
Insecticides	Never	Hardly ever	Occasionally	Regularly	Often
Disinfectants	Never	Hardly ever	Occasionally	Regularly	Often
Window cleaners	Never	Hardly ever	Occasionally	Regularly	Often
Ink / Toner Cartridge	Never	Hardly ever	Occasionally	Regularly	Often
Glue / Adhesives	Never	Hardly ever	Occasionally	Regularly	Often
Paint	Never	Hardly ever	Occasionally	Regularly	Often
Petroleum Fuel	Never	Hardly ever	Occasionally	Regularly	Often

52. Please check weekly Building/Structure maintenance, janitorial, and cleaning practices:

Dusting ☐
Dry Sweeping ☐
Vacuuming ☐
Polishing (furniture, etc.) ☐
Washing/waxing floors ☐
Other (describe) ☐

53. Other comments including items / subjects not covered in this questionnaire yet an issue or concern for the Building / Structure:

_____

_____

_____

_____

_____

_____

_____

_____

_____

Return to: VASLCHCS (00PA)
500 Foothill Drive
Salt Lake City, UT 84148

54. **Chemical Inventory/Summary**

Chemical/Chemical Product (consumer name)	Amount present in Building / Structure
a)	
b)	
c)	
d)	
e)	
f)	
g)	
h)	
i)	
j)	
k)	
l)	
m)	
n)	
o)	

ATTACHMENT 5

GEORGE E. WAHLEN
DEPARTMENT OF VETERANS AFFAIRS MEDICAL CENTER
VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, UT 84148

December 9, 2014

Re: Permission to Sample

Dear Property Owner:

The Department of Veterans Affairs Salt Lake City Medical Center (VA) is conducting initial CERCLA Remedial Investigation of the 700 South 1600 East PCE Plume, its' known location is centered to the southwest of the VA. The National Contingency Plan (NCP) requires that:

> *"The lead agency shall characterize the nature of and threat posed by the hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment or to support the analysis and design of potential response actions by conducting, as appropriate, field investigations to assess* [among other things] *characteristics or classifications of air, surface water, and ground water"* (NCP: 40CFR 300.430(d)(2)(ii)).

As the lead agency, VA is requesting permission to take samples of air, water and soil on your property. this is a preliminary characterization, samples will be collected by field instruments and for laboratory for analysis of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and total metals according to EPA SW-846 methods. In addition, water quality parameters (pH, DO, Temperature, Conductivity, and ORP) and VOCs in air (both indoors and out of doors) will be measured using field instrumentation.

You will be provided a copy of the field results after all sampling is completed and you will also receive laboratory results upon completion of data validation procedures. VA will use the field and laboratory data as part of reports to be submitted to the USEPA and the Utah Department of Environmental Quality.

Please sign at the location provided below if you authorize VA and its contractors to collect environmental samples at your property.

If you have any questions or require additional information, please contact me at (801) 582-1565 ext. 2021.

Best regards,

D. Lynne Welsh, Remedial Manager/CERCLA RPM
Department of Veteran's Affairs
VA Salt Lake City Health Care System

PERMISSION TO TAKE ENVIRONMENTAL SAMPLES OF IDENTIFIED PROPERTY:

_____

Name/ address and date

ATTACHMENT 6

ATTACHMENT 6

700 South 1600 East Superfund Site
East Side Springs (AOU-1)

VA Salt Lake City Health Care System
George E. Wahlen Department of Veterans Affairs Medical Center
500 Foothill Drive
Salt Lake City, UT 84148
801-582-1565

Jill Atwood, Chief Communications Officer, 801-584-1252, cell 801-330-1198, jill.atwood@va.gov
D Lynne Welsh: Remedial Project Manager; 801-582-1565, ext. 2021, dlynne.welsh@va.gov

Environmental Protection Agency (EPA)
U.S. EPA Region 8
1595 Wynkoop Street, Denver, CO 80202-1129

Cynthia Peterson, Community Involvement Coordinator, 303-313-6879, peterson.cynthia@epa.gov
Mark Aguilar, Project Manager, 303-312-6251, aguilar.mark@epa.gov
Vera Moritz, Project Manager, 303-312-6981, moritz.vera@epa.gov

Utah Department of Environmental Quality (UDEQ)
Dave Allison, Community Involvement Coordinator, 801-536-4479, dallison@utah.gov
Tom Daniels, Project Manager, 801-536-4090, tdaniels@utah.gov

ATTACHMENT 7

ATTACHMENT 7

Contact Card for Distribution to Stakeholders in the Field

Salt Lake City Veterans Affairs Health Care System

700 South 1600 East Superfund Site
East Side Springs Site Investigations
Ground Water Study/Indoor Air Sampling

D. Lynne Welsh, Remedial Project Manager
801. 582.1565 ext. 2021
DLynne.Welsh@va.gov
or
Jill Atwood, Chief Communication Officer
801.584.1252
jill.atwood@va.gov

Additional Local and Federal Contacts:	
Vera Moritz Remedial Project Manager U.S. Environmental Protection Agency, Region 8 303-312-6981 moritz.vera@epa.gov **Mark Aguilar** Remedial Project Manager U.S. Environmental Protection Agency, Region 8 303-312-6251 aguilar.mark@epa.gov **Cynthia Peterson** Community Involvement Coordinator U.S. Environmental Protection Agency, Region 8 303- 313-6879 peterson.cynthia@epa.gov **David Dorian** Environmental Health Scientist U.S. Environmental Protection Agency (ATSDR) 303-312-7011 dorian.david@epa.gov	**Tom Daniels** Project Manager Utah Department of Environmental Quality 801-536-4090 tdaniels@utah.gov **Dave Allison** Community Involvement Coordinator Utah Department of Environmental Quality 801-536-4479 dallison@utah.gov **Craig Dietrich** Utah Department of Health 801-538-6003 dietrich@utah.gov **Teresa Gray** Bureau Manager Salt Lake County Health Department 385-468-4100 tgray@slco.org

ATTACHMENT 8

ATTACHMENT 8

Stakeholder Contact Log
Date/Time:
Contact Name:
Organization:
Address #1
Address #2
City, State, Zip:
Phone:
Email
Location of Contact:
Concern/Question:
Resolution:
Field Team Member Name:

ATTACHMENT 9

Frequently Asked Questions

1. How did this happen?

The exact source of the dry cleaning solvent (i.e., tetrachloroethylene, also known as PCE) contamination present in the groundwater at 700 East and 1600 South in Salt Lake City, Utah is unknown. EPA Region 8 has identified the Veterans Administration (VA) as a potentially responsible party (PRP), since the VA operated a dry cleaning operation at its adjacent medical center in the late 1970s and early 1980s. Under CERCLA (the Comprehensive Environmental Response Compensation, and Liability Act, commonly called Superfund), any party identified as contributing to a Superfund National Priorities List site can be held liable for the entire NPL site cleanup costs. The CERCLA remedial investigation (RI) that is being initiated by the VA will help establish if other businesses operating in this area of Salt Lake City, Utah may have contributed to the groundwater contamination and will be sharing in the cleanup costs for the PCE plume identified at 700 South and 1600 East.

2. How did the EPA learn about the PCE plumes in groundwater and seeps in residents' yards?

In the summer of 2010 in response to an oil spill in Red Butte Creek, sampling was conducted by Salt Lake City Public Utilities (SLCPU) to find contamination related to the spill. While no crude oil was detected, PCE was detected. After performing some initial sampling, the Utah Department of Environmental Quality (UDEQ) requested the EPA's assistance with conducting a further investigation.

3. Why is the EPA getting involved now?

After receiving results of primary sampling efforts by SLCPU and new information about seeps in residential yards, UDEQ asked the EPA to support additional site investigation to determine the level and source of the PCE contamination, and to evaluate potential threats to human health and the environment.

4. What is the primary contaminant of concern?

Tetrachloroethylene (PCE) is a synthetic chemical that is widely used for dry cleaning fabrics and for metal-degreasing operations. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products. PCE is a nonflammable, colorless liquid at room temperature and has a sharp, sweet odor. Other names for PCE include perchloroethylene, perc, tetrachloroethene, perclene and perchlor.

5. This problem was identified in the 1990s, why is it just now being addressed?

The EPA only recently discovered springs and shallow groundwater contamination further down on the hill. Prior to that, this was thought to be primarily a groundwater issue, and the city took measures to prevent exposures by removing drinking water wells from service. The discovery of the springs has changed conditions, creating new potential exposure pathways that are more difficult and costly to evaluate and manage. For that reason a more rigorous investigation is needed.

6. Is drinking water safe?

Yes. Salt Lake City routinely tests its drinking water as required by federal standards. The city removed the affected drinking water well from service pending additional investigation and corrective action. In addition, the artesian fountains at Liberty Park and at 800 South and 500 East are routinely tested, and no PCE has been detected.

7. Is private well water safe to drink?

We are not aware of private wells in the area that are being used for drinking water. If you have a private well in the area that you are drinking from, it is recommended that you have your water tested for PCE and other organic compounds.

8. What happens to PCE when it gets into the environment?

Much of the PCE that gets into water and soil will evaporate into the air. However, because PCE can travel through soils quite easily, it can get into groundwater where it may persist without being broken down. If conditions are right, bacteria will break down some of it, and some of the chemicals formed may also be harmful. Under some conditions, PCE may stick to the soil and stay there. It does not seem to build up in animals that live in water, such as fish, clams and oysters. We do not know if it builds up in plants grown on land.

9. How might I be exposed to PCE and how does it affect my health?

A very common example is when clothes are brought home from the dry cleaners. The sweet odor you smell is a small amount of PCE being released into the air. In addition to breathing contaminated air, you may also drink contaminated water or your skin may come in contact with the water while taking a shower. Exposure to very high concentrations of PCE can cause dizziness, headaches, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness and death. The Department of Health and Human Services (DHHS) has determined that PCE may reasonably be anticipated to be a carcinogen.

10. I'm concerned about the health risks to my family, what can I do now to make sure they are protected?

Public water supplies are safe and Salt Lake City routinely tests its drinking water following federal standards. If you have a natural spring or private water well on your property, it is recommended that you have your water tested for PCE and other organic compounds before drinking it. There are numerous independent laboratories that can analyze your water sample(s) for a fee. Contact your local or state health department for referral to a certified laboratory in your area. Many of these labs can also analyze indoor air samples; however, you would likely need to hire a contractor with vapor intrusion expertise to collect the sample(s) for you.

11. My kids and dogs play in the spring water, are they going to get sick?

We currently know there is a potential for some health risks, but until a thorough investigation is completed we do not know the extent of the risks. This level of investigation takes place during the remedial investigation (RI), which is why the site needs to be placed on the NPL. The long-term effects from inhalation (vapor intrusion) and ingestion (drinking water) at low levels are some of the most concerning issues at this site. Dermal (skin) contact for humans and pets playing in the springs is not likely a serious health concern, based on the PCE concentrations measured in the springs. Assuming some incidental ingestion, inhalation and dermal contact during play, concentrations are still within the EPA's acceptable limits.

12. I water my vegetable garden with spring water. Are my vegetables safe to eat?

Given the high volatility of PCE, its low potential for bioaccumulation, and the relatively low lipid content of most fruits and vegetables, it is unlikely that fruits and vegetables irrigated with PCE-contaminated spring water from the East Side Springs sites would harm people's health. Additionally, this is something that would be evaluated in the Remedial Investigation (RI). There are studies which have shown that plant uptake of PCE and other chlorinated solvents are negligible and do not pose a serious risk to human health. PCE is extremely volatile and much of the chemical that gets into the water or soil evaporates into the air before it has a chance to be absorbed by plant tissue.

13. Are there any indoor air concerns at this site?

Indoor air may become a concern if vapors from volatile chemicals migrate into air spaces of overlying buildings. This phenomenon is generally referred to as "vapor intrusion." Vapor intrusion is typically influenced by factors such as contaminant concentration, depth of contamination, depth to groundwater, and building construction and condition. Based on several of these factors, the potential for vapor intrusion does exist at this site.

14. Can the contamination get inside the house?

Volatile organic compounds (VOCs) in contaminated soils and/or contaminated groundwater can emit vapors that may migrate through the soil and other air spaces of overlying buildings. This phenomenon is generally referred to as "vapor intrusion." Contaminated vapors typically enter buildings through cracks in basements and foundations, sewer lines and other openings. Vapor intrusion becomes a concern because vapors may build up to a point where the health of residents or workers in those buildings could be at risk.

15. Is there a concern for the air quality in this area?

No air samples were collected as part of this investigation. Much of the site is capped with concrete and asphalt; therefore, the threat of exposure from ambient outdoor air is believed to be relatively low.

16. Is there a medical test to show whether I have been exposed to PCE?

One way of testing for PCE exposure is to measure the amount of the chemical in the breath, much the same way breath-alcohol measurements are used. A simple blood test can be administered, but this is usually done at specialized laboratories. Contact your personal physician if you have questions or concerns about potential PCE Exposure.

17. Who is going to pay for the cleanup?

At this point the federal government (VA – VISN 19) will pay for the CERCLA (Superfund) groundwater investigations and cleanups at the PCE plume identified at 700 South and 1600 East in Salt Lake City, Utah. If other potentially responsible parties (PRPs) are discovered, their ability to financially contribute to the investigation and cleanup of the PCE plume identified at 700 South and 1600 East will need to be evaluated and adjudicated by EPA Region 8 and UDEQ.

18. Have you determined who's responsible for the contamination?

The EPA has identified a potentially responsible party (PRP)—the former dry cleaning facility at the George E. Wahlen Department of Veterans Affairs Medical Center (VA). There may be others, but as of now EPA has not identified additional PRPs. However, it's not uncommon to discover additional PRPs during the Remedial Investigation (RI) phase, when more resources are available to conduct a more thorough and comprehensive investigation.

19. What is the Department of Veterans Affairs (VA) position on this problem?

The VA is working collaboratively with the EPA and Utah Department of Environmental Quality (Utah DEQ), as well as, with the city and other stakeholders. The EPA, Utah DEQ and the VA are working closely together to establish a schedule for next steps.

20. Could the VA clean up the site without it being listed on the NPL?

While the EPA initially identified this problem and potential risks, we do not know how widespread it is and what the actual risks are. We do know it is bigger than previously thought. Listing the site on the NPL unlocks resources needed to better determine the nature and extent of the contamination, and to address risks if and where they exist. The state and city do not have resources to investigate a problem of this scale. Listing mandates a response, thereby allowing the VA to obtain that level of resources.

21. What is the benefit of being listed on the National Priorities List (NPL)?

NPL placement ensures that a comprehensive investigation will occur, that any identified health risks will be addressed and, if necessary, that the problem will be cleaned up. The NPL provides access to technical and financial resources that are otherwise unavailable. In addition to funds for investigation and cleanup, NPL listing unlocks resources for communities to help them better understand the technical issues and guarantees the citizens will have the opportunity to provide input in the process and comment on decisions before they are made. Community involvement is ongoing throughout the

investigation and cleanup, including the formation of a Community Advisory Group (CAG) and the availability of Technical Assistance Grants (TAG) funding and the Technical Assistance Services for Communities (TASC) program through EPA.

22. Will National Priorities List (NPL) listing reduce my property values?

During the buying or selling process we are happy to assist where we're able. This would include providing cleanup information and meeting with property owners, realtors, lending institutions or prospective buyers. There are no easy answers with property value issues. People buy and sell homes for a variety of reasons: great school ratings, close to family, a popular location usually win out with real estate decisions. We have printed out some additional information for you to read on the topic as well as invited an expert in the area to speak on the topic.

Based on past cleanups, the EPA believes that Superfund cleanup has an overall beneficial impact on the community, because the listing of a site on the NPL triggers a federal commitment to do cleanup work. This step reduces uncertainty and may act as a signal to real estate markets that property improvements are imminent.

23. Do I have to disclose this cleanup information when I attempt to sell this property?

If the property is shown to not be impacted by site contaminants, that would be beneficial to share with prospective buyers. If the property is impacted, but gets cleaned up, that would also be helpful information for buyers and would likely increase buyers' level of comfort with the home and neighborhood.

http://www.nolo.com/legal-encyclopedia/utah-home-sellers-disclosures-state-law.html

24. This sounds expensive, what impact will this have on care for Veterans or hospital jobs?

The VASLC CERCLA/Superfund Project will have an impact on the VA Rocky Mountain Network's operating budget for several years but we are continuously working with all parties to mitigate this impact and ensure our Veterans continue to receive care that is second to none.

25. Who decides how the site is cleaned up?

The federal government and states have the authority under the Superfund law to make the final clean up decisions. However, the Superfund law also requires that the community be given every opportunity to have meaningful input on how the cleanup is completed. The VA, EPA and UDEQ are committed to involving any interested citizens or groups along with local government throughout the decision process.

26. How quickly can you start, what has to happen next?

The EPA, Utah DEQ and the VA are currently working together to develop a schedule for next steps. The first step in the process will be a more detailed investigation of nature and extent (RI/FS). This will be followed by cleanup as is necessary.

27. What voice does the community have after a site is listed?

The VA, Utah DEQ and EPA will work very closely with the community and the State of Utah during the cleanup process at this site. Some communities choose to be very involved and form a Community Advisory Group, others do not. The EPA, Utah DEQ and the VA welcome input and involvement from all stakeholders. Technical Assistance Grants and other financial resources are available to communities to encourage and facilitate meaningful involvement. For more information about community involvement at Superfund sites, visit www.epa.gov/superfund/community.

28. How are the site boundaries determined in the National Priorities List (NPL) process?

Superfund designation includes the source of the contamination and wherever contamination may have spread and is a threat to human health and the environment. When the site is proposed, a basic area is described in the listing package, a report prepared and sent to EPA headquarters supporting why the site qualifies for placement on the National Priorities List (NPL). Boundaries are not determined until after the Remedial Investigation and Feasibility Study (RI/FS) are complete. If more contamination is found later in the cleanup process the boundaries may be changed to include the new area. If less contamination is found than suspected, the boundaries may be changed to reflect the smaller size.

29. Who do I contact to get more information or if I want to be involved somehow?

VA Salt Lake City HCS

Jill Atwood, Chief Communications Officer
500 Foothill Drive
Salt Lake City, UT 84148
801-584-1252
Jill.Atwood@va.gov

Environmental Protection Agency, Region 8
Libby Faulk
1595 Wynkoop St., Mail Code: 80C-IO
Denver, CO 80202-1129
303-312-6083
Faulk.Libby@epa.gov

Utah Department of Environmental Quality
David Allison, Community Involvement
P.O. Box 144840
Salt Lake City, UT 84114-4840
(801)536-4479
dallison@utah.gov

ATTACHMENT 10

Background Information

On May 24, 2013, EPA added the 700 South 1600 East PCE Plume site (the Site) to its National Priorities List (NPL) of Superfund sites. The listing became final on June 24, 2013. A former dry cleaning facility at the nearby Salt Lake City VA Medical Center (VAMC) currently is the only identified source in the area for groundwater beneath the site which is contaminated with tetrachloroethylene, commonly known as PCE. PCE levels at the site are above federal drinking water standards, but drinking water for the community, which comes from the Salt Lake City public water supply, is not impacted. Salt Lake City routinely tests its drinking water pursuant to federal standards. In addition, the artesian fountains at Liberty Park and at 800 South 500 East are routinely tested, and no PCE has been detected. As currently the only identified PCE source, VA is responsible for leading the cleanup under the Superfund program. The addition of the Site to the NPL requires VA to pay for and manage the cleanup. Placement on the NPL guarantees the public the opportunity to participate in the cleanup process from its early stages, which include a detailed site assessment and investigation.

What is PCE?

Tetrachloroethylene (PCE) is a synthetic chemical that is widely used for dry cleaning fabrics and for metal-degreasing operations. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products. PCE is a nonflammable, colorless liquid at room temperature and has a sharp, sweet odor.

What is Vapor Intrusion?

When chemicals or petroleum products are spilled or leak from underground storage tanks, they can give off gases or vapors that can get inside buildings. Common products that can cause vapor intrusion are gasoline or diesel fuel, dry cleaning solvents and industrial degreasers. The vapors can move through the soil and seep through cracks in basements, foundations, sewer lines and other openings.

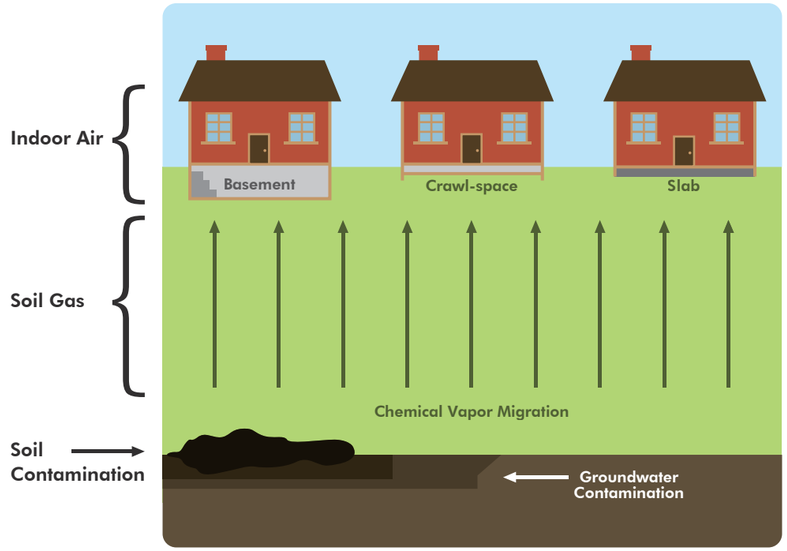

Illustration of how vapors can rise up through soil into your home.

Vapor intrusion is a concern because vapors can build up to a point where the health of residents or workers in those buildings could be at risk. Some vapors from petroleum products have a gasoline odor, others are odor-free.

Health Effects?

Health risks vary based on the type and amount of chemicals. How healthy you are and how long you are exposed are also factors. Some people may experience eye and respiratory irritation, headaches or nausea. These symptoms are temporary and should go away when the vapors are vented. Low-level chemical exposures over many years, however, may raise your lifetime risk of cancer or chronic disease.

Resident's Role

There are just a few things we ask of you to ensure the most accurate sampling possible.

WHAT WE NEED YOU TO DO

- ☐ Continue to live your life as normal. You can do most of the things you would do on a normal day. You don't have to leave the house and, for the most part, won't have to take any special precautions.
- ☐ Prior to the technicians arriving at your home, it would be helpful to make sure they have access to the first floor and the basement in order to screen with a portable gas chromatograph mass spectrometer (GC/MS).
- ☐ When technicians arrive, they will ask you questions about products you use, then screen your home. If needed, they will place a canister to check for longer term vapor presence.
- ☐ During the day of sampling you may stay in your home. Technicians will first look for indoor air sources, temporarily remove them and then conduct the tests.

WHAT **NOT** TO DO THE WEEK OF SAMPLING

- ☐ Avoid having freshly dry-cleaned clothing in the home, if at all possible. If you have dry cleaning ready to be picked up, please wait until after the canister has been collected to pick it up.
- ☐ Avoid using solvents or degreasers.
- ☐ Avoid working on hobby projects that would require the use of paint, glues or other chemicals.
- ☐ If you own guns, avoid cleaning them.
- ☐ Avoid contact with the canister.

Step-by-Step Air Sampling Process

1. Agree to have air sampling done in your home by mailing back the response postcard or by calling the VA's Communications Officer at: 801-584-1252
2. After October 2014 someone will call to schedule a sampling appointment that is convenient for you.
3. Approximately one week before the scheduled appointment, you will receive a reminder postcard in the mail. This will include instructions to prepare for the air sample.
4. Technicians will arrive at the scheduled time and ask you some questions about chemical products in your home. They will be in your home to screen for indoor sources and then characterize for possible vapors.
5. If needed, technicians will place a canister in your home and then 24 hours later, the technicians will return and pick up the canister. It will be sent to an off site laboratory to be analyzed.
6. Within approximately six to eight weeks you will receive a letter about your preliminary sampling results.
7. Further action will depend on your results.

Household Chemicals

Not all chemical vapors found in homes are coming from the groundwater. A number of commercially available products contain the same chemicals found in the contaminated groundwater. The use or storage of these products in homes or attached garages can cause chlorinated solvents to be found.

Please carefully read the labels of products inside your home to see if they contain ingredients with "chloro" in their name, such as tetrachloroethylene (PCE) or trichloroethylene (TCE). The products that most likely contain this chemical are typically found in metal tubes, aerosol cans, or glass containers.

The following are some examples of chemicals that could contain constituents of concern:

GUN CARE PRODUCTS

Many commercially available gun cleaners and other gun care products contain chlorinated solvents.

ELECTRICAL CLEANERS AND DEGREASERS

Many commercially available electrical cleaners and degreasers contain chlorinated solvents.

GLUES AND ADHESIVES

Some specialized glues contain chlorinated solvents. Check glues that are made to bond acrylics and other plastics.

AUTOMOTIVE DEGREASERS AND CLEANERS

Some common automotive products use chlorinated solvents. In particular, look at brake parts cleaners or "non-flammable" solvents.

Answers to Questions you may have:

Q: What if I don't want indoor air sampling?
A: Sampling is completely optional and you are not required to have your home tested.

Q. How do you know if vapors are coming from inside the home or from the groundwater?
A. The canister we use to take the initial sample only tells us if vapors are present in the air inside the home. It does not tell us the source of those vapors. If vapors are detected in the initial sample, we come back with a specialized instrument that we can use to narrow down the source to a specific room and even to a specific item. Once the source is identified, we ask the resident to remove the item and then we test again. If the follow-up sample still shows vapors, we repeat the process to ensure all inside sources are identified and removed. If we cannot identify an inside source, then we can conclude the source is likely to be the groundwater and we will offer to install a vapor removal system.

Q: How often do you test?
A: Homes with previous detections or systems installed are sampled more frequently.

Q: How much will testing cost me?
A: Nothing. VASLCHCS covers all costs associated with the testing.

Q: What if I don't have a basement?
A: We still recommend having your home tested. We will place the canister in the lowest livable space of your home.

Q: Is my drinking water safe?
A: You are most likely connected to city water. The city obtains its drinking water from deep aquifers or mountain reservoirs, not from the contaminated shallow aquifer. In addition, your city regularly tests its water to ensure it is safe. If you are drinking city water, you are not drinking contaminated water. For information about your drinking water, contact your city's public works office.

Q: What will happen if volatile organic compound vapor is found to be intruding into my house?
A: The investigation and cleanup of the PCE Plume will take a long time but in the meantime VA is committed to installing air remediation systems in those houses that need it while cleanup of the plume is on-going. These systems are similar to those installed to address radon issues. After a successful plume cleanup system is in place, the air remediation systems may no longer be needed and can be decommissioned. Periodic testing will determine when that may happen.

Contact Information

If you have questions or comments, please contact:
Jill Atwood, Chief Communications Officer, VASLCHCS
801-584-1252
jill.atwood@va.gov

VA SALT LAKE CITY HCS

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1600 E. 700 S. SUPERFUND SITE

INDOOR AIR SAMPLING STUDY

ATTACHMENT 11

GEORGE E. WAHLEN
DEPARTMENT OF VETERANS AFFAIRS MEDICAL CENTER
VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, UT 84148

[DATE]

Dear [NAME]:

Thank you again for allowing us access to your home on [DATE]. Your cooperation is paramount in getting the information we need to properly address vapor intrusion, your questions and concerns and to further help us determine the distribution and extent of the tetrachloroethylene (PCE) plume. It is important to us that you are comfortable with the process and that we answer all of your questions.

The main chemical we are concerned about in this investigation, PCE, was [or was not] detected in the air in your home during the January/February/March/April 2015 sampling event.

[Below statements Individualized to each home.]

Examples:

1. All rooms tested below the screening level of 1.60 parts per billion by volume (ppbv). This means PCE levels are so low that they cannot be considered significant to the investigation and are highly unlikely to have any negative effect on your family. Any readings below the screening level are likely to come from cleaners, glues, cosmetics, or other sources that are typical of background levels not related to groundwater. No further action is warranted at this time in your home.

-or-

2. There are some readings in your home that merit further testing. While concentrations were below the levels that would require immediate action, they do exceed the screening level. VA would like to confirm field results by collecting additional indoor air samples for laboratory analysis. Any additional recommendations would be based on the laboratory results. We will contact you within the next 2 weeks to discuss follow-up sampling with you.

-or-

3. There are some areas in your home that are at or exceed the removal action level of 5.97 ppbv. The removal action level is well below levels that may cause health effects, however in order to take every precaution, we need to discuss continued monitoring along with the possibility of

SAMPLE LETTER

installing a mitigation system to remove PCE from your home. We will contact you within the next two weeks to discuss additional actions proposed for your residence.

[If there are any data above screening levels for TCE, DCE, or VC, discuss here]

Your Results – Tetrachloroethylene (PCE)

Here is what the monitoring equipment reported about the air in your home in parts per billion by volume (ppbv).

Room	***Field Results – PCE in ppbv**

**Field results can vary from validated data, but are accurate enough to determine whether further sampling or monitoring is necessary.*

The graphic below represents your results compared to other points of interest; all units are in parts per billion by volume (ppbv).

What do the screening and action levels mean?

The screening level indicates a reference point at which VA can use the data for the purposes of the study. When a result is below the screening level, it is so low that it cannot be considered significant, and is highly unlikely to have any effect on the well-being of occupants in your home. If there are any results found below the screening level, they could be easily attributed to cleaners, glues, cosmetics, other sources in the home, or unknown sources that are typical of background levels not attributed to the groundwater plume. The screening level for PCE is 1.60 ppbv.

Comparatively, the average background indoor air PCE concentration in the U.S. is 3.01 ppbv. This U.S. average comes from an EPA database of 2,195 indoor air samples from non-exposed areas. “Non-exposed” means there was no reason to believe that the area had PCE exposure due to contamination (areas not located next to a PCE source, nor in an area with confirmed groundwater/soil contamination).

SAMPLE LETTER

Medical studies have found that the lowest level of PCE to affect humans was 49.93 ppbv, which had an effect on children's vision. The lowest level found to cause human health effects beyond vision (e.g., neurobehavioral) was 199.84 ppbv. VA has set action levels below the indicators in these studies as follows:

Screening Level = 1.60 ppbv. If samples exceed this value, we will contact you to conduct additional testing. The samples collected will undergo certified laboratory analysis and we will continue to communicate with you about any further actions.

Removal Action Level = 5.97 ppbv. Although this level of PCE is still below those cited in medical studies, we believe this level merits certified laboratory analysis and continued monitoring. If these efforts confirm the presence of PCE above 5.97 ppbv, VA will design and install a PCE mitigation system for your home. Such mitigation system will divert or filter out PCE until the groundwater plume is shown to no longer have an effect on the air quality in your home.

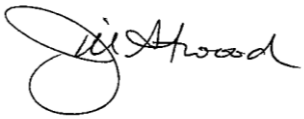
The efforts and results discussed above are part of preliminary indoor air sampling, targeting the most likely neighborhoods based on proximity to areas impacted by PCE in shallow groundwater or area spring waters. VA will use this information as part of the overall remedial investigation of PCE in groundwater in your neighborhood.

If you would like to read more about PCE, the following resources provide substantial detail:

> Tetrachloroethylene Hazard Summary (US EPA), available at: http://www.epa.gov/ttn/atw/hlthef/tet-ethy.html
>
> Tetrachloroethylene Toxicological FAQs (US EPA's Agency for Toxic Substances & Disease Registry), available at: http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=264&tid=48

Please do not hesitate to call with further questions. Your family's health and safety is VA's top priority.

Sincerely,



Jill Atwood
Chief Communication Officer
Department of Veterans Affairs
VA Salt Lake City Health Care System
801-330-1198

Encloslure: Contact Information Card

SAMPLE LETTER

Discussion of Field Results Letter Outline

VA received a lot of interest and suggestions about what might be shared regarding field results. Below is a brief summary about some of the input received.

Why talk about the screening level?
The screening level is a reference point at which VA determines whether the data collected is useful in the study. While this term could be left out of letters for individuals who's results were below the screening level, any discussion that will take place with owners about results above that point will likely use the term. Further, this term may offer relief to those who's results are below the screening level. The text in the letter says that results below the screening level are "so low that it cannot be considered significant," and with that context, it is unlikely to cause alarm or be confused with the removal action level.

Why give the US Average?
It is human nature to compare our status to others'; in fact, residents in one neighborhood have reportedly already gathered for an informal meeting to discuss what they've learned about PCE and their results so far, even though VA hasn't yet communicated anything to owners in writing yet. The U.S. average concentration of PCE gives them a measuring stick to compare against; for some it will be relieving, though there may be some above the average.

Why give information about medical studies?
Many residents want to know if there is an impact to their health. While studies summarized by the EPA and ATSDR generally indicate that the majority of health effects have occured at levels much higher than the level cited in this letter, VA has cited the lowest observed effect level (LOEL) in order to take a conservative approach.

Why have the ppbv values changed since the last draft we saw?
The screening level and action level are established in ug/m^3, but the field instruments report data in ppbv. The equation used to convert from ug/m^3 to ppbv in draft copies of the letter utilized 25°C for the temperature input. After further consideration, 25°C is believed to be warmer than the air in most properties being sampled. The equation has been corrected to 21°C, which effects the ppbv value.

Is the line-graphic that represents results, screening level, action level, etc., to scale?
Yes, but with some margin of error due to the method used.

What contact information will be provided to property owners?
VA's Chief Communication Officer's contact information is listed on the letter, and a contact card will be included with the letter. The contact card includes contacts at VA, DEQ, ATSDR, EPA, Salt Lake County Health, and Utah Dept of Health.

APPENDIX J

FINAL

Quality Assurance Project Plan
700 South 1600 East PCE Plume
AOU-1: East Side Springs
Salt Lake City, Utah

Amendment No. 1

BPA No. VA259-14-A-0021
TO No. VA259-14-J-1384

February 24, 2015

Effective Dates: 02/10/2015—9/30/2015
Revision 0

Prepared for: VA Salt Lake City Health Care System
500 Foothill Drive
Salt Lake City, Utah 84148

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

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Title and Approval Sheet

Quality Assurance Project Plan (QAPP)

Effective Period: October 1, 2014 – September 30, 2015

700 South 1600 East PCE Plume
AOU-1: East Side Springs
Salt Lake City, Utah

First Environment Program Manager:	Edward J. Reid First Environment, Inc. (Prime)	Date: 2/25/15
First Environment QA/QC Manager:	First Environment, Inc. (Prime)	Date: 2/25/15
CH2M Hill Project Manager:	CH2M Hill (Subcontractor)	Date: 3/5/15
CH2M Hill Project Quality Assurance Manager:	CH2M Hill (Subcontractor)	Date: 3/5/15
VA COR/Remedial Program Manager, CERCLA:	Department of Veteran's Affairs	Date: 3/6/2015
U.S. EPA Remedial Project Manager:	U.S. EPA Region 8	Date: 4/1/2015
U.S. EPA Project Manager:	U.S. EPA Region 8	Date: 4/1/15
U.S. EPA Quality Assurance Manager:	Linda J. Hemmelberger U.S. EPA Region 8	Date: 4/2/15
UDEQ Project Manager:	NOT REQUIRED PER FFA LANGUAGE RE: Primary Document Approval SEE Routing Slip.	Date:

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Background

Residences and structures within the downgradient footprint of the 700 South 1600 East PCE plume are being assessed as part of an accelerated investigation to determine potential health impacts to the public from vapor intrusion (VI). As part of this investigation, a field portable gas chromatograph/mass spectrometer (GC/MS) manufactured by Inficon (the "HAPSITE") is being used for real-time screening of indoor air background sources, VI sources, and near-slab soil gas. The data collected with the HAPSITE is being used to identify potential points of entry, potential indoor source materials, assess the potential for VI, and determine the need to collect and analyze confirmatory air samples using SUMMA canisters and TO-15 analyses.

The primary contaminant of concern for this assessment is Tetrachloroethylene (PCE). Due to the possibility of reductive dechlorination of PCE, the daughter products Trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-DCE), and vinyl chloride (VC) are also being assessed. Site-wide groundwater data collected to date indicates that the aquifer and associated springs are aerobic in nature and that reductive dechlorination and significant daughter product generation is not occurring. However, there is still a slight possibility that daughter products may be generated due to localized reducing conditions in groundwater.

As part of the screening and decision making process, the Department of Veterans Affairs (VA) adopted U.S. Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) for PCE, TCE, and VC (cis-DCE does not have an established RSL) applicable to EPA indoor air exposures. The HAPSITE analytical results for indoor air are compared to the RSLs to identify the need for further sampling (long-term monitoring), confirmation sampling using TO-15 Summa canister analyses, or immediate mitigation actions. The approved RSLs for the project are as follows: PCE, 11 ug/m3 (1.62 ppbv); TCE, 0.42 ug/m3 (0.1 ppbv); and VC, 0.17 ug/m3 (0.07 ppbv).

The Quality Control (QC) protocols for the HAPSITE, as established in the approved Quality Assurance Project Plan (QAPP) and approved by EPA on December 19, 2014, required a four compound calibration (PCE, TCE, cis-DCE, and VC) using a five-point (concentration) calibration method for each analyte (specifically, concentrations of 0.1, 0.5, 1, 5, 10 ppbv for indoor air). During the use of the HAPSITE for indoor air screening and near-structure soil gas

screening, the instrument did not provide reliable data for quantifying VC at concentrations below the 5 ppbv calibration level. This is well above the established RSL of 0.07 ppbv for VC. Therefore, this (1) eliminates the collection of VC screening and characterization data with the HAPSITE and the requirement to calibrate the HAPSITE for VC; and (2) presents a data collection and analysis effort to ensure that not screening for VC with the HAPSITE does not compromise the results of the AOU-1 remedial investigation.

Elimination of VC Data Collection Using the HAPSITE

As approved by this Amendment, VC data will no longer be assessed or reported using the field-portable HAPSITE instrument. In addition, the five-point calibration of the HAPSITE for VC and the CCV for VC will not be performed. A three-analyte/five-point calibration for PCE, TCE, and cis-DCE will continue to be performed.

There will be no changes made to the existing procedure for analyzing VC in confirmatory SUMMA canisters using Method TO-15. Assessment criteria for potential further actions and risk assessment calculations for all four analytes of interest will remain the same. No changes to the established project RSLs for the COCs are proposed.

Data Collection and Analysis Effort for Assessing VC Presence

As stated in the QAPP, the HAPSITE is used to screen for indoor air sources of the chlorinated volatiles of interest, and to use these data to determine the need to collect confirmatory samples using SUMMA canisters and analyze them according to Method TO-15. Collection of SUMMA samples is triggered by exceedances of the assessment criteria for any of the analytes of interest. In the event of an assessment criteria exceedance for PCE, TCE, or cis-DCE, vapor samples will be collected using SUMMA canisters and volatile organics analyzed by TO-15. VC will also be measured as part of the SUMMA analysis and will be considered in making subsequent decisions regarding further action and risk assessment. Analysis of SUMMA canister samples (25 already identified in the Sample and Analysis Plan and these 4) will provide definitive data of the quality needed to accurately and quantitatively assess the risk to human health and ensure that appropriate remedies are evaluated, where needed.

By eliminating the screening of VC using the HAPSITE, there is a potential risk of not identifying VI issues from VC. The overall probability of exceeding RSLs for VC in the absence of PCE,

TCE, or cis-DCE exceedances is low. Analytical data collected to date indicate that the groundwater and associated springs are aerobic and reductive dechlorination is not generating significant concentrations of daughter products. It is believed that eliminating the field screening of VC using the HAPSITE will not compromise the data quality objectives or decision making process.

To address the possibility that VC is present in indoor air and soil gas above assessment criteria when the other contaminants of interest (PCE, TCE, and cis-DCE) are below, additional samples will be taken to verify VC is not present. Four sampling locations from surveyed and characterized structures within the study area will be selected for additional SUMMA canister sample collection. The selected structures will be located within the expected area of the PCE plume, where groundwater is within 10 to 20 feet of the ground surface and where the HAPSITE indicates that PCE, TCE, and cis-DCE do not exceed the RSLs. At each of these structures, a 24-hour SUMMA canister sample will be collected from breathing zone air and will be analyzed for VOCs using Method TO-15. One location will include a duplicate SUMMA sample (side-by-side canisters). The sample locations will be co-located with a HAPSITE reading in the lowest occupied level of the structure. At least two structural types (slab on-grade, partial finished basement, residential, school, etc.) will be assessed. These samples are in addition to the other QA samples being collected per the QAPP.

The data from the SUMMA canisters will be used to determine if VC is present above assessment levels when PCE, TCE, and cis-DCE are not detected above RSLs with the HAPSITE.

If VC measurements from the SUMMA canisters are below assessment levels at all four structures, it can then be reasonably assumed that eliminating VC from the HAPSITE screening had minimal impact on data quality objectives or decision outcomes.

If VC results from any of the four SUMMA canisters are above assessment criteria (RSLs), there is then a possibility that risk associated with exposure to VC cannot be determined using PCE, TCE, and cis-DCE as field indicators. If so, VA will address this with regulators at that time and may need to re-think the use of HAPSITE as a screening tool. However, the presence of VC

hits may not be attributable to the 700 South 1600 East PCE Plume Superfund Site, and an alternative assessment strategy will be required to address it which may include such actions as reporting another release to the appropriate regulatory authority and notify the property owner of the results.

APPENDIX K

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RIWP Minor Field Modification-01
Protocol for Performing Indoor Air and Near-slab Soil Gas Assessments
700 South 1600 East PCE Plume Superfund Site
Salt Lake City, Utah

PREPARED FOR: D. Lynne Welsh, VA Salt Lake City Health Care System

PREPARED BY: Ed Reid, First Environment, Inc.

COPIES: David Waite, CH2M-Hill; Rolf Lange, Avalon; Devin DeMarco, Ellen Reid, First Environment, Inc.

DATE: July 17, 2015

Introduction

This document provides a description of a minor modification to the Protocol for Performing Indoor Air and Near-slab Soil Gas Assessments, Version 4.0 (dated December 23, 2014) for the use of real-time on-site gas chromatography/mass spectrometry (GC/MS) analysis to evaluate the potential for vapor intrusion in structures associated with the Accelerated Operable Unit-1 (AOU-1) portion of the 700 South 1600 East PCE Plume (Plume). The protocol is included as Appendix H of the RIWP. The minor modification is a result of lessons learned during implementing the protocol in early January 2015, additional field training with the field-portable GC/MS (HAPSite™), and the initial screening using the protocol at a variety of sites during the first four weeks of the field effort.

The changes to the protocol are primarily changes in the order of various components of the indoor air screening process. In addition, further clarification to the quantitative indoor ambient air testing process to better define the location and number of rooms to be tested per floor level are provided.

Indoor Air Screening Process Modification

The current Protocol provides general procedures in Sections 7.0, 8.0, and 9.0 for conduct of initial qualitative (HAPSite™ in survey mode) screening for indoor background sources, conduct of initial qualitative (HAPSite™ in survey mode) vapor entry point screening, and conduct of quantitative (HAPSite™ in analyze mode) indoor ambient air sampling, respectively. This portion of the testing is done under ambient conditions. Currently, immediately upon entering a site, the HAPSite™ is used to conduct surveys throughout the building to identify potential locations of indoor background source materials and potential locations of vapor entry. Then, based on the surveys, the HAPSite™ is used in analyze mode to quantify concentrations on each floor of the structure and in habitable rooms.

After testing a number of buildings, it is apparent that walking through a site room-by-room with the HAPSite™ in survey mode is inefficient due to the lack of elevated indoor sources above the survey mode detection limits of about 100 ppb in nearly all structures. Below the survey mode

detection limits, the team can only record total ion counts (TICs) relative to baseline TIC to obtain a gross representation of target compounds. In addition, the vapor entry survey has rarely assisted in identifying entry points when random surveys of cracks, wall penetrations, and crawl spaces have been performed in survey mode. Quantitative testing of ambient air has proven to be better at providing initial data that allows the HAPSite™ operator to isolate specific rooms or areas of a site for further evaluation of indoor sources and entry points.

The original Protocol should be changed so that the order of indoor air testing begins with ambient indoor air analysis (Section 9.0) and then proceeds with either indoor background source surveys (Section 7.0) based on ambient results and visual observation of source materials, or vapor entry point surveys based on ambient results and observations of potential entry points.

The regulatory agencies (EPA and UDEQ) verbally agreed to the change on February 5, 2015 and effective upon VA acceptance of the Minor Field Modification, the Protocol is modified so that ambient indoor air analysis will be conducted upon entry into a site. Ambient air samples will be collected and analyzed by the HAPSite from each occupied level of the site and from selected representative rooms or areas on each level. In addition, the operator will collect ambient samples from selected spaces (i.e., closets, utility rooms, and crawl spaces accessed via entry doors from the basement areas) where indoor source materials may be present. Rooms or spaces with notable potential entry points (i.e., large floor cracks, open sump pits, floor drains, exposed sub-slab soil) will also be tested to determine ambient air concentrations within the space.

Upon completion of ambient air sampling and analysis with the HAPSite™, the operator will evaluate the initial ambient results and, in conjunction with visual observations of potential source materials, will switch the HAPSite™ to survey mode and run short (2-3 minute) surveys at locations where indoor sources are more likely to be present, as discussed in the Protocol. TICs will be noted during each survey and the specific item provoking the response also noted, if any. If ambient quantitative data indicates target compounds were below the HAPSite™ detection limits (approximately 0.1 ppbv) and no source materials were observed, then an indoor source survey is not necessary and shall be noted on the VI field forms. If ambient quantitative data shows target compound concentrations just above detection limits from a structure level where only one or two representative samples were initially collected, additional ambient samples will be collected from other locations (at least one other location) throughout that level to verify concentrations do not increase in other portions of the level – as a result of an indoor source.

After indoor source surveys are complete or deemed un-necessary, the operator will use the ambient-results evaluation and previous visual observations of potential vapor entry points to select locations to survey for vapor entry. The HAPSite will be used in survey mode as described in the original protocol and 2-3 minute surveys at suspected entry points (typically sumps, floor drains, foundation wall penetrations, and bare soil crawl spaces). TIC response will be noted and the type of entry and location also noted. If ambient quantitative data indicates target compounds were below or just above the HAPSite™ detection limits (approximately 0.1 ppbv) and no potential entry points were observed, then a vapor entry survey is not necessary and shall be noted on the VI field forms.

APPENDIX L

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RIWP MINOR FIELD MODIFICATION-02
Clarification of QAPP Amendment Number 1
700 SOUTH 1600 EAST PCE PLUME SITE
SALT LAKE CITY, UTAH

PREPARED FOR: D. Lynne Welsh, VA Salt Lake City Health Care System

PREPARED BY: Rolf Lange, Avalon Business Engineering Services

COPIES: Devin DeMarco, Ed Reid, First Environment, Inc.; David Waite and Michael Novak, CH2M-Hill; and Brian Speer, Avalon

DATE: July 17, 2015

Introduction

This document describes a minor field modification to Section 6.2.1 of the Remedial Investigation Work Plan (RIWP) for Accelerated Operable Unit-1 (AOU-1) of the 700 South 1600 East PCE Plume (the "Plume"), Salt Lake City, Utah, Superfund Site. Specifically, this document memorializes changes to QAPP Amendment No. 1 that were discussed by the U.S. Department of Veteran's Affairs (VA) with the Environmental Protection Agency Region 8 (EPA) and the Utah Department of Environmental Quality, Division of Environmental Response and Remediation (DERR) staff to clarify:

1) The selection criteria for additional quality assurance samples identified in QAPP Amendment No. 1.
2) The number of structures to be sampled. Together, these clarifications are designed to further ensure that VC is not present in indoor air, above assessment criteria, when the other contaminants of interest (PCE and TCE) are below the screening levels established in the AOU-1 Screening Level and Removal Action Level Memo.

This modification, along with Minor Field Modification No. 1, affects how the Quality Assurance Project Plan (QAPP) and the Quality Assurance Project Plan Amendment No. 1 (QAPP Amendment 1) will be implemented. It also supplements Section 2.3.1 of the QAPP and Section 4.1 of the Sampling and Analysis Plan (SAP), both entitled: *Indoor Air Quality Screening, Characterization and Verification.* Section 12 of the Protocol for Performing Indoor Air and Near-slab Soil Gas Assessments at the 700 South 1600 East PCE Plume Superfund Site, Salt Lake City, Utah (the "VI Protocol") is also affected by this modification.

Background

VA adopted EPA Regional Screening Levels (RSLs) for Tetrachloroethylene (PCE), Trichloroethylene (TCE), and Vinyl Chloride (VC) as indoor air screening levels (SLs) for AOU - 1 RIWP. Selected structures are assessed for vapor intrusion impacts and indoor air sources. If vapor intrusion is suspected, 24-hour Summa canister samples are analyzed for volatile organic compound according to Method TO-15. The indoor air SLs for the project are as follows: PCE,

11 µg/m^3 (1.60 ppbv[1]); TCE, 0.48 µg/m^3 (0.09 ppbv[1]); and VC, 0.17 µg/m^3 (0.07 ppbv[1]). Field analytical results for indoor air are compared to the SLs to identify the need for confirmation sampling. Another common degradation product, cis 1, 2-Dichloroethene (cis-DCE), does not have an established RSL applicable to indoor air exposures but is included in the indoor air characterization.

The QAPP/QAPP Amendment 1 established quality control protocols for the HAPSITE™ portable Gas Chromatograph/Mass Spectrometer (GC/MS), which is used in the field to analyze contaminant concentrations in indoor air and soil gas. The QAPP for AOU-1 required a four compound calibration (PCE, TCE, cis-DCE, and VC) at five different concentrations for each analyte (0.1, 0.5, 1.0, 5.0, and 10 ppbv).

During the indoor air screening and near-structure soil gas screening process, the field team discovered that the instrument was unable to reliably quantify VC at concentrations below the 5 ppbv calibration level. QAPP Amendment No. 1, approved by EPA on March 13, 2015, eliminated HAPSITE™ calibration requirements for VC.

Number of Additional SUMMA™ Canister Samples

QAPP Amendment No. 1 presents additional quality assurance data collection requirements for VC that are designed to ensure that field screening with the HAPSITE does not compromise the objectives of the AOU-1 Remedial Investigation. These requirements include:

1) Collecting indoor air SUMMA™ canister samples in buildings where the indoor air screening level is exceeded for PCE or TCE. The SAP identified up to 25 SUMMA™ canister samples for laboratory analysis. QAPP Amendment No. 1 will add four additional samples at specific structures, meeting selection criteria that are based on knowledge of VI impact area gained from earlier sampling.

2) Collecting duplicate soil gas and indoor air samples in the field at a 10 percent frequency for laboratory analysis, or a minimum of one field duplicate for each sampling event as outlined in the AOU-1 SAP and QAPP approved by EPA and UDEQ. QAPP Amendment No. 1 will add a duplicate sample collocated with one of the four additional sample locations described above.

Clarification of Additional SUMMA™ Canister Sample Collection Locations

This modification identifies criteria that will be used to determine where additional SUMMA™ canister samples will be collected. This step was added in response to UDERR's request to better describe the criteria for choosing sample locations.

The exact locations where additional SUMMA™ canister samples are collected will be determined based on a review of previous indoor vapor intrusion surveys, available surface water, and groundwater sampling and near-slab soil gas data. These data will help to estimate the depth-to-groundwater, distribution of PCE contamination, and the dimensions of the groundwater plume impact in the area of AOU-1.

[1] The SL conversion from ug/mg^3 to ppbv for PCE and its degradation products was calculated using a temperature of 21°C at one atmosphere of pressure.

The selected structures will be located where groundwater is within 10 to 20 feet of the ground surface and will include:

- One sample outside the Plume where PCE, TCE, and cis-DCE in the indoor air are below the SLs or the detection limit of the HAPSITE™ instrument.
- Three samples will be collected inside the area of the Plume where PCE and TCE are equal to or less than their respective SLs but above the instrument detection limits.

At each of these structures, a 24-hour SUMMA™ canister sample will be collected from breathing zone air and will be submitted to ALS Laboratory for analysis of VOCs using EPA Method TO-15. The sample locations will be approximately co-located with a HAPSITE reading in the lowest occupied level of the structure. At least two structural types (slab on-grade, partial finished basement, residential, etc.) will be assessed.