Department of Veterans Affairs Salt Lake City Health Care System

Final

700 South 1600 East PCE Plume
AOU-1: East Side Springs
Remedial Investigation Report

Sections 1-11

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FINAL

Department of Veterans Affairs
Salt Lake City Health Care System

700 South 1600 East PCE Plume
AOU-1: East Side Springs
Remedial Investigation Report

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

Prepared by:
EA Engineering, Science, and Technology, Inc., PBC
2363 N. Hill Field Road, Suite 104
Layton, Utah 84041

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Acronyms and Abbreviations

µg/L	Micrograms per liter
µg/kg	Micrograms per kilogram
µg/m^3	Micrograms per cubic meter
AF	Attenuation factor
amsl	Above mean sea level
AOU-1	Accelerated Operable Unit 1
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
Bowen Collins	Bowen Collins and Associates, Inc.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Chemtech	Chemtech Consulting Group
CLP	Contract Laboratory Program
cm^2	Square centimeters
cm^3-H$_2$0/cm^3-air	Cubic centimeters of water per cubic centimeters of air
COC	Contaminant of Concern
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CRQL	Contract-Required Quantitation Limit
CSEM	Conceptual Site Exposure Model
CSM	Conceptual Site Model
cVOC	Chlorinated volatile organic compound
DCE	Dichloroethene
DO	Dissolved Oxygen
DQO	Data Quality Objective
E	Estimated value
E&E	Ecology and Environment, Inc.
EA	EA Engineering, Science, and Technology, Inc., PBC
ELCR	Excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ESS	East Side Springs

FE	First Environment, Inc.
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
f_{oc}	Fraction of organic carbon
ft	Feet(foot)
ft^2/d	Square feet per day
ft/d	Feet per day
ft/ft	Foot per foot
GC/MS	Gas chromatograph/mass spectrometer
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
HRS	Hazard ranking system
ICP	Inductively coupled plasma
ICPMS	ICP mass spectrometry
IDW	Investigation derived waste
IHI	IHI Environmental
J	Analyte was detected but the reported value is estimated
J+	Analyte was positively identified; the associated numerical value is its approximate concentration with a high bias in the sample
J-	Analyte was positively identified; the associated numerical value is its approximate concentration with a low bias in the sample
K_{oc}	Organic carbon partition coefficient
K_{ow}	Octanol-water partition coefficient
MCL	Maximum Contaminant Level
MDL	Method detection limit
MFM	Minor field modification
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mmHg	Millimeters of mercury
MRL	Method reporting limit
MS	Matrix spike
MSD	Matrix spike duplicate
MWH	MWH Americas, Inc.
NA	Not applicable
NCP	National Oil and Hazardous Substance Contingency Plan

ND	Non-detect
NEON	National Ecological Observatory Network
ng	Nanograms
NPL	National Priorities List
NRCS	National Resource Conservation Service
OMS	Organizational Maintenance Shops
ORP	Oxidation-reduction potential
OU-2	Operable Unit 2
PA	Preliminary Assessment
PCE	Tetrachloroethene
PCOPC	Preliminary contaminant of potential concern
PID	Photoionization detector
ppb	Parts per billion
ppbv	Parts per billion by volume
PRP	Potentially responsible party
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
R	Result has been rejected and data do not meet the project objectives
RAL	Removal action level
RBSL	Risk-based screening level
RfC	Reference concentration
RI	Remedial investigation
RME	Reasonable maximum exposure
ROD	Record of Decision
RSL	EPA Regional Screening Levels
SAP	Sampling and Analysis Plan
SI	Site investigation
SIM	Selective ion monitoring
SIRFER	Stable Isotope Ratio Facility for Environmental Research
Site	700 South 1600 East PCE Plume
SL	Screening level
SLC-18	SLCDPU Drinking Water Well No. 18
SLCDPU	Salt Lake City Department of Public Utilities
SLERA	Screening level ecological risk assessment
SMP	Site Management Plan
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOC	Semi-volatile organic compound

TAL	Target analyte list
TCA	1,1,1-trichloroethane
TCE	Trichloroethene
TCRA	Time-Critical Removal Action
TDS	Total dissolved solids
U	Analyte was not detected above the method detection limit
UANG	Utah Army National Guard
UBWPC	Utah Bureau of Water Pollution Control
UDEQ	Utah Department of Environmental Quality
UDNR	Utah Department of Natural Resources
UDWR	Utah Division of Water Rights
UJ	Analyte was not detected above the MDL. The reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
UOS	URS Operating Services, Inc.
USFS	U.S. Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
VA	U.S. Department of Veterans Affairs
VAMC	George E. Wahlen Veterans Affairs Medical Center
VC	Vinyl chloride
VI	Vapor intrusion
VOC	Volatile organic compound
WSL	Water screening level

1.0 Introduction

The U.S. Department of Veterans Affairs (VA) has contracted EA Engineering, Science and Technology, Inc., PBC (EA), to perform a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI) under contract number GS-10F-0228J, order number VA259-15F-3886, for the 700 South 1600 East Tetrachloroethene (PCE) Plume (Site), Accelerated Operable Unit 1 (AOU-1), East Side Springs (ESS), Salt Lake City, Utah (Figure 1-1). Chlorinated volatile organic compounds (cVOCs), primarily PCE and trichloroethene (TCE), have been detected in seeps and springs within the ESS area where the underlying shallow groundwater table intersects the ground surface near the Wasatch Fault Scarp west of the George E. Wahlen VA Medical Center (VAMC). The ESS area is shown on Figure 1-2 and is generally located between the East Bench Fault and the east spur of the East Bench Fault, both segments of the Wasatch Fault. The ESS area also extends south of 600 South to Yale Avenue.

Prior groundwater investigations upgradient of the ESS area conducted by the U. S. Environmental Protection (EPA) and the Utah Department of Environmental Quality (UDEQ) also detected cVOCs. The EPA and UDEQ concluded that the cVOCs in groundwater were likely from a former dry-cleaning facility located at the VAMC. The EPA listed the Site on the National Priorities List (NPL) in 2013 and named VA as the potentially responsible party (PRP) for CERCLA response addressing the Site, including the cVOCs detected in the ESS area. The location of seeps, springs, and shallow groundwater within a residential area with occupied structures raised concerns for potential cVOC vapor intrusion (VI) into occupied spaces. The RI area where groundwater and springs are known to have PCE contamination, and a buffer of 100 feet (ft), was identified as AOU-1. The full extent of the plume has been identified as Operable Unit 2 (OU-2), including shallow groundwater within the AOU-1 area, and will be investigated separately. Figure 1-1 shows the location and anticipated extent of AOU-1 as defined in the RI Work Plan AOU-1: East Side Springs, 700 South 1600 East PCE Plume (First Environment, Inc. [FE] 2015a). AOU-1 is located in Salt Lake City, Salt Lake County, Utah, along the Wasatch Fault Scarp within the general residential area bounded by 500 South and Michigan Avenue between 1300 East and 1100 East.

This RI report documents investigation activities and results for indoor air, soil gas, shallow groundwater (i.e., less than 50 ft below ground surface [bgs]), surface water, and soil sampling conducted to determine whether VI is present in structures overlying PCE-contaminated groundwater and evaluates the potential for direct exposure risk from cVOCs in surface water and soil. The RI activities presented in this document provide an accelerated assessment of VI potential in residences and other occupied structures in AOU-1 and presents a human health and ecological risk assessment. The investigation approach is consistent with CERCLA and National Contingency Plan requirements as described in the Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA 1988).

1.1 Purpose of the Remedial Investigation

The purpose of the accelerated RI of AOU-1, as documented in the AOU-1 RI Work Plan (FE 2015a, EA 2016a), is to conduct an accelerated assessment of VI potential in the AOU-1 area. Achieving this objective will also support characterization of the nature and extent of cVOCs, including preliminary contaminants of potential concern (PCOPCs) (1,4-dioxane, cis-1,2-dichloroethene (DCE), PCE, TCE, and vinyl chloride [VC]) identified in the RI Work Plan, in order to assess the existence of a complete pathway potential for VI of PCOPCs into dwellings and other structures and the associated public health risk from inhalation exposure to those compounds. The compound 1,4-dioxane was included with the PCOPCs at the request of the EPA and not identified in previous sampling associated with AOU-1 as a contaminant of concern. As stated in the RI Work Plan, the overall objectives of the AOU-1 RI include:

- Assess the existence of complete pathway potential for VI of cVOCs into dwellings and other structures and the associated human health risk from inhalation exposure to those compounds
- Determine the lateral extent of the human health risk and provide sufficient data to implement a removal action, if VI presents a significant risk
- Provide additional data to better assess the lateral extent of the PCE plume
- Determine if a potential impact on human health through direct exposure to cVOCs in surface water or soil exists. Qualitatively, the AOU-1 data will also be reviewed for potential health impacts to pets.

This RI Report addresses the following principal study questions/objectives that were defined in the RI Work Plan (FE 2015a):

1. Determine whether VI is a complete pathway to structures overlying AOU-1 and whether VI is significant
2. Determine the lateral extent of AOU-1 groundwater contamination that may result in a complete exposure pathway and significant VI in overlying structures
3. Determine if there are potential unacceptable impacts to human health through direct exposure to AOU-1 PCOPCs in surface water or soil. This RI Report also provides the result of an ecological risk assessment to evaluate the exposure pathway and risk to biota from surface water and groundwater. In addition, although CERCLA risk assessments do not address risk to pets, the RI includes a qualitative review of the AOU-1 data for possible health impacts to pets to address a community concern (FE 2015a).

In achieving the objectives, the RI report will:

- Identify, summarize, and evaluate available data to support a description of the nature and extent of VI and indoor air contaminants related to VI
- Present the conceptual model of fate and transport for the VI pathway
- Present data collected for the PCOPCs that were identified in the technical memorandum, Vapor Intrusion Screening Levels and Removal Action Levels, included in Appendix F of the RI Work Plan (FE 2015a)
- Evaluate risk for receptors identified in the RI Work Plan
- Evaluate uncertainties potentially effecting the conclusions of the RI
- Provide recommendations for the locations, media, and contaminants to be considered during the forthcoming AOU-1 Focused Feasibility Study (FFS).

The AOU-1 2015-2017 field effort focused on the areal extent where groundwater was expected to be within 50 vertical ft of the ground surface and where PCOPCs have been previously detected in seeps and springs or where PCOPCs were expected to be present. For the VI assessment, data collection activities included indoor air sampling and VI assessment performed concurrently with outdoor ambient air background monitoring, near-slab (within 5 ft of the foundation) soil gas sampling, and open field soil gas sampling (greater than 5 ft from a building foundation). The VI assessment was combined with an investigation of surface water from seeps and springs, water from stormwater sewer lines, shallow groundwater (from temporary well points and piezometers), and surface soil.

1.2 Regulatory History and Authority

On 12 October 1990, the Groundwater Protection Section of the (now defunct) Utah Bureau of Water Pollution Control (UBWPC) was contacted by a representative of Salt Lake City Water Treatment office and informed that PCE was detected during routine monitoring of an irrigation well at the Mount Olivet Cemetery at a concentration of 32 micrograms per liter (µg/L) (Figure 1-1). The national drinking water standard for PCE is 5.0 µg/L. The discovery resulted in identification of the Mount Olivet Cemetery Plume, which was added by the EPA to the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list with EPA identification number UTD981548985 (UDEQ 2012).

In 1998, additional follow-on investigations were conducted by the EPA and documented in a Site Activities Report (URS Operating Services, Inc. [UOS] 1999). Six monitoring wells installed east (upgradient) of the Mount Olivet Cemetery, confirmed widespread PCE contamination. PCE concentrations from the 1998 investigation ranged from 11 to 320 µg/L. Conclusions of the report indicated a northwesterly groundwater flow direction and indicated there were no identified sources towards the southeast. The EPA report also inferred that a former dry-cleaning facility located within Building 7 at the VAMC could be an indirect source if PCE followed a south or southwest-flowing sewer line or other conduit (UOS 1999). The detections downgradient of the sewer line, and affidavits from Salt Lake City Department of Public Utilities (SLCDPU) employees who recalled observing discolored water and solvent odors from the same sewer, lead the EPA and UDEQ to conclude that the dry-cleaning facility and sewer line was the suspected source of PCE (UDEQ 2012).

In June 2010, in an event unrelated to the PCE detections in groundwater, a release of crude oil from a pipeline was discovered at the base of Red Butte Canyon. Samples to assess the extent of the impact from the oil release were collected by SLCDPU from seeps and springs within the ESS area. No crude oil was detected. However, PCE was detected in six of the eleven springs and in a stormwater manhole located at 900 South and 1071 East at concentrations ranging between 2.5 and 40.4 µg/L. Concern that the PCE may be from the same PCE plume detected at the Mount Olivet Cemetery and west of the VAMC resulted in UDEQ and EPA conducting additional investigations (UDEQ 2012).

In 2011, under authority from EPA, UDEQ utilized the 2010 data collected by SLCDPU to prepare a Preliminary Assessment (PA) specific to the ESS area (UDEQ 2011). UDEQ concluded in the PA that the contamination source remained unknown, but potential sources for the PCE included the Mount Olivet Cemetery Plume and/or five underground storage tank facilities located near the site. Two of these facilities are commercial gas stations: a vacant gas station located at 877 South 1300 East and a gas station and attached automobile service station located at 904 South 1300 East. The other UST locations are fueling facilities at State Fuel Service, Interagency Fire, and the VAMC (UDEQ 2011). Younger children and pets drinking or contacting spring water and potential migration from groundwater-to-indoor air through VI were identified as potential contaminant exposure pathways (UDEQ 2011). EPA placed the Site on the CERCLIS list in January 2011 (UDEQ 2012).

In 2012, UDEQ finalized a follow-on Site Investigation (SI) specific to the ESS which included data from soil, the permanent wells installed in 1998, shallow groundwater, surface water (i.e., springs), and soil gas sampling conducted in 2011. PCE and TCE were detected in groundwater samples collected from the permanent wells installed during the 1998 investigation, as well as in the shallow groundwater and surface water samples collected from within the ESS area. Conclusions of the 2012 SI indicated the springs were the result of the groundwater aquifer surfacing along the Wasatch Fault, and the potential source of PCE was the Mount Olivet Cemetery Plume, which was renamed the 700 South 1600 East PCE Plume. The SI goes on to state that prior evaluations by UDEQ and EPA found the source of groundwater contamination to be the former dry-cleaning facility operated in Building 7 at the VAMC (UDEQ 2012).

In 2012, the EPA completed the hazard ranking for the Site and determined the hazard ranking system (HRS) score to be 50 (EPA 2012a). As a general policy, the EPA indicates that sites with a known or threatened release of hazardous substance, pollutants, or contaminants resulting in a HRS score exceeding 28.5 are eligible for listing on the NPL. The NPL identifies sites considered by the EPA to be a priority for further investigation; however, listing of a site on the NPL does not assign liability, nor does it indicate that remediation is mandatory. Due to the presence of PCE in groundwater and a HRS score of 50, the EPA proposed the Site for inclusion on the NPL on 18 September 2012 as Docket ID No. EPA-HQ-SFUND-2012-0647 (EPA 2012a). The Site was officially designated as a NPL federal facility site effective 24 May 2013 (EPA 2013).

The May 2013 NPL listing by the EPA indicated the only identified source of the contamination is a historic dry-cleaning facility owned and operated by VA at the VAMC. Results are pending for a remedial investigation to more thoroughly assess PCE contamination in the vicinity of the VAMC. Pursuant to CERCLA Section 120 and Executive Order 12580 (EPA et al. 2017) and as the only PRP identified by EPA, VA is conducting a response action at the Site in accordance with CERCLA and implementing National Oil and Hazardous Substance Pollution Contingency Plan regulations (40 Code of Federal Regulations [CFR] Sections 300-399), as applicable. As the designated agency for implementing CERCLA, the EPA is the lead regulatory agency overseeing the remedial response and provides advice and consent on the federal agency's response actions for the Site's cleanup to ensure that CERCLA and National Contingency Plan (NCP) requirements are met (EPA et al. 2017). Pursuant to CERCLA Section 121, the State provides a supporting role and is given a reasonable opportunity to review and comment on the RI/FS, and supporting technical documents, as well as the remedial action, the remedial design, and remedy implementation (if warranted). If, following the results and conclusions of the RI for AOU-1, a remedial action is warranted, the remedy will be jointly selected by VA and EPA. If mutual agreement of the remedy is not reached, selection of the remedy is made by the EPA per CERCLA Section 430 (40 CFR 300.430).

In addition, VA, EPA, and UDEQ have entered into a Federal Facility Agreement (FFA) pursuant to CERCLA Section 120. The FFA became effective on 30 January 2017, and establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions to address contaminants on or originating from the VAMC. The schedule for site activities is updated annually as part of the Site Management Plan (SMP). The current SMP schedule date for finalization of the AOU-1 RI is August 2018; however, a request to revise the date to December 2018 is pending regulatory approval of the SMP update.

1.3 Report Organization

This Report is organized into 11 sections, followed by Appendices A through K. The report sections and appendices are summarized as follows:

- ***Section 1.0 – Introduction***—Describes the purpose of the RI, regulatory history, and report organization.

- ***Section 2.0 – Site Background***—Describes the site, site history, and includes a brief description of historical, current, and future land use.

- ***Section 3.0 – Summary of Previous Investigation***—Describes previous investigations, the contaminants of potential concern (COPCs) for the site, data gaps identified, and data limitations.

- ***Section 4.0 – Physical Characteristics of the Investigation Area***—Describes physical characteristics of the site.

- ***Section 5.0—Remedial Investigation Field Activities***—Describes communications and coordination activities, groundwater, surface water, soil and VI sampling, ecological survey activities, investigation derived waste (IDW) management, and deviations from the RI Work Plan.

- ***Section 6.0—Nature and Extent of Contamination***—Describes data collected and analytical results. Includes a summary of screening levels, data quality evaluation, and contaminant sources.

- ***Section 7.0—Contaminant Fate and Transport***—Describes contaminant characteristics, transport processes, potential routes of migration, and media-specific migration trends.

- ***Section 8.0—Updated Conceptual Site Model for Risk***—Describes sources of contamination, transport mechanisms, receptors, data gaps, and uncertainties.

- ***Section 9.0—Summary of Risk Assessments***—Describes human health and ecological evaluations.

- ***Section 10.0—Summary and Conclusions***—Summarizes the nature and extent of contamination, contaminant fate and transport, and risk assessment. Includes conclusions of the RI and recommendations for future site work.

- ***Section 11.0—References***.

- ***Appendix A—EPA Monitoring Well Logs—***Presents boring logs for the EPA monitoring wells.

- ***Appendix B—Boring and Piezometer Logs—***Presents boring logs for the temporary monitoring points and construction logs for piezometers.

- ***Appendix C—Groundwater Sampling Forms—***Presents start cards and sampling forms for groundwater sampling performed in 2016.

- ***Appendix D—Surface Water and Stormwater Sampling Forms—***Presents sampling forms for surface water and stormwater sampling performed in 2016.

- ***Appendix E—Indoor Air, Outdoor Air, and Soil Gas Sampling Forms—***Presents sampling forms for indoor air, outdoor air, and soil gas sampling performed in 2015-2018.

- ***Appendix F—Human Health Risk Assessment—***Presents results of the human health risk assessment for AOU-1.

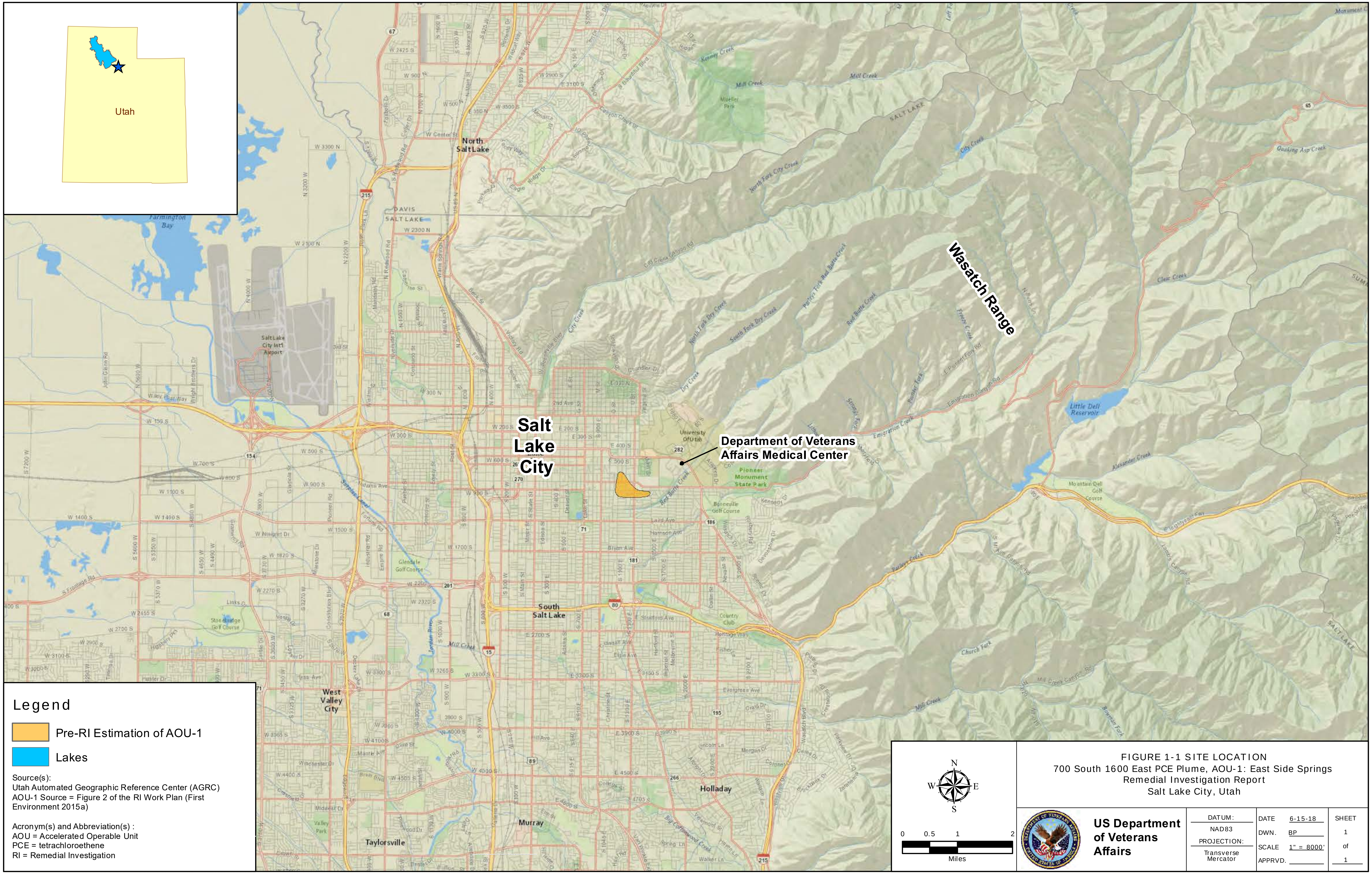
- ***Appendix G—Screening Level Ecological Risk Assessment*—**Presents results of the ecological risk assessment for AOU-1 and ecological checklists.

- ***Appendix H—Data Validation Reports*—**Presents the groundwater, surface water, stormwater, soil and VI Data Validation Reports for data collected from 2015-2017.

- ***Appendix I— Shallow Groundwater Field Monitoring Data*—**Presents shallow groundwater field monitoring data from 2016 sampling.

- ***Appendix J— Laboratory Analytical Reports*—**Presents locations of laboratory analytical reports from groundwater, surface water, indoor air, outdoor air, and soil gas sampling performed from 2015-2018.

- ***Appendix K— Project Analytical and HAPSITE® Database Files*—**Presents database files for HAPSITE® sampling in 2016 and 2017 and laboratory analytical database files for data collected from 2015-2017.



Legend

🟧 Pre-RI Estimation of AOU-1

🟦 Lakes

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

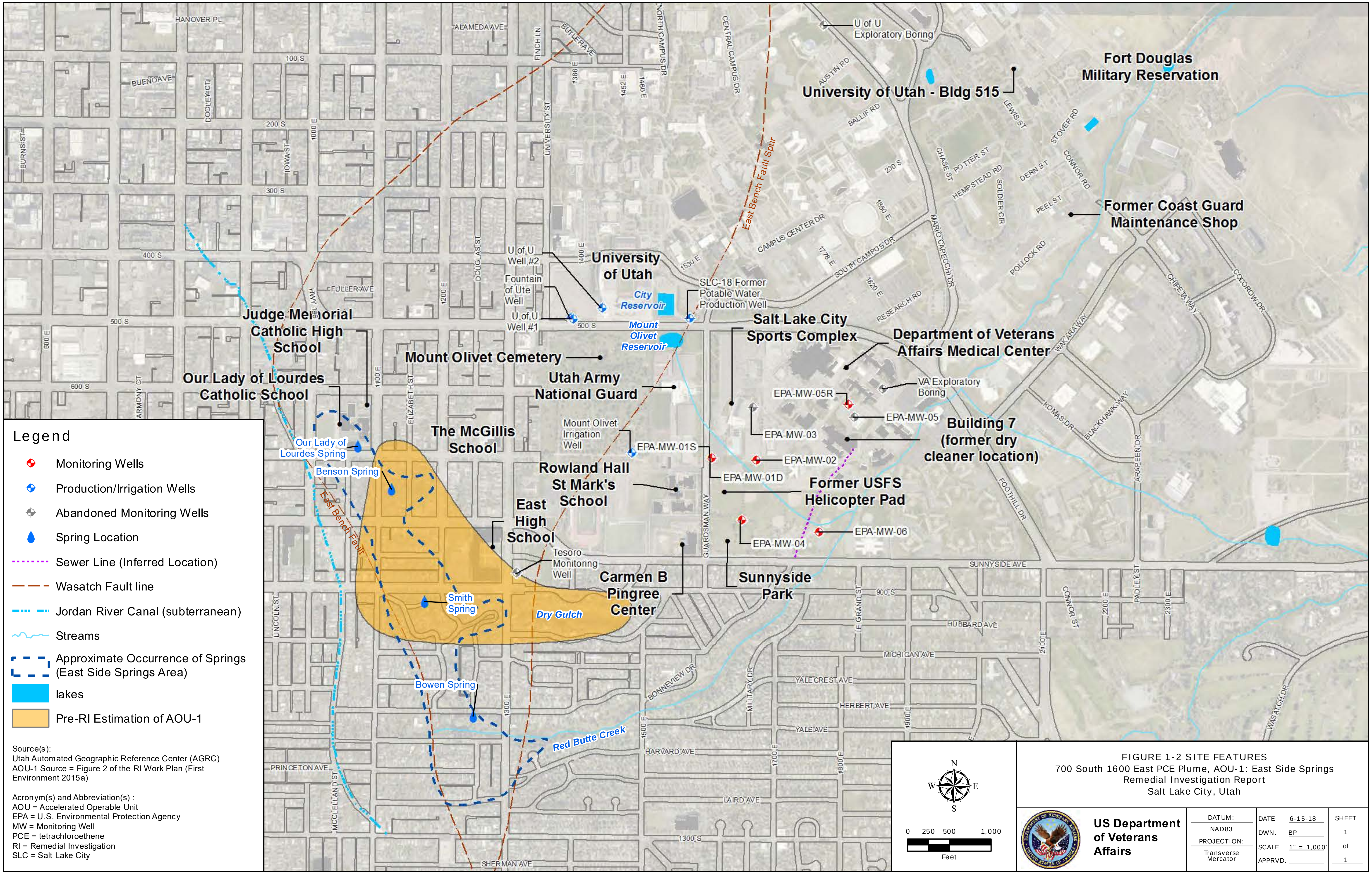
Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
PCE = tetrachloroethene
RI = Remedial Investigation

FIGURE 1-1 SITE LOCATION
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE 6-15-18	SHEET
PROJECTION: Transverse Mercator	DWN. BP	1
	SCALE 1" = 8000'	of
	APPRVD.	1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 1-1 Site Location.mxd bpawling 6/5/2018



Legend

- ✦ Monitoring Wells
- ✦ Production/Irrigation Wells
- ✦ Abandoned Monitoring Wells
- 💧 Spring Location
- ⋯ Sewer Line (Inferred Location)
- – – Wasatch Fault line
- –·– Jordan River Canal (subterranean)
- ~ Streams
- ⌐ ¬ Approximate Occurrence of Springs (East Side Springs Area)
- 🟦 lakes
- 🟧 Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation
SLC = Salt Lake City

N
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0 250 500 1,000
Feet

FIGURE 1-2 SITE FEATURES
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE	6-15-18	SHEET 1
PROJECTION: Transverse Mercator	DWN.	BP	of
	SCALE	1" = 1,000'	1
	APPRVD.		

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 1-2 Site Features.mxd bpawling 6/8/2018

2.0 Site Background

2.1 Site Description

The Site is west of the VAMC in Salt Lake City Utah and is roughly centered on the intersection of 900 South and 1200 East (Figure 1-2). The area is a blended commercial and residential area of approximately 300 acres. The Site is currently comprised of two operable units:

- AOU-1 consists of the ESS area only and is defined as the 100-ft buffer around the area where groundwater and springs are known to have PCE contamination and where groundwater is within a maximum of 50 ft of the surface and may have PCE contamination. The concern at AOU-1 is risk from VI due to PCE-contaminated shallow groundwater.

- OU-2 consists of the potential source area of PCE-contaminated groundwater in the area near the VAMC and the entire groundwater plume, including AOU-1 contaminated groundwater.

AOU-1 is in a predominantly residential area on and just below the Wasatch Fault Scarp. AOU-1 is characterized by numerous small seeps and springs, some of which daylight near the suspected downgradient margin of the PCE plume and contain PCE-contaminated groundwater.

The RI at AOU-1, the subject of this RI Report, is accelerated because prompt action was considered necessary to address human health risks, possibly prior to completion of the final Record of Decision (ROD). The immediate concern over the human health impacts is associated with the potential for VI into residences, businesses, and schools. OU-2 is the subject of a separate RI.

The geographical boundary of the AOU-1 investigation is shown on Figure 1-2 and the investigation boundary was defined by:

- Areas where groundwater and springs are known to have PCE contamination
- Areas where groundwater is within 50 ft of the surface
- A 100-ft buffer around the areas defined by the previous two criteria.

2.2 Site History

The VAMC was constructed beginning in the late 1940s on property that was formerly part of Fort Douglas (U.S. Army) military reservation. A dry-cleaning facility was operational on the VAMC property from approximately 1976 through 1984. A single dry-cleaning machine was installed and operated on a part-time basis. The system was a “closed loop” system, meaning the system contained a distillation process for the recovery of PCE at the end of each cycle. The condensate from the distillation process was emptied into a vitrified clay drain line which discharged to the sanitary sewer. This method of disposal was common practice in the 1980s (EPA 2012a).

The VAMC dry-cleaning facility, and specifically the drain line, has been identified by EPA as a potential source for the PCE plume. The history of the discovery of PCE at the Site is included in the description of the regulatory history in Section 1.2. As explained in Section 1.2, the Site was identified for investigation and cleanup under CERCLA on 18 September 2012. Remedial investigation was warranted because the presence of PCE in shallow groundwater, seeps, and springs created the potential for human exposure to volatile organic compounds (VOCs) through inhalation of vapors associated with indoor air intrusion and direct contact and ingestion of PCE-contaminated water or soil in the ESS area. Ecological receptors could also come in contact with PCE-contaminated soil and water near the seeps and springs.

Preliminary evaluation of indoor air sample data collected at Residence 0040-H in AOU-1 in support of this RI indicated PCE detections above the Tier 1 indoor air removal action level (RAL) of 41 micrograms per cubic meter (µg/m^3). TCE was also detected above the Tier 1 RAL of 2.1 µg/m^3. VA installed a temporary vapor filtration system and initiated a filter replacement regime and periodic indoor air monitoring prior to commencing a Time-Critical Removal Action (TCRA) (VA2016). The TCRA was initiated in 2016 in accordance with an EPA and UDEQ-approved Action Memorandum dated 20 October 2016 (VA 2016) and the RI Work Plan, AOU-1 Time Critical Removal Action and Mitigation System Installation for the 700 South 1600 East PCE Plume Superfund Site (CTI and Associates, Inc. 2016). A VI mitigation system was installed at Residence 0040-H, replacing the temporary vapor filtration system, to reduce indoor air concentrations of PCE and TCE to below action levels. The system included a carbon canister filtration unit connected to the house air flow unit. Air sampling was conducted prior to installation, during system startup and is conducted quarterly to evaluate the effectiveness of the system (VA 2016). The results of the installation and monitoring of the TCRA are presented in a Pollution Report and quarterly reports/annual summaries. Monitoring, maintenance and evaluation of effectiveness of the filtration system to ensure the system meets the RALs is ongoing. To date, exceedances of the RALs due to VI have been reported at 0040-H only.

2.3 Land Use

Background information for the Site, including land use, historical operations, and information about its physical characteristics, is presented below. Information on land use is described in the RI Work Plan (FE 2015a) and is restated here for context in this RI Report.

2.3.1 Current Land Use

As depicted on Figure 1-2, the Site is in a developed urban area. It is bordered by the Wasatch Mountains and Sunnyside Park to the east, Red Butte Creek to the south, and the University of Utah Campus to the north. The plume appears to originate on or near the VAMC and the Salt Lake City Sports Complex. Various University of Utah buildings, schools, sports fields, residential areas, and the East Bench Fault overlie the PCE plume to the west of the VAMC.

The land use within the AOU-1 portion of the Site, is predominantly single family residential properties with several schools, churches, and small businesses located along the major streets. East High School and its grounds form a significant portion of eastern extent of AOU-1. The McGillis School and Our Lady of Lourdes/Judge Memorial Catholic School lie within, or in close proximity to, AOU-1. The few commercial operations in AOU-1 include an auto repair shop, convenience store/gasoline station, and coffee shop located near the intersections of 800 South and 900 South with 1300 East.

2.3.2 Historic Land Use

2.3.2.1 VAMC and Surrounding Area

As indicated by historical aerial photographs, the land now occupied by the VAMC, as well as Sunnyside Park and the Salt Lake City Sports Complex to the east of Guardsman Way and the University of Utah sports facilities, Carmen B. Pingree Center, and the Rowland Hall St. Marks School to the west of Guardsman Way were, until the late 1940s, predominantly open fields used to park vehicles and support ground-based training activities for Fort Douglas (U.S. Army) military reservation. Fort Douglas, which was located to the east of AOU-1, dates to the 1860s and nearly the entire area east and north of Mount Olivet Cemetery to the Wasatch Mountains was part of Fort Douglas until about 1900, when portions of the reservation north of 500 South were transferred to the University of Utah. The original 20 acres for the Mount Olivet Cemetery were set aside from (then) Camp Douglas in 1874, with an additional 50 acres granted to the cemetery from (then) Fort Douglas Military Reservation in 1909.

The Utah Army National Guard (UANG) operated a support center on the west side of Guardsman Way at the location currently occupied by the Carmen B. Pingree Center and Rowland Hall St. Marks School and the University of Utah sports facilities. The support center included two Organizational Maintenance Shops (OMS-3 and OMS-5) and a Combined Support Maintenance Shop, which were used to perform heavy duty drivetrain overhauling, body work, upholstering, and general routine maintenance on motor vehicles (UDEQ 1996). These maintenance shops operated from 1958 to 1989; from 1973 to at least 1996; and from 1962 to 1989, respectively (UANG 1996).

The development of portions of the University of Utah to the north of the VAMC began in 1900 on lands formerly part of Fort Douglas. Expansion of the University continued on property acquired from Fort Douglas through the early 1990s, when the remaining portions of Fort Douglas were closed and vacated by the Army. The University grounds now contain nearly all of the original Fort Douglas post buildings. The historic buildings are maintained and utilized by the University.

2.3.2.2 East Side Springs Area

The residential areas in the vicinity of Sunnyside Avenue and along the Wasatch Fault Scarp were developed beginning in the 1910s and development continued through the 1940s. Homes in this area range from small brick bungalows and wood frame cottages to large multi-story brick homes. Large multi-story homes built into the steep hillsides of the fault scarp and very small homes with on-grade concrete slab foundations also exist in the area. Many of the homes, both large and small, have partially to wholly below-ground basements that are finished as living spaces. The homes are closely spaced, with typical lot sizes of 0.10 to 0.15 acres.

Prior to development, the land was undeveloped open fields and farm land. Limited aerial photography and tax map records suggest the area on both sides of Sunnyside Avenue, immediately east of East High School, were undeveloped open fields prior to being developed as athletic fields.

2.3.3 Future Land Use

AOU-1 is likely to remain as an urban developed area for some decades due to the well-established, stable neighborhoods, public and private schools, and the abundant public parklands. A review of Salt Lake City Property Tax maps indicates that current land use within AOU-1 is approximately 75 percent residential, 5 percent commercial, 10 percent public or private schools, and the remainder are publicly owned rights of way or parkland.

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3.0 Summary of Previous Investigation

This section provides a brief description and summary of previous investigations conducted in association with the Site between 1990 and 2014.

3.1 Previous Site Investigations

The following subsections present investigations and data gathered prior to the initiation of the accelerated RI initiated in 2015. These historical investigations are described for the following portions of the site:

- PCE plume
- ESS area
- Other potential source areas.

Table 3-1 is a chronological listing of these investigations.

3.1.1 PCE Plume

As stated in Section 1.2, the PCE plume was first identified in 1990. Numerous investigations have been conducted since 1990 to measure concentrations of PCE and other cVOCs and identify potential sources. In doing these investigations, a groundwater monitoring framework has been established to evaluate and better understand the PCE plume and prepare initial groundwater models and to better define the groundwater characteristics at the site through modeling. This work has been conducted to determine the PCE distribution within the groundwater plume. These historical investigations are described in the following subsections.

3.1.1.1 Chronology of the PCE Plume Investigations

Investigations of contaminant concentrations in the PCE plume area are summarized below. For reference, the Maximum Contaminant Level (MCL) for PCE and TCE in drinking water set by the EPA is 5 µg/L (equivalent to 5 parts per billion [ppb]) (EPA 2017a).

Salt Lake City Water System Sampling 1989-2004. Between July 1989 and 2004 SLCDPU Drinking Water Well No. 18 (SLC-18) was sampled for compliance with the Safe Drinking Water Act (EPA 2012a). The location of SLC-18 is shown on Figure 1-2. Analytical data from groundwater sampling at SLC-18 (summarized in Table 3-2) shows this well was free of PCE until 1997. After 1997, PCE was detected periodically in samples collected by the SLCDPU at concentrations ranging from non-detect to 1.4 µg/L. In 2004, SLC-18 was taken offline (EPA 2012a). SLC-18 has remained out of service but has been sampled by multiple parties to continue to monitor the occurrence of PCE in groundwater. PCE detections have ranged between 0.2 µg/L and 2.23 µg/L. Results of this monitoring have been summarized and reported within numerous investigations conducted by EPA, UDEQ, and VA, as described below and identified on Table 3-2.

SLCDPU Monitoring of the Mount Olivet Irrigation Well - Initial PCE Discovery and Monitoring, 1990-1997. During routine monitoring of the Mount Olivet irrigation well in 1990 by the SLCDPU, PCE was detected in groundwater at a concentration of 32 µg/L (UBWPC 1991). In April 1995, EPA sampled the Mount Olivet irrigation well and analytical results included detections of PCE at 85 µg/L; TCE at

1.3 µg/L; and 1,2-DCE at 2.8 µg/L (Ecology and Environment, Inc. [E&E] 1995). By 1997, the PCE concentration in the Mount Olivet irrigation well increased to 184 µg/L (Bowen Collins and Associates, Inc. [Bowen Collins] 2004). Subsequent monitoring of this well has been conducted by the EPA, UDEQ, and VA; and PCE detections have decreased since 1997 (Table 3-2).

EPA 1995 Soil Gas Investigation. In May 1995, EPA conducted an investigation to try to locate the source of PCE contamination in the Mount Olivet irrigation well and to determine the extent to which the contamination migrated from the source (E&E 1995). Fifteen soil gas samples were collected near the Mount Olivet irrigation well at the following locations (Figure 3-1).

- Seven locations surrounding the Mount Olivet irrigation well
- One location near the University of Utah / former UANG property located at the intersection of Guardsman Way and 500 South
- Two locations at the U.S. Forest Service (USFS) helicopter pad (southeast side of Guardsman Way)
- Five locations around UANG maintenance buildings (southwest end of Guardsman Way) (E&E 1995).

The samples were analyzed using a portable gas chromatograph for cVOCs. Two of the 15 soil gas samples reported detections. One of the samples collected on the Mount Olivet Cemetery property (OC-SG-06) reported PCE at 16 ppb, and a sample collected near one of the UANG maintenance buildings (NG-SG-02) reported an estimated TCE concentration of 1 ppb. The units for these concentrations are ppb by volume (ppbv) because they are gas measurements based on volume-to-volume ratios, rather than mass-to-mass ratios used for other types of sample media. Other sample location results were non-detect. Results of the 1995 EPA Investigation are documented in the Analytical Results Report, Mt. Olivet Well Site (E&E 1995).

EPA 1996 Soil Gas Investigation. In November 1996, EPA collected four soil gas samples at the following three locations:

- One composite sample was collected from three locations southeast of Building 7 on the VAMC campus, where the sewer line which potentially received PCE-contaminated water from the VAMC dry cleaners exited the building. The composite sample was comprised of subsamples collected where the sewer line exited the building, and from a parking area adjacent to the buried sewer line (UOS 1996).
- Two samples were collected adjacent to Red Butte Creek on the Fort Douglas Army Base, southeast of the Coast Guard Building maintenance shop: one from the center of the gulch and one from the northeast side of the gulch.
- One sample was collected adjacent to the south side of a loading dock attached to Building 515 on the University of Utah property.

The samples were analyzed by a commercial laboratory in accordance with EPA SW-846 Method 8260 modified for VOCs in gaseous phase. The sample collected near the Building 7 sewer line reported 1.9 ppbv PCE. The sample collected adjacent to the Building 515 loading dock reported 49 ppb PCE and 3.4 ppbv TCE. As described above, these units are ppbv because they are gas measurements based on volume-to-volume ratios, rather than mass-to-mass ratios used for other types of sample media. All other results were reported non-detect. Results of the soil gas sampling are documented in the Field Activities and Analytical Results for Soil Gas Sampling at the Mount Olivet Cemetery Plume (UOS 1996).

UDEQ Investigation 1998-2000. Between 1998 and 2000, the UDEQ Division of Environmental Response and Remediation conducted a CERCLA investigation of the Mount Olivet Cemetery Plume, under agreement with EPA. The Analytical Results Report, Mount Olivet Cemetery Plume included an evaluation of soil gas data collected in 1995 and 1996 by the EPA, in conjunction with groundwater sampling conducted by EPA in 1998 and 1999 and sampling of water from springs in 1998 (described below). With respect to soil gas sampling, UDEQ concluded that while a PCE groundwater plume is present, the “soil gas surveys failed to locate surface soil contamination" and that the potential for direct contact via dermal or ingestion pathways was low (UDEQ 2000).

EPA Monitoring Well Installation and EPA/UDEQ Groundwater Sampling 1998 – 2012. In 1998, the EPA initiated a SI of the Site and installed six monitoring wells designated EPA-MW-01S, EPA-MW-01D, and EPA-MW-02 through EPA-MW-05. These wells were located on and near the VAMC, located east of the Mount Olivet irrigation well (Figure 1-2). Except for MW-01D, which is screened in the deep unconfined aquifer, the wells are screened in saturated zones, which were believed to be perched shallow aquifers or the uppermost portion of the unconfined aquifer. Data from the initial sampling of these wells in November 1998 is presented in Table 3-2. PCE was detected at concentrations of 320, 290, 11, and 190 µg/L in EPA-MW-01S, EPA-MW-02, EPA-MW-03, and EPA-MW-04, respectively. PCOPCs in the November 1998 samples were below reporting limits in wells EPA-MW-01D and EPA-MW-05 (UOS 1999).

Water level measurements collected in November 1998 from the shallow monitoring wells (EPA-MW-01S, EPA-MW-02, EPA-MW-03, EPA-MW-04, EPA-MW-05, and EPA-MW-06) indicated that the shallow hydraulic gradient was northwest. Water levels for the deep monitoring wells (EPA-MW-01D, the Mount Olivet irrigation well, and other deep wells in the area) indicated that the hydraulic gradient for the deep unconfined aquifer was to the west, although groundwater modeling conducted in 2004 and 2011, utilizing a larger number of wells and ground water flow modeling, has shown that groundwater actually flows to the west-southwest (Bowen Collins 2004, MWH Americas, Inc. [MWH] 2012).

In the fall of 1999, EPA-MW-03 was abandoned. Prior to abandonment, a sample was collected from EPA-MW-03 and PCE was reported at a concentration of 7.1 µg/L. A new monitoring well, EPA-MW-06, was installed in 1999, south of the VAMC. The initial sampling event for EPA-MW-06 in January 2000 indicated that this well did not contain detections of cVOCs (UOS 2000).

Periodic groundwater sampling of the EPA monitoring wells continued by EPA and UDEQ through 2012. Table 3-2 includes a summary of pre-RI detections of PCE that have been reported in the EPA monitoring wells and references to the source documents. During this pre-RI sampling period, EPA-MW-01S and EPA-MW-02 typically contained the highest PCE concentrations, with EPA-MW-06 exhibiting only traces of PCE and EPA-MW-05 (upgradient to VAMC Building 7) showing no detections of PCE (UDEQ 2012).

Results of the EPA/UDEQ groundwater sampling are documented in the following reports:

- *Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
- *Supplement to Site Activities Report, Mt. Olivet Cemetery* (UOS 2000)
- *Preliminary Assessment, East Side Springs* (UDEQ 2011)
- *Site Investigation Analytical Results, East Side Springs* (UDEQ 2012).

EPA, UDEQ, and SLCDPU Sewer Survey December 2003. At the request of EPA and UDEQ, the SLCDPU conducted a video survey of the Building 7 sewer line on 17 December 2003. The purpose of the survey was to look for major breaks or cracks in the sewer line that could have allowed migration of contaminants into the soil or groundwater. Numerous defects were documented in most sections of the pipe, including cracks, root penetrations, offsets, a sag in the pipe. Evidence of previous breaks and repairs to the historical clay pipe were also apparent (EPA 2012a, SLCDPU 2012).

USGS Groundwater Sampling between 2004 and 2005. The U.S. Geological Survey (USGS) conducted a groundwater study for EPA in 2004 and early 2005, including collection of water level measurements from monitoring and supply wells and the collection of nine groundwater samples from eight wells: two samples were collected from the Fountain of Ute well (one at a depth of 140 ft and a second sample collected at a depth of 260 ft), one sample collected from SLC-18 (named SLC 1016a in the documents), and one sample was collected from each of the remaining EPA monitoring wells (USGS 2005, EPA 2012a) (Figure 1-2). PCE was detected in SLC-18 and the EPA wells at concentrations ranging from 0.2 µg/L in SLC-18 to 296 µg/L in EPA-MW-02 (EPA 2012a). No PCE was detected in the University of Utah Fountain of Ute Well (USGS 2005). The USGS sample data is summarized in Table 3-2.

EPA and UDEQ Investigations between 2004 and 2012. EPA and UDEQ conducted a series of investigations between 2004 and 2012. These are summarized below:

- In June 2004, UDEQ collected 32 soil samples for VOC analysis to determine whether a PCE source was present along the sewer line originating from the VAMC Building 7. Soil samples were collected at 50-ft intervals along the length of the sewer line, at depths between 2 ft and 13 ft bgs, between Building 7 and Sunnyside Avenue. This information was collected to support the EPA evaluation of the site. No VOCs were detected (UDEQ 2004).

- In October 2004, UDEQ and EPA's federal facilities enforcement program jointly conducted an investigation, which consisted of groundwater sampling at four wells: SLC-18, the Mount Olivet irrigation well, EPA-MW-01D, and EPA-MW-05. PCE was detected in the three wells that were cross-gradient/downgradient of Building 7: in SLC-18 at a concentration of 2.23 µg/L (cross-gradient); at the Mount Olivet irrigation well at 92 µg/L and 128 µg/L cross-gradient); and in EPA-MW-01D at 8.33 µg/L (downgradient) (UDEQ 2011). No PCE was detected in well EPA-MW-05, upgradient of Building 7 (UDEQ 2012).

- In October 2005, EPA and UDEQ returned to the Site to conduct groundwater sampling and prepare an HRS package. Groundwater samples were collected from the EPA monitoring wells. PCE detections ranged from 0.33 µg/L in EPA MW-01D, 120 µg/L in EPA-MW-04, and 160 µg/L in EPA-MW-06 (UDEQ 2012). Based on this information, the suspected source of the contamination at the Site was listed as the dry-cleaning facility operated at the VAMC during the period of 1976 – 1984 (UDEQ 2011). Based on the HRS score, it was determined the Site was eligible for the NPL. However, efforts to include the Site on the NPL were suspended in 2006 while City officials sought money from Congress to address the issue (EPA 2012a).

- In 2010, during sampling to support investigation of an unrelated release of crude oil (described in Section 1.2), PCE was discovered in several residential springs located downgradient from the PCE plume. In June, July, and August 2010, eleven springs were sampled in response to the crude oil spill, and results from six of these spring samples contained PCE in concentrations ranging from 2.5 µg/L and 40.4 µg/L. In response to these detections, UDEQ compiled the investigation results into a PA and SI, focused on the ESS area (UDEQ 2011, UDEQ 2012).

The PA and SI were completed in 2012 and are described in additional detail in Section 3.2.2, where the historical investigation of the ESS area is summarized. The findings and data from the PA and SI are documented in the Preliminary Assessment, East Side Springs (UDEQ 2011) and the Site Investigation Analytical Results Report, East Side Springs (UDEQ 2012).

Following the PA and SI, the EPA named VA as a PRP for the PCE plume.

VA Pre-RI Groundwater Sampling 2014. In 2014, VA conducted groundwater sampling of the EPA permanent groundwater monitoring wells. The sampling is not a part of the AOU-1 RI but was conducted concurrently with the RI. PCE detections in the EPA monitoring wells ranged from 240 µg/L in EPA-MW-01S to non-detects in EPA-MW-05. A sample was also collected from University of Utah Well #1, and no PCE was detected. The results are listed in Table 3-2. Results of this monitoring are provided in Results of Initial Groundwater Sampling Event June 2014, 700 South 1600 East PCE Plume (FE 2014).

VA Groundwater Sampling 2016. In 2016, VA conducted groundwater sampling of the EPA permanent groundwater monitoring wells. The sampling is not a part of the AOU-1 RI but was conducted concurrently with the RI. Samples were collected from the EPA monitoring wells, SLC-18, University of Utah Well #1, and the Mount Olivet irrigation well, in April, July, and September 2016. Results are summarized in Table 3-2. PCE was detected in the Mount Olivet irrigation well at 40 µg/L. PCE ranged from 46 to 210 µg/L in three of the shallow EPA monitoring wells (EPA-MW-01S, 02, and 04), and was detected between 1.6 and 9.1 µg/L in the deep EPA monitoring well (EPA-MW-01D). Results of this monitoring are provided in the 700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum (EA 2017a).

3.1.1.2 Groundwater Well Network

Historical PCE plume monitoring locations include monitoring wells installed by EPA, drinking water and irrigation wells, and artesian wells installed by Salt Lake City and University of Utah and are described in the following subsections.

Monitoring Wells. Six monitoring wells (EPA-MW-01S, EPA-MW-01D, EPA-MW-02, EPA-MW-03, EPA-MW-04, and EPA-MW-05) were installed by EPA in 1998. In 1999, monitoring well EPA-MW-03 was abandoned and well EPA-MW-06 was installed (UOS 2000). In 2016, MW-05 was damaged and abandoned, and replaced with EPA-MW-05R. Monitoring wells EPA-MW-01S and 01D are nested wells, used to monitor the perched groundwater and the deep unconfined aquifer, respectively. The remaining EPA wells are completed in the perched aquifer. Historical analytical data from these wells is presented in Table 3-2. Well locations are presented on Figure 1-2.

Drinking Water and Irrigation Wells. The municipal drinking water wells and irrigation wells in the vicinity of the VAMC groundwater monitoring well network include the Mount Olivet irrigation well; three University of Utah irrigation wells: 1) University of Utah Fountain of Ute irrigation well, 2) University of Utah Well #1 and 3) University of Utah Well #2 irrigation well; and the SLC-18 municipal drinking water well. These five wells have been monitored and/or sampled periodically since the discovery of PCE in groundwater in 1990. The elevation and depth bgs for each of these wells is presented in Table 3-2.

Other Boreholes, Drinking Water, and Irrigation Wells. Six abandoned boreholes were identified near the PCE plume area that provide additional information about the local geology and hydrogeology through available stratigraphic logs. These include an irrigation well at the Bonneville Golf Course, municipal water well SLC-1064, an irrigation well installed by the University of Utah, a 1,000-ft deep boring located on VAMC property; a 1,500-ft boring drilled by the University of Utah; and a shallow exploratory borehole drilled by the University of Utah. Because these abandoned boreholes and logs were located in the general area of the PCE plume, they provide useful data for modeling and regional geologic interpretation. The elevation and depth bgs for each of these wells is presented in Table 3-3.

Artesian Wells. There are two artesian wells that are used as municipal drinking water sources downgradient of AOU-1 beyond the expected western extent of the PCE plume:

1. The 800 South 500 East (8th South Well) (described as ESS-GW-3 in some reports)

2. The water fountain at the southeast corner of Liberty Park, approximately 3,200 ft west of AOU-1 (UDEQ Division of Drinking Water 2010) (described as ESS-GW-2 in some reports).

Both of these sources are artesian wells that are not treated but are regularly sampled by SLCDPU (UDEQ 2011). The artesian conditions at these wells are the result of confined aquifer conditions. PCE sample data for these two wells is included in Table 3-2. Information on the elevation of these two artesian (flowing) wells is provided in Table 3-4.

3.1.1.3 Groundwater Modeling

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

1. *PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)

2. *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection at Salt Lake City's Drinking Water Well #18 (also referred to as the 500 South Well)* (MWH 2012).

These two modeling efforts are described below:

2004 Groundwater Modeling. The PCE Well Contamination Evaluation Technical Memorandum presented the results of a MODFLOW/MODPATH model depicting water levels, particle traces, and the capture zone for the SLC-18 well (Bowen Collins 2004). 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 VAMC; however, the modeled horizontal hydraulic gradient differed from that inferred by the EPA. Data obtained by the EPA 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. This seeming discrepancy may be the result of the regional scope of the MODFLOW model and the current poor understanding of the localized site-scale hydrogeology created by thin low-permeability intervals and perched aquifers. More data will be collected during the future OU-2 RI activities to address the nature of groundwater flow. The technical memorandum concluded that the 500 South Well (SLC-18) is hydraulically downgradient and cross-gradient of the PCE plume. The memorandum also indicated there appeared to be a correlation between prolonged pumping of SLC-18 and detections of PCE (Bowen Collins 2004).

2012 Groundwater Modeling. The Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection at Salt Lake City's Drinking Water Well #18 (also referred to as the 500 South Well) presented a numerical groundwater model (MODFLOW/MT3D) developed for SLCDPU (MWH 2012). Pump tests were conducted in the SLC-18 well in Fall 2011. Eight wells were used to evaluate hydrogeological conditions during the pump tests: the Mount Olivet irrigation well, the University of Utah Fountain of Ute well, and the six EPA monitoring wells. Geophysical, hydrophysical, and video logging of SLC-18 was also conducted. Groundwater modeling was used to predict the timeframe for PCE contamination to reach the SLC-18 well from the presumed center of the PCE plume at various pumping rates, as well as to develop a preliminary capture zone induced by pumping SLC-18 (MWH 2012). The modeling results suggested that PCE could potentially reach SLC-18 within 10 days of initiating pumping, and the capture zone would extend past EPA-MW-03 located near the western boundary of the VAMC property. Based upon these long-term pumping tests at SLC-18 and in situ permeability (slug) tests at EPA-MW-01S and EPA-MW-01D, MWH evaluated the potential for PCE contamination to migrate to the northwest (toward SLC-18) from an assumed source near VAMC 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).

The 2012 report also commented on the 2004 modeling, suggesting that the discrepancy between the EPA 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” (MWH 2012). Some uncertainties and data needs remain from the 2004 and 2012 studies. Although the MWH model had somewhat more data to evaluate, the model was not calibrated to specific site conditions and the contaminant transport portion of the model used the center of the PCE plume as defined by monitoring wells, which are located some distance from the suspected source. These data gaps will be addressed during implementation of the OU-2 RI.

3.1.1.4 PCE Distribution in the Plume

The focus of AOU-1 is the VI pathway in the ESS area. However, an additional RI, specific to OU-2 is currently being conducted by VA. The focus of the OU-2 RI is to clearly delineate the nature and extent of the PCE groundwater plume, identify and define the characteristics of the source area(s), and define the hydrogeologic characteristics of the plume and PCE transport within the plume. Initial work to understand the distribution of PCE within the PCE plume is described in the following previous investigations:

- *Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
- *PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
- *Final Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection at Salt Lake City’s Drinking Water Well #18 (also referred to as the 500 South Well)* (MWH 2012)
- *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012).

Table 3-2 is a compilation of historical groundwater data that has been obtained to identify the presence and concentrations of PCE in the groundwater throughout the PCE plume.

3.1.2 East Side Springs (AOU-1)

UDEQ Spring Sampling in 1998. In August and September 1998, as a component of the UDEQ investigation of the Mount Olivet irrigation well PCE detections, UDEQ sampled four springs to attempt to track the PCE plume's western and southwestern extent. At the following four springs, water was emerging west to southwest of the Mount Olivet Cemetery (Figure 1-2):

- Our Lady of Lourdes Spring
- Benson Spring
- Smith Spring
- Bowen Spring.

Samples were analyzed for VOCs and all results were below detection limits. Results of this spring sampling are documented in the Analytical Results Report, Mount Olivet Cemetery Plume (UDEQ 2000) and are presented in Table 3-5.

SLCDPU/UDEQ Investigation of ESS in 2010. As described in Section 1.2, a release of crude oil from a pipeline in an area immediately to the southwest of Red Butte Canyon occurred on 12 June 2010 that resulted in an investigation by SLCDPU of springs within the ESS area. Twenty-five springs located along the Wasatch Fault line in the area between 800 South and Michigan Avenue and 1100 East and 1300 East were identified as potentially impacted by the crude oil contamination. The springs are formed by groundwater that surfaces along the Wasatch Fault. Out of the 25 springs identified, 11 springs were sampled by SLCDPU and elevated concentrations of PCE were detected in 6 locations at concentrations ranging from 2.5 µg/L to 40.4 µg/L (UDEQ 2012). Figure 3-1 illustrates the locations of the springs that were sampled during the investigation. Table 3-5 presents the PCE concentrations (see data dated June, July, and August 2010).

UDEQ Spring Investigation in 2011. Additional investigation of the ESS area was conducted in November and December 2011. Results of this investigation are documented in the Site Investigation Analytical Results Report (UDEQ 2012). UDEQ prepared this report to summarize their own sampling and to compile information from previous investigations conducted by EPA. The following is a summary of samples collected and the analytical results from this field effort. Sample locations are shown on Figure 3-1.

- Surface water/spring water (3 samples) ─ Surface water samples were collected from three spring locations. The analytical results identified PCE in two of the samples at concentrations of 3.7 µg/L and 20 µg/L (Table 3-5, Figure 3-1). PCE was not detected in the third sample; however, TCE was detected in that sample at an estimated 4.6 µg/L, which was below the contract-required quantitation limit, or reporting limit. No TCE was detected in the other two samples. No other VOCs were detected in these samples.

- Groundwater (10 samples) ─ Samples were collected using direct push technology to evaluate shallow groundwater in the area of the contaminated springs and to determine the western groundwater plume boundary to establish whether there was a correlation to the PCE plume. PCE was detected in two of the groundwater samples at concentrations of 6.1 µg/L and 8 µg/L. TCE was detected in a third sample at 12 µg/L. Shallow groundwater was measured between 6.5 and 10 ft bgs (UDEQ 2012) (Table 3-2, Figure 3-1).

- Soil (2 samples) ─ PCE and TCE were not detected in two soil samples collected during the 2011 investigation (UDEQ 2012).

- Soil gas (8 samples) ─ Samples were collected from three locations, using direct push technology, in upgradient locations unrelated to the seeps and springs. PCE was detected in two of these samples at concentrations of 2.8 µg/m^3 and 6.4 µg/m^3 (UDEQ 2012).

Based on data collected, the report concluded that:

- The PCE plume is the likely source of PCE contamination in the ESS area.
- The contaminated groundwater plume is believed to extend as far west as 1100 East.
- The groundwater plume is expected to be oriented in a northeast-southwest direction with an origin immediately to the west of the VAMC and terminating near the ESS area (UDEQ 2012).

3.1.3 Potential Source Areas

Historical investigations have not definitively identified a source area on the VAMC property, but historical reports suggest that the source is potentially the dry-cleaning operation that operated at VAMC Building 7 and the degraded sewer line in Sunnyside Park into which effluent from Building 7 was discharged (UDEQ 2000, UDEQ 2012). Additional clarification as to the source of the PCE plume is an objective of the OU-2 RI. The following subsections describe the source area investigations conducted to date.

3.1.3.1 VAMC Building 7 (Former Dry-Cleaning Facility)

The sewer line associated with the former dry-cleaning facility at the VAMC Building 7 has been identified as a potential source area (EPA 2012a). In addition, there is unconfirmed information there may have been a spill near the former loading dock. Building 7 and the associated sewer line are shown in Figure 1-2. However, significant data gaps exist with regard to PCE distribution in the PCE plume, and previously collected soil and soil gas data have been inconclusive. The following is a summary of observations and investigations conducted in association with VAMC Building 7 and the associated sewer line.

SLCDPU Employee Observations, early 1980s. During routine cleaning of the sanitary sewer line near VAMC Building 7 in the early 1980s, employees of the SLCDPU observed discolored (purple) water and odors of drycleaner solvent (EPA 2012a). The observations were documented in affidavits. However, the affidavits were completed well after the actual observation and could potentially include some inaccuracies.

UDEQ/EPA Soil Gas Investigation, November 1996. As discussed in Section 3.1.1.1 (under EPA 1996 Soil Gas Investigation), EPA conducted soil gas sampling in four locations, including near the southeast corner of Building 7 of the VAMC where the sewer line exited the building. The sample collected near Building 7 contained 1.9 ppb of PCE. This sample was a composite of three soil gas subsamples. While coordinates for the three subsamples are not provided in the report, the text explains that the subsamples were collected “uphill of the Building 7 sewer line”, from the location where the sewer line exited Building 7, and from a parking area adjacent to the buried sewer line. These samples were collected approximately 5 ft bgs, using direct push technology (UOS 1996).

SLCDPU Sewer Line Survey, December 2003. A SLCDPU video survey of the sewer line between Building 7 and Sunnyside Avenue 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 (EPA 2012a, SLCDPU 2012). The survey was performed to see if there were any major breaks or cracks in the sewer line that could have provided for a preferential pathway for contaminants, if released into the sewer, to migrate into the soil or groundwater.

UDEQ Soil Sampling, June 2004. Soil samples were collected along the Building 7 sewer line to determine whether a PCE source existed along the line. The soil sampling was conducted by UDEQ and VA conducted oversight and collected duplicates. Samples were collected at approximately 50-ft intervals from Building 7 to Sunnyside Avenue. A total of 32 soil samples were collected using direct push technology, between 2 ft and 14 ft bgs (UDEQ 2004). No PCE (and no VOCs) was detected in the UDEQ samples (UDEQ 2004). PCE was detected in three of the duplicate soil samples at concentrations ranging from 2.6 to 3.9 ppb (IHI Environmental [IHI] 2005).

VA Soil Gas Investigation, February 2007. VA conducted a soil gas investigation along the sanitary sewer line lateral beginning at Building 7 and running south to Sunnyside Avenue. During the investigation, 48 passive soil gas samplers were installed along the sewer line (Figure 3-1). These samples were collected from approximately 1 ft bgs along the length of the sewer line. PCE was detected in 4 of the 48 samples; 3 of which were collected where the sewer line exits Building 7, directly adjacent to the loading dock area. PCE concentrations near the loading dock ranged from 34 to 90 nanograms (ng) (mass value). The fourth sample, located near manhole 22658 in Sunnyside Park, reported a concentration of 29 ng PCE (IHI 2007).

3.1.3.2 Former Utah Army National Guard Vehicle Maintenance Facility

The former UANG vehicle maintenance facility was located east of the Mount Olivet Cemetery. In 1995, EPA conducted soil gas sampling (E&E 1995). Fifteen soil gas samples were collected from the area surrounding the facility, including five samples from the UANG facility. The soil gas samples were analyzed for VC, 1,1-DCE, trans-1,2-DCE, TCE, and PCE. No PCE was detected, and only one of the five samples collected at the UANG facility reported a detection of 1 ppb TCE. All other analytes were reported below detection levels for the UANG samples (E&E 1995).

3.1.3.3 Former United States Forest Service Helicopter Pad

To support interagency fire-fighting efforts, the USFS 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 USFS 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 environmental restoration efforts associated with the termination of use of the helicopter pad are unknown. The 1995 soil gas survey included two samples at the former helicopter pad. The soil gas results for all analytes (VC, 1,1-DCE, trans-1.2-DCE, TCE, and PCE) were below detection limits (E&E 1995).

3.1.3.4 East Side Springs TCE Detections

TCE has been detected historically in surface water and groundwater samples in AOU-1. TCE is one of the identified PCOPCs and was detected in the springs and seeps in 2011 at AOU-1, although it was not always co-located with PCE or other PCE degradation products (UDEQ 2012). TCE is generally present downgradient of areas with the highest PCE concentrations. Concentrations of PCE and TCE in groundwater within the larger OU-2 area are being investigated in additional detail during the OU-2 RI.

3.1.3.5 Other Potential Sources

Other potential sources may exist for the PCE plume. VA is conducting a historical records review and the OU-2 RI activities to further assess other potential sources.

3.2 Preliminary Contaminants of Potential Concern

Following the initial investigations described in Section 3.1 and in preparation for the RI, VA and EPA agreed upon a list of PCOPCs associated with AOU-1. The PCOPCs were investigated as part of the AOU-1 RI and are evaluated in the risk assessment included in Section 9 of this RI Report. PCOPCs identified for the AOU-1 RI and their current risk-based screening levels (RBSLs) and RALs are identified for indoor air and soil gas on Table 3-6. PCOPCs and associated RBSLs for soil and surface water are listed on Table 3-7. PCOPCs and screening levels applicable for the ecological receptors are identified in Appendix G, the Screening Level Ecological Risk Assessment (SLERA).

PCE is the primary contaminant of concern. In addition, degradation products identified as PCOPCs include: TCE, cis-1,2-DCE, and VC. Although these three chemicals can be PCE degradation products, they may also originate from other sources. Additionally, 1,4-dioxane was used as a stabilizer for 1,1,1-trichloroethane (TCA), and its inclusion as a PCOPC was specifically requested by the EPA. The list of PCOPCs will be refined to identify COPCs based on the results of the AOU-1 risk assessment (Section 9) VA will continue to refine the list of COPCs during implementation of the OU-2 RI.

3.3 Summary of Data Gaps from Previous Investigations and Data Limitations

Data gaps from previous investigations exist for AOU-1, and these are presented in the Conceptual Site Model (CSM) Update for the 700 South 1600 East PCE Plume AOU-1: East Side Springs (EA 2017b). In addition, the project objectives and principal study questions presented in Section 1.1 were developed based upon data gaps and data needs. Data gaps that have been addressed either in part or in whole, during the AOU-1 RI are discussed in Section 5. Additional data gaps pertaining to the groundwater plume will be investigated as part of the OU-2 RI.

3.3.1 Delineation of Plume Boundaries and PCOPC Concentrations

Based on previous investigations, additional data are required to delineate the lateral and vertical boundaries of the PCE plume and to understand the distribution of PCOPC concentrations across the Site. Specific to the AOU-1 RI, additional data are required to delineate the lateral extent of cVOCs in shallow groundwater and surface springs and seeps in the ESS area. This data will be used to investigate the potential pathway for VI into indoor air and other risks presented by potential exposure to water and soil. The following data were collected during the AOU-1 RI:

- Near-slab (i.e., within five ft of occupied structure) and open field (i.e., greater than five ft from any structure) soil gas data to better define areas with PCOPCs in soil gas which may have the potential to migrate into occupied structures. Open field soil gas samples were collected where groundwater is shallow and the occurrence of PCOPCs in soil gas serve as a general indicator of the area where VI may be occurring.

- Shallow groundwater PCOPC concentrations in AOU-1 using direct push technology. These samples form the foundation for further delineation and characterization of the distal end of the plume. Occurrence of PCOPCs in shallow groundwater within AOU-1 represents the areal extent of the potential for VI. In addition, the direct-push borings and temporary well points offer insight into the depth-to-groundwater, which may inform the CSM as to whether groundwater depth contributes to defining the area where VI may be occurring.

- Spring, seep, and surface water data from identified and accessible springs and seeps within AOU-1 to assess the lateral extent of PCE contamination. The location of the springs with relation to contaminant concentrations may be useful in evaluating potential groundwater and contaminant flow pathways, as well as further identifying the areal extent of potential VI. The data will also be used to evaluate potential direct exposure risk.

- PCOPC concentration data from stormwater in the vicinity of the ESS area. Some surface water samples were collected from the stormwater sewers within the ESS area. This information will allow evaluation of transport mechanisms.

- PCOPC concentrations in soil. Three soil samples were collected to provide a qualitative evaluation of possible direct exposure concerns.

3.3.2 Identification of Potential Exposure Pathways

3.3.2.1 Indoor Air

The VI pathway is the primary human exposure pathway evaluated during the AOU-1 RI. Sampling of indoor air, shallow groundwater, surface water, and soil gas support refinement of the CSM that will assist in identifying locations where VI of PCOPCs may result in indoor air concentrations in exceedance of RBSLs.

3.3.2.2 Groundwater

The use of shallow groundwater as a drinking water source by private landowners has not been identified as an exposure pathway within the bounds of AOU-1. As documented by UDEQ in the PA, residences are connected to municipal water lines (UDEQ 2011). However, occupied structures that overlie, or are in direct contact with shallow groundwater within the footprint of the delineated PCE plume, may present VI risk, and groundwater that daylights may also be a potential exposure pathway (described below).

3.3.2.3 Surface Water

PCE-impacted groundwater daylights in several springs and seeps in the ESS area, resulting in PCE-impacted surface water (e.g., drains, ponds, overland flow, and sumps). Residents, and possibly pets, may come into contact with the water, or incidentally ingest the surface water. These potential dermal and/or ingestion exposures may contribute to potential risk. During AOU-1 RI activities, PCE-impacted surface water from seeps and springs was located, documented, and further assessed.

3.3.2.4 Soil Gas

Soil gas data collected during the AOU-1 RI will be used in conjunction with regional and site-specific groundwater information to refine the CSM, including refining the area within which VI may be occurring.

TABLE 3-1
Chronology of Previous Investigations
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Investigation Date	**Organization Leading the Investigation (and Contractor Name if applicable)**	**Media**	**Investigation**	**Reference**
Oct 1990	SLCDPU	Irrigation well groundwater	Routine monitoring at Mount Olivet irrigation well. Initial detection of PCE, at 32 µg/L	Memorandum to File from Dennis Frederick, UBWPC (UBWPC 1991)
Apr-May 1995	EPA (E&E)	Soil gas	Mount Olivet irrigation well sampling. 15 soil gas samples collected from the: Mount Olivet Cemetery, University of Utah (former UANG property), current UANG property, and the U.S. Forest Service helicopter pad.	*Analytical Results Report, Mt. Olivet Well Site* (E&E 1995)
Nov 1996	EPA and UDEQ (UOS)	Soil Gas	Four soil gas samples collected by EPA (UOS) southwest of VAMC Building 7, Ft. Douglas, and University of Utah Building 515).	*Field Activities and Analytical Results for Soil Gas Sampling at the Mount Olivet Cemetery Plume* (UOS 1996)
May 1997	EPA and UDEQ (UOS)	Irrigation well groundwater	Mount Olivet irrigation well sampling	*Site Activities Report, Mount Olivet Cemetery* (UOS 1999)
Jun-Aug 1998	EPA and UDEQ (UOS)	Groundwater	Site Investigation - 6 monitoring wells installed around VAMC	*Site Activities Report, Mount Olivet Cemetery* (UOS 1999)
Aug-Sept 1998* (*May have been Aug-Sept 1999. Both years are mentioned in the text for collection of spring samples)	EPA and UDEQ (UOS)	Spring water	4 - 5 screening samples collected of spring water emerging west to southwest of Mount Olivet Cemetery: Our Lady of Lourdes Spring Benson Spring Smith Spring Bowen Spring	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
Nov 1998	EPA and UDEQ (UOS)	Groundwater	Sampling at EPA monitoring wells	*Site Activities Report, Mount Olivet Cemetery* (UOS 1999)
Sept 1999	EPA and UDEQ (UOS)	Groundwater	EPA-MW-03 abandoned, EPA-MW-06 installed in southeast corner of Sunnyside Park. Sept.	*Supplement to Site Activities Report, Mt. Olivet Cemetery* (UOS 2000)

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700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Investigation Date	Organization Leading the Investigation (and Contractor Name if applicable)	Media	Investigation	Reference
			1999: Groundwater sample collected at EPA-MW-03 prior to abandonment for PCE analysis. .	
Jan 2000	EPA and UDEQ (UOS)	Groundwater	EPA-MW-06 sampled on Jan. 6, 2000. No organic chloride or metals detected above laboratory reporting limits.	*Supplement to Site Activities Report, Mt. Olivet Cemetery* (UOS 2000)
May 2001	USGS	Groundwater	Sampling at SLC-18	*PCE Well Contamination Evaluation*. Technical Memorandum prepared for Salt Lake City Department of Public Utilities (Bowen Collins 2004)
July – August 2001	UDEQ (Beacon)	Soil Gas	19 soil gas samples collected around U of U Building 515.	*EMFLUX Passive Soil-Gas Survey, Building 515 University of Utah* (Beacon 2001)
December 2003	EPA/UDEQ/ SLCDPU	Sewer Survey	Survey of the sewer line leading from Building 7 of the VAMC for breaks and cracks, conducted by SLCDPU at the request of EPA and UDEQ.	Screen shots from a video survey recorded by SLCDPU of the sewer line leading from Building 7 of the VAMC (SLCDPU 2012)
June 2004	Bowen Collins	Groundwater Modeling	Groundwater modeling conducted to evaluate PCE contamination in SLC wells, including PCE in the Mount Olivet Cemetery Plume.	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
June 2004	EPA/UDEQ	Soil	Soil sampling was conducted along the Building 7 sewer line between Building 7 and Sunnyside Avenue.	*Soil-Sampling Event Summary Report, Mount Olivet Cemetery Plume* (UDEQ 2004)
October 2004	EPA/UDEQ	Groundwater	Sampling at EPA-MW-01D, EPA-MW-05, Mount Olivet irrigation well, and SLC-18 drinking water well.	*Memorandum, Analytical Results—Mt. Olivet VA* (EPA 2004a).
February 2005	USGS	Groundwater	Sampling from SLC-18, EPA-MW-01S, EPA-MW-01D, EPA-MW-02, EPA-MW-04, EPA-MW-05, and EPA-MW-06; and University of Utah Fountain of Ute well (shallow and deep)	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
Fall 2005	EPA/UDEQ	Groundwater	Sampling from EPA monitoring wells, SLC-18, and preparation of the CERCLA HRS package	*Preliminary Assessment, East Side Springs* (UDEQ 2011)
February 2007	VA (IHI)	Soil gas	Soil gas sampling in 48 locations along the VAMC Building 7 sewer line.	*Soil Gas Investigation Report, Sanitary Sewer Lateral, VALSCHCS Building 7 to Sunnyside Avenue (IHI 2007)*
Jun-Aug 2010	SLCPDU	Spring water, storm drain	Response to crude oil release near Red Butte Canyon. Identification of 25 springs. Samples	Described generally in *Preliminary Assessment, East Side Springs* (UDEQ 2011)

Investigation Date	Organization Leading the Investigation (and Contractor Name if applicable)	Media	Investigation	Reference
		water, groundwater	collected from 11 springs, 1 manhole, and 2 artesian wells.	
Aug 2010	UDEQ	Soil	10 soil samples were collected from 5 locations around Building 515 using direct push. Sample intervals were 0-4 ft and 4-8 ft bgs	*Expanded Site Investigation (ESI) Analytical Results Report, University of Utah Building 515* (UDEQ 2013)
Nov-Dec 2011	UDEQ	Groundwater, spring water, soil, soil gas	10 groundwater samples (from 5 direct-push borings, 3 monitoring wells, and 2 artesian drinking wells), 3 surface (spring) water samples, 2 soil samples, 8 soil gas samples collected in ESS area	*Site Investigation-Analytical Results Report, East Side Springs* (UDEQ 2012)
2014	VA (FE)	Groundwater	FE collected groundwater samples under contract to VA.	*Results of Initial Groundwater Sampling Event June 2014, 700 South 1600 East PCE Plume* (FE 2014)
2017	VA (EA)	Groundwater	EA collected groundwater samples under contract to VA. Samples were collected from the EPA monitoring wells, SLC-18, University of Utah Well #1, and the Mount Olivet irrigation well., in April, July and September 2016.	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)

NOTES:

µg/L = Micrograms per liter.
Bowen Collins = Bowen Collins and Associates, Inc.
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act.
E&E = Ecology and Environment, Inc.
EA = EA Engineering, Science, and Technology, Inc., PBC.
EPA = U.S. Environmental Protection Agency.
ESS = East Side Springs.
FE = First Environment, Inc.
HRS = Hazard Ranking System.
MW = Monitoring well.
PCE = Tetrachloroethene.
SLC = Salt Lake City.
SLCDPU = Salt Lake City Department of Public Utilities.
UANG = Utah Army National Guard.

TABLE 3-1
Chronology of Previous Investigations
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

UBWPC = Utah Bureau of Water Pollution Control.
UDEQ = Utah Department of Environmental Quality.
USGS = U.S. Geological Survey.
UOS = URS Operating Services, Inc.
VA = U.S. Department of Veterans Affairs.
VAMC = George E. Wahlen Veterans Affairs Medical Center.

TABLE 3-2
Historical Groundwater Monitoring Data
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
Wells screened in perched aquifer									
EPA-MW-01S (installed in summer1998)	4,662.54	Sep-98	--	--	--	--	4,506.83	155.71	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Oct-98	--	--	--	--	4,508.28	154.26	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	320	4 J	5 J	--	4,509.22	153.32	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Nov-98	310	4 J	3 J	--	4,509.22	153.32	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Feb-05	278	2.3	1.4	--	4,504.20	158.34	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Nov-11	150	ND	ND	ND	4,508.18	154.36	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	240	1.7	0.94 J	--	4,507.55	154.99	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	98	1.3	0.79	ND	4,507.97	154.57	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	60	1.0	0.63	ND	4,507.51	155.03	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	210	1.5	0.85 J	ND	4,507.32	155.22	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
EPA-MW-02 (installed in summer1998)	4,678.41	Oct-98	--	--	--	--	4,515.51	162.90	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	290	ND	ND	--	4,516.31	162.10	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Feb-05	296	2	1.1	--	4,511.39	167.02	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)

TABLE 3-2
Historical Groundwater Monitoring Data
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
		Oct-05	160	--	--	--	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Nov-11	--	--	--	--	4,515.51	162.90	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	190	0.86 J	0.44 J	--	4,508.43	169.98	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	98	0.66	0.36 J	ND	4,508.75	169.66	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	72	0.56	0.40 J	ND	4,508.40	170.01	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	130	0.56	0.32 J	ND	4,508.18	170.23	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
EPA-MW-03 (installed in summer 1998; abandoned in September 1999)	4,695.54	Sep-98	--	--	--	--	4,510.38	185.16	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Oct-98	--	--	--	--	4,508.23	187.31	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	11	ND	ND	--	4,509.08	186.46	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Sep-99	7.1	--	--	--	4,505.88	189.66	*Supplement to the Site Activities Report, Mt. Olivet Cemetery* (UOS 2000)
EPA-MW-04 (installed in summer1998)	4,654.35	Sep-98	--	--	--	--	4,521.50	132.85	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Oct-98	--	--	--	--	4,522.80	131.55	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	190	2 J	1 J	--	4,523.50	130.85	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Feb-05	119	1.1	0.6	--	4,516.29	138.06	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)

TABLE 3-2
Historical Groundwater Monitoring Data
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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
		Oct-05	120	--	--	--	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Nov-11	--	--	--	--	4,519.95	134.40	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	72	0.48 J	0.21J	ND	4,519.84	134.51	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	56	0.44 J	ND	ND	4,520.45	133.90	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	41	0.42 J	ND	ND	4,520.05	134.30	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	46	0.37 J	ND	ND	4,520.05	134.30	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	59	0.35 J	0.17 J	ND	4,519.65	134.70	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	62	0.35 J	0.18 J	ND	4,519.65	134.70	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
EPA-MW-05 (installed in summer 1998 and abandoned in 2016, a replacement, MW-05R was installed in	4,732.45	Sep-98	--	--	--	--	4,524.99	207.46	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Oct-98	--	--	--	--	4,526.59	205.86	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	ND	ND	ND	--	4,527.38	205.07	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Oct-04	ND	--	--	--	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Feb-05	ND	--	--	--	4,519.91	213.00	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)

Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
2016 but has not yet been sampled)		Oct-05	ND	ND	ND	ND	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Nov-11	ND	ND	ND	ND	4,523.56	208.80	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	ND	ND	ND	--	4,523.47	208.98	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	ND	0.19 J	ND	--	4,523.58	208.87	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
EPA-MW-06 (installed Sept. 1999)	4,678.63	Jan-00	ND	ND	ND	ND	--	--	*Supplement to the Site Activities Report, Mt. Olivet Cemetery* (UOS 2000)
		Feb-05	0.8	ND	ND	--	4,554.82	123.81	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Nov-11	--	--	--	--	4,554.65	123.98	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	0.46 J	ND	ND	--	4,560.56	118.07	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	ND	0.15 J	ND	ND	4,555.20	123.43	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	0.48 J	ND	ND	ND	4,554.63	124.00	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	0.39 J	ND	ND	ND	4,555.27	123.36	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)

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Well	**Ground Surface Elevation (ft amsl)**	**Date**	**PCE (µg/L)**	**TCE (µg/L)**	**cis-1,2-DCE (µg/L)**	**Vinyl Chloride (µg/L)**	**Water Level (ft amsl)**	**Water level (bgs)**	**Reference**
Wells screened in deep unconfined aquifer									
EPA-MW-01D (installed in summer1998; nested well in the same borehole as EPA-MW-01S)	4,662.54	Sep-98	--	--	--	--	4,471.65	190.89	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Oct-98	--	--	--	--	4,480.00	182.54	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Nov-98	ND	ND	ND	--	4,583.55	178.99	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999)
		Oct-04	8.33	--	--	--	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Feb-05	0.2	ND	ND	--	4,483.88	178.29	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Oct-05	0.33	--	--	--	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Dec-11	12	ND	ND	ND	4,492.64	169.90	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	8.3	ND	ND	--	4,491.64	170.90	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	9.1	0.16 J	ND	ND	4,491.96	170.58	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Apr-16	9.2	0.15 J	ND	ND	4,491.96	170.58	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	2.8	ND	ND	ND	4,490.47	172.07	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Sep-16	1.6	ND	ND	ND	4,490.87	171.67	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)

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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
SLC-18 municipal drinking water well Also referred to as: • the 5th South 15th East Well • SLC 1016a well Taken offline as a drinking water source in late 2004, after the October 2004 sample was collected)	4,673.95	May-95	ND	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Jul-97	0.6	--	--	--	--	--	*Site Activities Report, Mt. Olivet Cemetery* (UOS 1999); *PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Nov-98	ND	--	--	--	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Nov-99	ND	ND	ND	ND	--	--	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Aug-00	0.8	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Aug-00	0.8	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Jun-01	1.22	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Jul-01	0.9	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Aug-01	1.3	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Aug-01	1.2	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Aug-01	1.4	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Sep-01	ND	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Aug-02	ND	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Jan-03	ND	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Jun-03	ND	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)

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Historical Groundwater Monitoring Data

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Well	Ground Surface Elevation (ft amsl)	Date	PCE (μg/L)	TCE (μg/L)	cis-1,2-DCE (μg/L)	Vinyl Chloride (μg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
		Oct-04	2.23	ND	ND	ND	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Feb-05	0.2	ND	ND	--	4,477.57	192.53	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Sep-05	1.2	--	--	--	--	--	UDEQ 2005 Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Sep-05	1.5	--	--	--	--	--	UDEQ 2005 Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Sep-05	1.7	--	--	--	--	--	UDEQ 2005 Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Sep-05	1.8	--	--	--	--	--	UDEQ 2005 Record 1117460 – R8 SDMS. *Well Detections 700S 1600E PCE Plume* (EPA 2005)
		Nov-11	--	--	--	--	4,490.60	183.35	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	--	--	--	--	4,489.05	184.90	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	ND	ND	ND	ND	--	--	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
Mount Olivet Irrigation Well	4,635.74	Oct-90	32	--	--	--	--	--	Memorandum to File from Dennis Frederick (UBWPC 1991)
		Oct-90	25.7	--	--	--	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Apr-95	85	1.3	2.8	--	--	--	*Analytical Results Report, Mt. Olivet Well Site* (E&E 1995) *PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)

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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
		1997	184	--	--	--	--	--	*PCE Well Contamination Evaluation Technical Memorandum* (Bowen Collins 2004)
		Nov-98	150	1J	ND	ND	--	--	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)
		Jun-99	183	1.1	1.1	ND	--	--	EPA 1999 loose lab data (per VA data compilation)
		Oct-04	128	--	--	--	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Oct-04	92	--	--	--	--	--	Figure 5 of the *Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
		Apr-16	40	0.56	0.26	ND	--	--	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
Fountain of Ute Well	4,610.63	Feb-05 (shallow – 140 ft)	ND	ND	ND	ND	4,476.18	134.45	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Feb-05 (deep – 260 ft)	ND	ND	ND	ND	4,476.18	134.45	Record 1116769 – R8 SDMS. Compilation of 2005 well data (USGS 2005)
		Nov-11	--	--	--	--	4,484.65	125.98	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012) *Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well)* (MWH 2012)
		Jun-14	--	--	--	--	4,483.51	127.12	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
University of Utah Well #1	4,618.44	Jun-14	ND	ND	ND	--	--	--	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
		Apr-16	ND	ND	ND	ND	--	--	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
		Jul-16	ND	ND	ND	ND	--	--	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)

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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
		Sep-16	ND	ND	ND	ND	--	--	*700 South 1600 East PCE Plume 2016 Monitoring and Supply Well Groundwater Sampling Technical Memorandum* (EA 2017a)
University of Utah Well #2	4,636.15	Jun-14	--	--	--	--	4,489.82	146.33	*Results of Initial Groundwater Sampling Event June 2014. 700 South 1600 East PCE Plume* (FE 2014)
East Side Spring Direct Push Samples and Other Samples									
ESS-GW-04 Direct Push Boring in the front yard at 1127 E. Sunnyside Ave.	--	Nov-11	ND	12	ND	ND	--	10.00	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
ESS-GW-06 Direct Push Boring in front yard of 1205 E. Gilmer Drive	--	Nov-11	8	ND	ND	ND	--	9.50	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
ESS-GW-07 Direct Push Boring in front yard at 1115 E. Sunnyside Ave	--	Nov-11	6.1	4.5J	ND	ND	--	6.50	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
ESS-GW-10 Direct Push Boring at 1259 S. Lake St.)	--	Nov-11	ND	ND	ND	ND	--	6.50	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)

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Well	Ground Surface Elevation (ft amsl)	Date	PCE (µg/L)	TCE (µg/L)	cis-1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	Water Level (ft amsl)	Water level (bgs)	Reference
ESS-GW-11 Direct Push Boring at 818 S. 600 E. from median in roadway	--	Nov-11	ND	ND	ND	ND	--	9.50	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
Other Miscellaneous Groundwater Samples									
ESS-GW-02 Liberty Park Drinking Fountain	--	Nov-11	ND	ND	ND	ND	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
ESS-GW-03 800 South Street Artesian Well	--	Nov-11	ND	ND	ND	ND	--	--	*Site Investigation Analytical Results Report, East Side Springs* (UDEQ 2012)
Chapman Well 1457 South 900 East	--	Aug-98	ND	ND	ND	ND	--	--	*Analytical Results Report, Mount Olivet Cemetery Plume* (UDEQ 2000)

NOTES:

-- = Data unavailable or not identified in report.
µg/L = Micrograms per liter.
amsl = Above mean sea level.
bgs = Below ground surface.
Bowen Collins = Bowen Collins and Associates, Inc.
DCE = Dichloroethene.
E&E = Ecology and Environment, Inc.
EA = EA Engineering, Science, and Technology, Inc., PBC.
EPA = U.S. Environmental Protection Agency.
FE = First Environment, Inc.
ft = Feet.
J = Estimated value.
MWH = MWH Americas, Inc.
ND = Non-detect.
PCE = Tetrachloroethene.
TCE = Trichloroethene.

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Historical Groundwater Monitoring Data

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UBWPC = Utah Bureau of Water Pollution Control.
UDEQ = Utah Department of Environmental Quality.
UOS = URS Operating Services, Inc.
USGS = U.S. Geological Survey.
VA = U.S. Department of Veterans Affairs.

TABLE 3-3
Historical Hydrogeological Information from Permitted Boreholes, Drinking Water Wells, and Irrigation Wells
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Well Name/Location Identification	**Water Right Number**	**Elevation (1) (ft amsl)**	**Depth (ft bgs)**	**Comments**
Bonneville Golf Course Well	57-4409	4,695	240	USGS water level data available from 1934 to 2014
SLC-1064	57-4410	4,659	502	Not measured/sampled by USGS since 1947
University of Utah Well #1	57-112	4,618	444	Well log available
University of Utah Well #2	57-112	4,636	445	Well log available
Fountain of Ute	57-5212	4,610	500	Well log unavailable
SLC-18	57-2697	4,674	510	Well log available
Mount Olivet Irrigation Well	57-2526	4,637	470	Well log available
Abandoned VA Exploratory Borehole	1057004M00	4,758	1004	Stratigraphic log available
University of Utah Exploratory Borehole	0757007M00	4,848	1508	Stratigraphic log available
University of Utah Exploratory Borehole Well	0657008M00	4,848	39	

NOTES:
1. Measuring point elevations estimated from Google Earth (no published survey data identified)
amsl = Above mean seal level.
bgs = Below ground surface.
ft = Feet(foot).
SLC = Salt Lake City.
USGS = U.S. Geologic Survey.
VA = U.S. Department of Veterans Affairs.

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TABLE 3-4

Historical Groundwater Elevation Information from Artesian Wells

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location Identification	Description	Elevation (ft amsl)
ESS-GW-2	Artesian drinking water fountain on southeast corner of Liberty Park (700 East and 1300 South).	4,275
ESS-GW-3	Artesian Well Park (800 South and 500 East). Also referred to as the "*the 8th South Well."	4,261

NOTES:
ft amsl = Feet above mean sea level.
Ground elevation estimated from Google Earth.

TABLE 3-5
Historical Sampling Results for Seeps and Springs
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Location	PCE (1) (µg/L)	TCE (1) (µg/L)	Sample Date
SP-1	Our Lady of Lourdes Spring; 1063 East and 700 South	ND	ND	Aug-98
SP-2	Benson Spring; 761 South and 1100 East	ND	ND	Aug-98
SP-4	Bowen Spring; 1220 East Yale Avenue	ND	ND	Aug-98
SL13	Spring at 1066 East 700 South, parcel to west of address	ND	ND	Jul-10
SL35	Spring at 1203 Yale Avenue residence	ND	NR	Jul-10
SL36	Spring at 1126 East 1300 South residence	ND	NR	Jul-10
SL44	1319 Sherman Avenue residence	ND	NR	Jul-10
SL77	Spring at 1349 Yale Avenue residence	ND	NR	Jul-10
SL18	Spring at 1143 Sunnyside Avenue residence	39.3	NR	Jul-10
		8.7	NR	Aug-10
SL23	Spring at 1155 East 900 South residence	2.7	NR	Jul-10
		2.7	NR	Aug-10
SL25	Spring at 1173 Sunnyside Avenue residence	22.4	NR	Jul-10
		2.5	NR	Aug-10
SL30	Spring at 1205 Gilmer Drive, in collection vault at residence	17.2	NR	Jul-10
		18.1	NR	Aug-10
ESS-SW-16 (aka SL30)		20	ND	Nov-11
SL82	Spring at 1127 Sunnyside Avenue residence	7.7	NR	Jul-10
		40.4	NR	Aug-10
SP-3 (aka SL28)	Smith Spring at 1123 Alpine Place residence	ND	ND	Aug-98
SL28		12	NR	Jun-10
		14.4	NR	Jul-10
		16.3	NR	Aug-10
ESS-SW-15	Spring at 1127 East Sunnyside Avenue residence	ND	4.6	Nov-11
ESS-SW-17	Spring at 1115 East Sunnyside Avenue residence	3.7	ND	Nov-11

NOTES:

1. 'ESS-SW' PCE data from UDEQ (2012); 'SP' PCE data from UDEQ (2000); ‘SL’ data from figure summarizing results at 11 locations sampled by SLCDPU, 2010 and reported in UDEQ, 2011a)

µg/L = Micrograms per liter.
ND = Non-detect.
NR = Not reported.
PCE = Tetrachloroethene.
TCE = Trichloroethene.

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TABLE 3-6

Preliminary Contaminants of Potential Concern - Indoor Air and Soil Gas Risk-Based Screening Levels and Removal Action Levels

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

		Residential					Commercial/Industrial				
Chemical	**CASRN**	**Residential Indoor Air RBSL (a) (μg/m^3)**	**Residential Indoor Air Tier 1 RAL (b) (μg/m^3)**	**Residential Indoor Air Tier 2 RAL (c) (μg/m^3)**	**Residential Soil Gas RBSL (a) (μg/m^3)**	**Residential Groundwater RBSL (d) (μg/L)**	**Commercial/ Industrial Indoor Air RBSL (a) (μg/m^3)**	**Commercial/ Industrial Indoor Air Tier 1 RAL (b) (μg/m^3)**	**Commercial/ Industrial Indoor Air Tier 2 RAL (c) (μg/m^3)**	**Commercial/ Industrial Soil Gas RBSL (a) (μg/m^3)**	**Commercial/ Industrial Groundwater RBSL (d) (μg/L)**
cis-1,2-Dichloroethene	156-59-2	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
1,4-Dioxane	123-91-1	0.56	5.6	56	19	2,900	2.5	25	250	83	13,000
Tetrachloroethene	127-18-4	11	41	120	370	15	47	180	540	1,600	65
Trichloroethene	79-01-6	0.48	2.1	6.3	16	1.2	3	8.8	26	100	7.5
Vinyl chloride (chloroethene)	75-01-4	0.17	1.7	17	5.7	0.15	2.8	28	280	93	2.5

NOTES:

a. The Indoor Air RBSLs are the indoor air RSLs from the EPA RSL table (EPA 2017a). The Soil Gas RBSLs are the indoor air RSLs multiplied by a generic soil gas-to-indoor air attenuation factor of 0.03 (EPA 2017b). The Indoor Air RBSL and the Soil Gas RBSL based on either a target cancer risk of 1 x 10^{-6} and a non-cancer hazard quotient of 1, whichever results in the lower SL.

b. The Indoor Air Tier 1 RALs are based on the indoor air RSLs from the EPA RSL table (EPA 2017a) using either a target cancer risk of 1 x 10^{-5} and a non-cancer hazard quotient of 1, whichever results in the lower RAL.

c. The Indoor Air Tier 2 RALs are based on the indoor air RSLs from the EPA RSL table (EPA 2017a) using either a target cancer risk of 1 x 10^{-4} and a non-cancer hazard quotient of 3, whichever results in the lower RAL.

d. The Groundwater RBSLs are based on the indoor air RSLs from the EPA RSL table (EPA 2017a) and the generic groundwater-to-indoor air attenuation factor of 0.001, assuming an average groundwater temperature of 25 degrees Celsius (EPA 2017b). The Groundwater RBSLs are based on either a target cancer risk of 1 x 10^{-6} and a non-cancer hazard quotient of 1, whichever results in the lower SL.

μg/L = Micrograms per liter.
μg/m^3 = Micrograms per cubic meter.
EPA = U.S. Environmental Protection Agency.
NSL = No screening level.
RAL = Removal action level.
RSL = EPA Regional screening level.
SL = Screening level.

TABLE 3-7
Preliminary Contaminants of Potential Concern - Soil and Surface Water Screening Levels
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

		Soil RBSL (a)				**Partition Coefficient**		**SW RBSL Protection of Soil (d)**		**SW RBSL (Resident Recreator) (e)**
Chemical	**CASRN**	**Residential Soil RBSL (mg/kg)**	**Key**	**Industrial Soil RBSL (mg/kg)**	**Key**	**Koc (L/kg) (b)**	**Kd (L/kg) (c)**	**Residential SW_{SOIL} RBSL (µg/L)**	**Industrial SW_{SOIL} RBSL (µg/L)**	**SW_{Direct} RBSL (Direct Contact Ing/Derm) (µg/L)**
cis-1,2-Dichloroethene	156-59-2	160	N	2,300	n	39.6	0.0792	2,000,000	29,000,000	3,000
1,4-Dioxane	123-91-1	5.3	C	24	c	2.633	0.005266	1,000,000	4,600,000	160
Tetrachloroethene	127-18-4	24	c**	100	c**	94.94	0.18988	130,000	530,000	1,500
Trichloroethene	79-01-6	0.94	c**	6.0	c**	60.7	0.1214	7,700	49,000	110
Vinyl chloride (chloroethene)	75-01-4	0.059	C	1.7	c	21.73	0.04346	1,400	39,000	0.61

NOTES:
a. Soil RBSLs were obtained from EPA RSL table (EPA 2017a). Soil RBSLs are based on ELCR = 10^{-6} and HI = 1.
b. Koc values were obtained from EPA RSL table (EPA 2017a)
c. Kd = Koc x foc, where foc is EPA's default value and foc = 0.002
d. SW_{SOIL} RBSL = Soil RSL x 1000 (µg/mg) x (1/Kd). SW_{Soil} SLs are based on ELCR = 10^{-6} and HI = 1.
e. SW_{Direct} RBSL was calculated using the EPA RSL calculator (EPA 2017b). SW_{Direct} RBSLs are based on ELCR = 10^{-6} and HI = 1.
* = n SL < 100X c SL.
** = n SL < 10X c SL.
µg/L = Micrograms per liter.
µg/mg = Micrograms per milligram.
c = Cancer.
ELCR = Excess lifetime cancer risk.
EPA = U.S. Environmental Protection Agency.
foc = Organic carbon content in soil.
HI = Hazard index.
Ing/Derm = Incidental ingestion/dermal contact.
Kd = Soil-water partition coefficient.
Koc = Organic carbon partition coefficient.
L/kg = Liter per kilogram.
mg/kg = Milligrams per kilogram.
n = Non-cancer.
RSL = EPA Regional screening level.
SL = Screening level.
SW = Surface water.

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File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 3-1 Historical Sampling Efforts.mxd bpawling 6/8/2018

Legend

- ⌖ Monitoring Wells
- ⌖ Production/Irrigation Wells
- ⌖ Abandoned Monitoring Wells

Historical Sample Locations

- ■ 1995 EPA Soil Gas Sample
- ■ 1996 EPA/UDEQ Soil Gas Sample
- ▲ 1998 EPA/UDEQ Spring Sample
- ■ 2001 UDEQ Soil Gas Sample
- ● 2004 EPA/UDEQ, 32 Soil Samples Along Sewer Line at 50 ft Interval
- ■ 2007 VA Soil Gas Samples
- ▲ 2010 SLCDPU Spring Sample (Following Crude Oil Release) with PCE Detections
- ▼ 2010 SLCDPU Stormwater Sample (Following Crude Oil Release) with PCE Detection
- ● 2010 UDERR Soil Sample
- ◆ 2011 UDEQ Groundwater Sample
- ● 2011 UDEQ Soil Sample
- ▲ 2011 UDEQ Surface Water Sample
- 💧 Spring Location
- ┈ Sewer Line (Inferred Location)
- ‒ ‒ Wasatch Fault line
- ‒ ┈ Jordan River Canal (subterranean)
- ∿ Streams
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)
- ▬ lakes
- ▬ Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation
SLC = Salt Lake City
UDEQ = Utah Department of Environmental Quality
UDERR = Utah Division of Environmental Response and Remediation

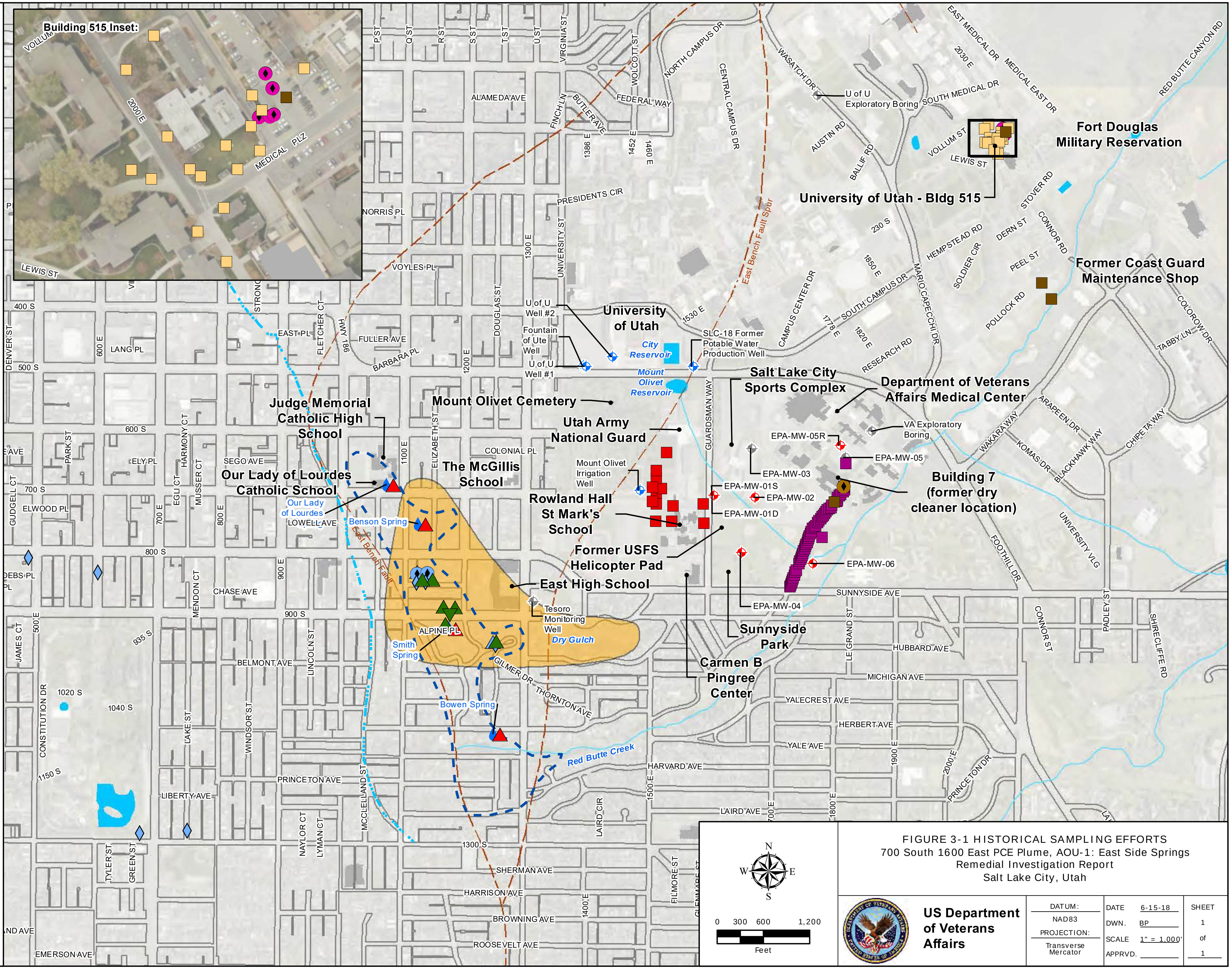

FIGURE 3-1 HISTORICAL SAMPLING EFFORTS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

N W E S

0 300 600 1,200
Feet

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 1,000'
APPRVD.

SHEET 1 of 1

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4.0 Physical Characteristics of the Investigation Area

The purpose of this section is to describe the physical characteristics of the investigation area to define potential transport pathways and receptor populations and to provide sufficient engineering data for development and screening of remedial action alternatives. Information provided includes the physiographic setting (surface features including natural and artificial features), geology and soil, surface water hydrology and hydrogeology, climatology, human populations, and ecology.

4.1 Physiographic Setting

The Site is located on the eastern edge of the Great Basin in the Basin and Range physiographic province of western United States. The eastern edge of the Great Basin bisects the state of Utah from north to south. The Basin and Range province is a series of valleys or desert basins separated by mountain ranges. Most of the mountain ranges in the province were formed from block faulting, and the ranges run to the north. As the ranges formed, erosional and depositional processes filled the valleys with alluvial deposits comprised of clay, silt, sand, gravel, and boulders.

The Great Basin is a large topographically closed basin of the province, which means it has no surface drainage to the sea. All surface drainage and most subsurface drainage is toward the saline mudflats and saline lakes in the lowest areas of the basin. The Great Salt Lake is the largest saline lake and receives nearly all the surface water run-off generated along the eastern edge of the Great Basin. Water within the Salt Lake is lost via evaporation.

Major mountain ranges along the eastern edge of the Great Basin include the Wasatch Range; the East Tintic, Lake, Traverse, Oquirrh, and Promontory Mountains. The Antelope Island mountains are also in the area and are a range located within the Great Salt Lake. Some of the mountains have elevations above 11,000 ft above mean sea level (amsl) with a difference of greater than 7,000 ft amsl to adjacent valleys (Thiros 2010). Major valleys along the eastern edge of the Great Basin include northern Juab, Goshen, Utah, and Salt Lake Valleys. The Site is located on an alluvial fan formed from erosion of the Wasatch Front on the edge of the Salt Lake Valley in northern Utah (Figure 1-1).

4.2 Geology

The regional and local geology are an important component of the PCE plume transport pathways and VI. The Site is located in the Salt Lake Valley. Geologic processes, especially in the Cenozoic era, of faulting; mountain uplift; and deposition of basin sediments established the relatively complex hydrogeologic conditions at the Site.

4.3 Regional Geology

The Salt Lake Valley 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 was once filled by paleo-lakes including Lake Bonneville, which resulted in deposition of lacustrine sediments that are present west of the Wasatch Fault (Figure 4-1). The mountain ranges bounding the valley are a result of extensional faulting during the Cenozoic era. The

Wasatch Range is formed by uplift along the Wasatch Fault. This is an active fault zone comprised of several seismically-independent segments that have been active since the Holocene era (Thiros 2010) (Figure 4-1). 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:

- Jurassic-age Twin Creek Limestone
- Triassic-age Nugget Sandstone, Ankareh Formation (comprised of members including sandstone, shale and mudstone), and the Thaynes Formation (comprised of members including limestone, interbedded with sandstone and shale)
- Permian-age Park City Formation (limestone and shale) and Weber Quartzite (Davis 1983).

The consolidated rocks in the Wasatch Range bounding the northeastern part of the Salt Lake Valley, from Mill Creek Canyon northward, are dominantly sedimentary, Triassic-age shale and mudstone with bedding planes striking approximately perpendicular to the mountain front. The Wasatch Fault is located just inside of the valley, west of the mountain front in this area, resulting in shallow depths to bedrock between the fault and the mountain front (Thiros 2010). The portion of the Wasatch Range that bounds the Salt Lake Valley is predominately comprised of consolidated, sedimentary, Triassic-era shale and mudstone with bedding planes that strike perpendicular to the mountain front (Figure 4-1).

The aeolian deposits forming the basin-fill of the Salt Lake Valley are unconsolidated to semi-consolidated, Tertiary-era deposits that are overlain by unconsolidated, Quaternary-era deposits. The contact between the unconsolidated basin-fill and the consolidated bedrock is believed to be as deep as 4,000 ft bgs in the center of the valley (Mattic 1970).

4.3.1 Local Geology

The surficial geology is comprised of the unconsolidated Quaternary-era deposits that formed as alluvial fans by streams as deltas and other lacustrine features associated with the paleo-lake, Lake Bonneville. The fans slope gently to the southwest. In general, the lacustrine deposits nearest the Wasatch Range to the east are coarser and become finer further into Salt Lake Valley to the west (Personius and Scott 2009). The VAMC sits atop the coarser-grained deposits, with the finer-grained deposits found west of the VAMC (Figure 4-1).

Segments of the Wasatch Fault are in the immediate vicinity of the Site and play a significant role in the hydrogeologic processes in this area. The East Bench Fault is one of these segments and runs predominately north-south. The fault segment is immediately west of the VAMC and approximately parallel to 1300 East in Salt Lake City (Figure 4-1). A spur off the East Bench Fault segment of the Wasatch Fault strikes to the northeast and is in the vicinity of SLC-18 (Figure 1-2) (Personius and Scott 2009).

The surficial geology changes from east to west across the Site. Coarse-grained alluvial fan deposits with gravel and sand and silty sand interbeds are found nearest the VAMC. The presence of the coarse-grained materials was confirmed by the boring logs for the EPA monitoring wells installed near the VAMC (UDEQ 2000). The boring logs are provided in Appendix A. These coarse-grained deposits are surrounded by lacustrine deposits to the north, south, and west. The lacustrine deposits become more fine-grained west of the VAMC until the East Bench Fault, which is identified by the presence of mixed colluvium and alluvium deposited as a debris apron at the base of the scarp. The contact for the sediments and the site is assumed to be present at a depth greater than 1,000 ft bgs.

The East Bench Fault has a significant impact on the configuration of shallow sedimentary deposits above the bedrock at the site and causes the deposits to vary greatly over the AOU-1 area. The deeper sediments are predominately sand and gravel with silt layers and lenses. To the west of the East Bench Fault a shallow clay layer creates local confined artesian aquifer conditions leading to the presence of artesian wells in Liberty Park and Artesian Well Park (Figure 1-2).

The USGS conducted a groundwater study using the EPA monitoring wells and SLC-18 in 2004 and 2005. The lithology around the monitoring wells was evaluated using a downhole geophysical logging tool. Using the geophysical data and the original boring logs, the USGS identified a series of shallow aquifers and aquitards and hypothesized the presence of a northwest-dipping clay layer at 180 ft bgs, which appeared to be continuous (FE 2015a). A flow meter deployed in the University of Utah Fountain of Ute Well demonstrated artesian conditions with water entering the well at 416 ft bgs and moving up and out at shallower intervals. However, the initial CSM discussed in the RI Work Plan cautioned that the presence of a continuous clay layer was based on a limited data set, and further evaluation would be needed (FE 2015a). A cross section from these boring logs is provided in Figure 4-2.

Additional boring logs from the Utah Division of Water Rights (UDWR) described in the RI Work Plan included a 1,004-ft exploratory boring on the VAMC property (abandoned in 2012) that did not encounter bedrock and a 1,508-ft deep exploratory boring on the University of Utah property (abandoned in 2008) that encountered bedrock at 280 ft bgs (Figure 1-2) (FE 2015a).

In February and March of 2016, VA installed 50 shallow direct push borings in the AOU-1 area as part of this RI. The locations of the borings are provided in Figure 4-3. Ten were converted to piezometers. The logs for the shallow borings are provided in Appendix B. A cross section of the shallow sediments is provided in Figure 4-4. The borings were advanced until groundwater was first encountered, as part of the evaluation that was focused on shallow groundwater to investigate the VI pathway. The total depths of the borings range from 8.5 ft bgs to 40.0 ft bgs. The shallow borings confirmed that the surficial soils and sediment at the Site are very heterogeneous. Generally, the top 0 to 10 ft of soil and sediment are comprised of finer-grained material. The fine-grained material is approximately 8- to 10-ft thick in the northern portion of AOU-1 near the Judge Memorial Catholic High School (Figure 4-4). Through the center of AOU-1, the thickness of the fine-grained material decreases to less than 2 ft near boring GW-06, resulting in the presence of groundwater closer to the surface. The fine-grained deposits thicken to the south where a discontinuous clay layer is present, and correspondingly, the depth to groundwater increases. Coarser sand and gravel deposits are located below the finer silt and clay deposits. These coarse deposits are where groundwater was first encountered. The total depth of the coarse deposits was not investigated because the scope of the study was to investigate shallow groundwater as a source for VI. Generally, saturated groundwater occurs in the coarse-grained material, but there is a capillary fringe into the overlying finer sediments.

4.4 Hydrology and Hydrogeology

The basin-fill deposits have resulted in complex geology and hydrogeology below and around the Site. The heterogeneity of the deposits and laterally discontinuous units resulted in multiple aquifers and confining layers. All the unconsolidated water-bearing materials in the valley are hydraulically connected to some degree (Waddell et al.1987, Thiros 2003). Groundwater in the Salt Lake Valley basin-fill sediments is divided into the following five aquifer units, from deep to shallow (FE 2015a, Waddell et al. 1987, Thiros 2003):

1. A deep unconfined aquifer near the Wasatch Front

2. Local perched aquifers that lie above the deep unconfined aquifer near the Wasatch Front
3. A "transition" aquifer where the deep unconfined aquifer becomes more confined, but a downward hydraulic gradient is still present (i.e., no artesian conditions have developed as the aquifer becomes confined)
4. A deep confined artesian aquifer with an upward hydraulic gradient, west of the Wasatch Fault
5. A laterally continuous shallow unconfined aquifer overlying the deep confined aquifers, west of the Wasatch Fault.

The deep unconfined aquifer and the deep confined aquifer form the "principal aquifer." Most of groundwater wells in the Salt Lake Valley utilize this principal aquifer.

The local perched aquifers near the Wasatch Front are discontinuous and the fine-grained materials that form the bases for the perched groundwater are relatively thin which allows for groundwater to move downward from the perched aquifers into the deep unconfined aquifer below.

The laterally continuous shallow unconfined aquifer overlies the deep confined aquifer west of the Wasatch Fault. The two aquifers are separated by an unsaturated zone, but since the unconfined aquifer is laterally continuous, it is not considered a perched aquifer.

The "transition" aquifer is where the deep unconfined aquifer becomes confined near the mountain front, between laterally continuous fine-grained layers, as it flows towards the center of the Salt Lake Valley. In this transition zone, the deep aquifer becomes confined, but artesian conditions have not yet developed, and a downward flow gradient is maintained. West of the Wasatch Fault, water pressure builds, and artesian conditions develop in what becomes the deep confined aquifer. Artesian flow is observed in wells at Liberty Park and Artesian Well Park.

4.4.1 Recharge Zones

The principal aquifer (the deep unconfined and deep confined aquifers) is primarily recharged near the mountain front, where there are no fine layers impeding recharge. The perched aquifers, above the deep unconfined aquifer in the primary recharge area, rest above the discontinuous fine materials where groundwater can migrate downward. Water can also move downward between the perched layers or, when it flows laterally, across a fine layer until the layer discontinues (Figure 4-3 and Figure 4-5).

Secondary recharge occurs where layers of fine-grained material are thin or discontinuous, and water flows through either localized perched aquifers, or the more extensive unconfined aquifer, into deeper basin-fill deposits. The secondary recharge zone borders the primary recharge area on the west and includes the general area of AOU-1.

West of AOU-1, the vertical hydraulic gradient changes from downward in the deep unconfined aquifer to upward from the deep confined aquifer to the shallow unconfined aquifer. While not well defined, the area west of AOU-1 and the East Bench Fault are considered discharge zones and are characterized by artesian conditions, such as those observed at wells in Liberty Park and the Artesian Well Park.

The VAMC and the PCE plume are within both primary and secondary recharge areas, based on boundaries defined by the USGS (Anderson et al. 1994). The eastern extent of the discharge area has been mapped and occurs between the flowing well at 800 South 500 East Streets (Artesian Well Park) and the ESS area (Anderson et al. 1994). SLC-18 and the Mount 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 ft but does not indicate that significant clay layers exist in the area that would impede the downward migration of water or contamination to the aquifer (Bowen Collins 2004). The ESS are in a localized discharge zone created by the East Bench Fault. The geology between the ESS and the VAMC is not known at this time, and it is unclear if the shallow groundwater discharging at the ESS is from the unconfined shallow aquifer, deeper water being brought up along the fault, or a mix of the two caused by the fault. This is a data gap that will be addressed as part of the OU-2 investigation.

4.4.2 Groundwater Levels and Potentiometric Surfaces

The depth-to-groundwater in the perched aquifers (near the mountain front) ranges from 150 ft to 200 ft bgs, and the depth-to-groundwater in the deep unconfined aquifer (near the mountain front) is typically from 150 ft to 500 ft bgs (Thiros 2010). The depth-to-groundwater in the shallow unconfined aquifer, in the secondary recharge area, is about 100 ft bgs (Thiros 2010); and artesian conditions are often present in wells screened in the deep confined aquifer in the discharge area.

Near the VAMC, water levels range from approximately 120 ft to 190 ft bgs in the water supply well operated by Mount Olivet Cemetery, SLCDPU, and the University of Utah. Water levels measured in the EPA monitoring wells range from approximately 124 ft bgs in EPA-MW-06, located in Sunnyside Park near Red Butte Creek, to 211 ft bgs in EPA-MW-05 (abandoned in 2016 and replaced by EPA-MW-05R), on the VAMC property (FE 2014). The depth-to-groundwater is deepest in the area of the VAMC and becomes shallower to the west, near the East Bench Fault. Groundwater was measured at a depth of approximately 38 ft bgs in a monitoring well installed at the corner of 1300 East and 900 South for Tesoro Refining and Marketing Co. in 2011, and the presence of seeps and springs between 1300 East and 900 East indicates that groundwater intersects the topographic surface within the approximate area of AOU-1 (Figure 1-2 and Figure 4-5).

Water level data collected from 1998 to 2016 for the EPA monitoring wells, SLC-18, and the Fountain of Ute well are presented in Table 3-2. EPA-MW-03 was abandoned during construction of the Salt Lake City Sports Complex in 1999; as such, the water level presented for this well was measured just after well construction in 1998 (UDEQ 2000). Water level data has been obtained periodically from the Mount Olivet irrigation well and the University of Utah Well #2.

Based on the available data, there are two water-producing zones below the VAMC: 1) an upper unconfined unit that is representative of the perched aquifers and may be preliminarily defined by monitoring wells EPA-MW-01S, EPA-MW-02, EPA-MW-03 (abandoned), EPA-MW-04, EPA-MW-05 (abandoned in 2016 and replaced with EPA-MW-05R), and EPA-MW-06; and 2) a lower unit representative of the deep unconfined aquifer and may be preliminarily defined by EPA-MW-01D, SLC-18, and the University of Utah Fountain of Ute well (FE 2015a). The approximate elevation of the upper unconfined unit near the VAMC ranges from 4,507.32 ft amsl in EPA-MW-01S to 4,555.27 ft amsl in EPA-MW-06 amsl, and the approximate elevation of this lower unit near EPA-MW-01D at the VAMC is 4,491 ft amsl (Table 3-2). The potentiometric elevations of the nested wells EPA-MW-01S and EPA-MW-01D differ by approximately 16.5 ft, indicating a relatively strong downward vertical hydraulic gradient of approximately 0.09 foot per foot (ft/ft) as would be expected in a primary recharge area (Table 3-2).

A potentiometric surface map for surficial groundwater in the ESS area was prepared based on the shallow groundwater, surface water, and stormwater study (Figure 4-6). The groundwater elevations ranged from 4,475.02 ft amsl in GW-01 to 4302.36 in GW-02 (Section 5). The details of the shallow ground water study are presented in Sections 5 and 6 of this report.

4.4.3 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 Front toward the Jordan River and the Great Salt Lake. In the northeastern part of the Salt Lake Valley, and near the VAMC, groundwater tends to flow from the northeast to the southwest (Lambert1995, Thiros 2010).

The regional groundwater hydraulic gradient was determined in 1998, using EPA-MW-01D and the Mount Olivet irrigation well, as being to the west. Groundwater flow models developed with the use of a larger data set have shown regional groundwater flows to the west-southwest (Bowen Collins 2004, MWH 2012). 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, was 0.004 ft/ft to the southwest. As previously stated, the horizontal hydraulic conductivity values were preliminary estimates and will be investigated during the OU-2 RI.

The hydraulic gradient of the shallow and unconfined aquifer is more complex. As previously explained in Section 3, the hydraulic gradient for shallow and perched groundwater in the unconfined aquifer was indicated to be to the northwest based on data from the shallow EPA groundwater monitoring wells obtained in 1998. The preliminary gradient and flow direction for the shallow unconfined unit near the VAMC was calculated in the RI Work Plan to be 0.02 ft/ft to the northwest (FE 2015a). Recent groundwater levels collected in 2016 still indicate the flow direction is to the northwest. However, the RI Work Plan noted that the northwest hydraulic gradient may be suspect due to limited data and complex geology. The shallow EPA wells may not be screened in the hydrologic unit. The difference in the groundwater flow directions between the shallow and deeper groundwater near the VAMC is unexpected, and possible distortion in the upper potentiometric contours may be attributable to an insufficient well network, both in terms of well density and the proper assignment of wells to the appropriate hydrostratigraphic units (i.e., multiple perched aquifers versus the upper part of the deep unconfined aquifer) (FE 2015a).

For this RI, new potentiometric surface mapping was conducted within the ESS area to understand the hydraulic gradient of the shallow groundwater (Figure 4-6). This mapping focused on the potentiometric surface of the shallow groundwater that is closest to the surface and daylighting in the ESS area and shows that the hydraulic gradient is to the southwest, like the regional groundwater flow direction. This potentiometric surface map was constructed from the densely spaced direct push borings and piezometers installed as part of the shallow groundwater study at AOU-1 described in Sections 5 and 6 of this RI report. Based on the difference from boring GW-27 to GW-31 the gradient of flow is 0.08 ft/ft. There is a steepening of the gradient in the center of the ESS area as groundwater nears the East Bench Fault spur, which then flattens out again on the west side of the spur (Figure 4-6).

4.4.4 Horizontal Hydraulic Conductivity and Transmissivity

Regional hydraulic conductivity values ranging from 0.03 ft per 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 (Bedinger, et. al. 1987). 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 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 square ft 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 deeper 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).

No well tests have been performed to evaluate the transmissivity of the surficial soil/sediments in the AOU-1 and ESS area.

4.4.5 Groundwater Velocity

Preliminary estimates of groundwater velocity for the deep unconfined aquifer range from 0.6 ft/d to 1.9 ft/d (MWH 2012). 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.

4.4.6 Vertical Hydraulic Conductivity

Groundwater moves downward in the primary and secondary recharge areas, from the source to the deep or shallow unconfined aquifers, where present, and ultimately to the deeper principal basin-fill aquifers. In locations where the shallow unconfined aquifer is 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).

4.4.7 Effects of Wasatch Fault on Groundwater Flow

The Wasatch Fault appears to have some influence on the hydraulic properties and flow for the ESS area. The ESS area lies between the East Bench Fault Segment and the East Bench Fault Spur (Figure 4-6). Although the hydraulic gradient in the shallow groundwater below the ESS area is same direction of regional flow (northeast to southwest), there is a steepening of the gradient in the center of the Site, where direct push refusal was encountered. Generally, groundwater flow is perpendicular to the fault.

Mapping of the potentiometric surface based on depth to groundwater data collected during the 2016 ESS groundwater study (EA 2016b) is consistent with studies that have concluded that it is unlikely the fault influences shallow groundwater flow through unconsolidated materials (UDEQ 2000). The Hydrogeological and Groundwater Model Summary Report for: Culinary Water Supply Protection Project at Salt Lake City's Drinking Water Well #18 (Also Referred to as the 500 South Well) (MWH 2012) also concluded that the Wasatch Fault was not modeled as a complete barrier-type boundary because pumps at SLC-18 produced a strong response at EPA-MW-01D, indicating a hydraulic connection between the two wells on either side of the fault. Groundwater data collected for the RI in 2016 in the ESS area provides consistent information; the East Bench Spur is not acting as a barrier to groundwater flow, which would cause smoothing or flattening of the potentiometric surface map (Figure 4-6).

Previous studies of the hydraulic gradient were conducted in 2012 and included aquifer testing of SLC-18. This test indicated that the East Bench Fault Spur, which has been mapped adjacent to SLC-18

(Personius and Scott 2009), is not a barrier to groundwater flow (MWH 2012). This interpretation is the result of a strong response recorded at EPA-MW-01D, 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. The groundwater relationship between the EPA monitoring wells, SLC-18, and the fault will be evaluated during the RI for OU-2.

4.4.8 Water Quality

In general, 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 their proximity to the land surface, and because they are 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 shallow and deep unconfined aquifers.

The chemical composition of groundwater in the Salt Lake Valley varies with location and depth, primarily due to quality of recharge sources and water-sediment interactions as it moves from recharge to discharge areas. Groundwater 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 because 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 near 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 (DO) 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 has neutral pH.

The USGS publication, Conceptual Understanding and Groundwater Quality of the Basin-Fill Aquifer in Salt Lake Valley, provides groundwater quality summary data for different parts of the Salt Lake Valley (Thiros 2010). For the east side of the Salt Lake Valley, Thiros states the following:

- Groundwater sampled from wells (5 wells) in the deeper unconfined basin-fill aquifer in the primary recharge area contains modern water and has median pH of 7.1, 7.4 mg/L DO, and 562 mg/L TDS concentrations.
- Groundwater sampled from wells (11 wells) in the shallow unconfined basin-fill aquifer in the secondary recharge area contains modern water and has a median pH of 7.3, 5.3 mg/L DO, and 414 mg/L TDS concentrations.

Groundwater sampled from wells (15 wells) in the deeper confined basin-fill aquifer in the secondary recharge area contains modern and mixed-age waters and has a median pH of 7.5, 5.8 mg/L DO, and 316 mg/L TDS concentrations.

Groundwater, surface water, and stormwater quality were evaluated as part of this RI and are discussed in Sections 5 and 6 of this RI report.

4.5 Surface Topography

The Site is located in a developed urban area. The topography of the area above and east of East High School (east side of AOU-1) 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 (Figure 4-5 and Figure 4-7) (EPA 2012a). The ground surface elevation at the VAMC, east of the AOU-1 area, is approximately 4,735 ft amsl; the approximate elevation of 1300 East, which runs parallel to the Wasatch Fault scarp in front of East High School, is 4,530 ft amsl; and the elevation of Artesian Well Park at 800 South and 500 East (also referred to as the 8th South Well) is approximately 4,261 ft amsl. The fault scarp that bisects the AOU-1 area from north to south is the defining topographic feature associated with the PCE plume (Figure 4-7).

4.6 Surface Water and Stormwater Hydrology

4.6.1 Red Butte Creek

The closest surface water body to AOU-1 is Red Butte Creek, located 1,500 ft to the southeast of the Site (Figure 4-7). Red Butte Creek flows west-southwest towards Liberty Park Pond where it is joined by Parley's Creek before continuing to the Jordan River.

The headwaters of Red Butte Creek are located in the Wasatch Range. Red Butte Creek is divided into two sub-watersheds, and the lower sub-watershed flows near AOU-1. The upper sub-watershed once served as the main water source for Fort Douglas, and the Army constructed the Red Butte reservoir in 1930 (University of Utah 2016). The upper sub-watershed is on U.S. Forest Service Land and is designated a Research Natural Area that is closed to public access. The water in the segment of Red Butte Creek is considered pristine (National Ecological Observatory Network [NEON] 2018). Red Butte Creek is no longer a source of drinking water for the Salt Lake City area (NEON 2018).

As Red Butte Creek exits the Wasatch Range through Red Butte Canyon, it enters the Salt Lake Valley. While the upper sub-watershed is undisturbed, the lower sub-watershed is within a fully-urbanized and flows through developed business and residential areas including the University of Utah campus, the VAMC, Sunnyside Park, and residential neighborhoods (University of Utah 2016). Surface exposure of Red Butte Creek terminates east of Liberty Park, and the creek is diverted underground into the 1300 South conduit where water is conveyed to the Jordan River via an underground pipe that is 3.4-miles long (Bio-West 2010). Water from Red Butte Creek support recreational areas such as the pond in Liberty Park (NEON 2018).

Red Butte Creek is classified as a perennial stream upgradient of the Red Butte Reservoir, with an average annual flow rate that ranges between 4.2 cubic ft per second (cfs) and 2 cfs (Bio-West 2010). Peak flow occurs in late April through June as a consequence of snow-melt (USGS 2010). Lower flow seasons are driven by groundwater infiltration (Ehleringer et al. 1992). Generally, in the summertime, stream flow is dominated by groundwater discharge which primarily enters the creek in the lower elevations (Ehleringer et al. 1992). Springtime flow in the creek is dominated by snow melt and run-off from the upper elevations. Significant fracturing in the bed rock of the upper elevations in Wasatch Range are believed to cause an increase in water loss to groundwater (Ehleringer et al. 1992). Red Butte Creek is a receptacle for surface water run-off in the general area (USGS 1975) via both direct run-off and storm sewer discharges.

4.6.2 Mount Olivet Reservoir

The Mount Olivet Reservoir is on the Mount Olivet Cemetery property, near the northeast corner of the cemetery adjacent to 500 South (Figure 4-7). The reservoir is supplied by diversions from Red Butte Creek and Emigration Creek and the Mount Olivet Cemetery irrigation well (FE 2015a). The diversion pipeline from the creek to the reservoir extends west-northwest along the southern and western edges of the VAMC.

4.6.3 Liberty Park Pond

The Liberty Park Pond is located in Liberty Park, Salt Lake City, downgradient and west of the AOU-1 area. 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 and the banks of Red Butte Creek (FE 2015a).

4.6.4 East Side Springs

Seeps and springs occur in abundance along the scarp of the Wasatch Fault in the AOU-1 area, but documentation of flow rates from these seeps and springs is generally absent. Many of these seeps and springs emerge as diffuse wet areas that form small trickling streams on slopes, while others have been altered by property owners to collect and channel flowing water into landscape features or into the street away from their homes. There are four named springs in the ESS area: 1) Our Lady of Lourdes Spring to the north-northwest just south of the Our Lady of Lourdes Catholic School and the Judge Memorial Catholic High School, 2) Benson Spring in the north central area of AOU-1, 3) Smith Spring which is central of the area on Alpine Place, and 4) Bowen Spring to the south (Figure 1-2 and 4-7).

A total of 33 seeps and springs were investigated during the AOU-1 RI, including the four springs identified above. Several of them are expressed as diffuse wet areas that form small trickling streams on slopes, while others have been altered by property owners to collect and channel flowing water into landscape features. More details on the locations and descriptions of these seeps and springs are described in Section 5.

4.6.5 Stormwater

Since ESS is developed as an urban area, stormwater run-off is managed via a stormwater system comprised of drains, culverts, and stormwater lines accessed through manholes. Seeps and springs in the ESS area provide the potential for groundwater expressed at the surface to run-off and end up in the stormwater system. A map of the stormwater network is provided in Figure 4-8. The stormwater network was sampled and evaluated as part of the surface water investigation in 2016. Details and results of this investigation are provided in Sections 5 and 6 of this RI Report.

4.7 Climatology

The Site is located in a semi-arid continental climate (Eubank and Brough 1979). This climate is defined by cold winters with highs in the 30s and 50s and warm summers with highs 80s and 90s (US Climate 2018). The following climate statistics were obtained from the U.S. Climate Data (US Climate 2018).

- January is the coldest month and July being the warmest.
- Data from a nearby Salt Lake City weather station indicates the average annual precipitation in the area is 18.58 inches per year with a normal monthly high of 2.32 inches in April and a normal monthly low of 0.59 inches in July.
- Average annual snowfall is 47 inches.

The winds in Salt Lake are predominantly from the southwest with a mean speed of 4 to 5 miles per hour. The next most common wind direction is from the north and northwest (Ashcroft et al. 1992).

4.8 Human Population and Ecology

AOU-1 is within a developed area, with well-established residential neighborhoods. The public land area near the AOU-1 area, as well as the public roads and alleys within AOU-1, are accessible to residents and visitors due to the location in an urban setting. Public parklands and publicly accessible school athletic fields are also present in the area. The residential areas where springs and seeps may discharge PCE and/or TCE-containing water are also readily accessible to residents and visitors.

4.8.1 Human Population

The ESS area is comprised of single family residential properties with several schools, churches, and small businesses located along the major streets. The few commercial operations near the residence include an auto repair shop/gasoline station (Craig’s Conoco), convenience store (7-Eleven), and coffee shop located near the intersections of 800 South and 900 South with 1300 East.

Residences in this area were developed beginning in the 1910s with most of the houses completed by the 1940s. Homes in this area range from small brick bungalows and wood frame cottages to large multi-story homes. Some homes are built into the steep hillsides of the fault scarp. Many of the homes, both large and small, have partially to wholly below-ground basements that are finished as living spaces. The homes are closely spaced, with typical lot sizes of 0.10 to 0.15 acres.

Prior to development, the land was open fields and farm land. AOU-1 is likely to remain under similar use conditions for the foreseeable future due to the well-established, stable neighborhoods, public and private schools, and the public parklands. A review of Salt Lake City Property Tax maps indicates that current land use within the vicinity is about 75 percent residential, five percent commercial, 10 percent public or private schools, and the remainder is publicly owned right of ways or parkland.

4.8.2 Ecology

The only areas near AOU-1 that remain in somewhat natural conditions are the streamside areas of Red Butte Creek just to the south of AOU-1, parts of the Dry Gulch in the eastern section of AOU-1, and several very small private woodland properties; however, even these areas have been modified by historic construction activities and the introduction of non-native species.

In 2010, Salt Lake City Department of Public Works conducted a stream corridor study to establish baseline riparian conditions of the lower sub-watershed of the Red Butte Creek and other stream within the City boundaries (Bio-West 2010). This study included a vegetation study of the riparian corridor and documented the presence of major vegetation species in the Red Butte Creek Area.

- The most common trees found along the streamside areas of Red Butte Creek are box elder (*Acer negundo),* cottonwood (*Populus* sp.), and Gambel oak (*Quercus gambelii)* dominant in undeveloped upper slope areas. Siberian elm (*Ulmus pumila*), an introduced invasive tree species, is also common. Russian olive (*Elaeagnus angustifolia)*, also an introduced invasive tree, is present but less prominent than the Siberian elm. Canopy tree cover is generally high, though it is markedly reduced in the lower urban reaches (Bio-West 2010).

- Common shrub species include Red osier dogwood (*Cornus sericea)*, twinberry honeysuckle (*Lonicera involucrate)*, and narrowleaf willow (*Salix exigua),* with Woods' rose (*Rosa woodsii)* which are both present on upper portions of slopes.

- The understory vegetation layer includes native species such as Western poison ivy (*Toxixodendron rydbergii)*, Virginia creeper (*Parthenocissus quinquefolia),* and field horsetail (*Equisetum arvense).* Introduced species such as ornamental English ivy (*Hedra helix)*, common periwinkle (*Vinca minor),* climbing nightshade (*Solanum dulcamara),* smooth brome (*Bromus inermis),* and lesser burdock (*Arctium minus)* are significant components of the understory cover in several reaches. In addition, the upper slope portions of some reaches contain the invasive species whitetop (*Cardaria draba)* and houndstongue (*Cynoglossum officinale)*.

The Utah Department of Natural Resources (UDNR), Division of Wildlife Resources maintains a sensitive species list, which includes "wildlife species that are federally listed, candidates for federal listing, or for which a conservation agreement is in place" (UDNR 2017). This list was updated in November 2017 and within Salt Lake County, identifies the presence of two Federally-listed or candidate species under the Endangered Species Act: the June Sucker (*Chasmistes liorus*) and "possibly" the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) (UDNR 2017). While these two species were identified in Salt Lake County, neither is near the AOU-1 area. The June Sucker is a United States Fish and Wildlife Service (USFWS) endangered species that was introduced into the reservoir in Red Butte Canyon by the Central Utah Water Conservancy District (NEON 2018). The Western Yellow-billed Cuckoo is USFWS threatened species. There was an unconfirmed sighting of this bird in 2011 near the Hogle Zoo (Utah Birds 2014).

Fish species were not identified in Lower Red Butte Creek by the Salt Lake County Watershed Planning and Restoration Program (Salt Lake County 2009) but the Utah Division of Wildlife Resources (UDWR) stocked the creek with Bonneville Cutthroat Trout in 2011, 2012, and 2014 (University of Utah 2016).

The Salt Lake City Riparian Corridor Study concluded that limited information was available about the wildlife of the urban lower portion of Red Butte Creek. Deer, raccoon, and skunk have been observed along the Lower Red Butte Creek. The Audubon Society's 2005 Christmas bird count indicated that over 30 species of birds were observed within the University of Utah survey area, which includes portions of the Lower Red Butte Creek riparian corridor (Bio-West 2010).

Although detailed ecological information is lacking for the Dry Gulch area and small pocket woodlands, these areas are expected to have flora and fauna generally similar to the Red Butte Creek stream banks and hillsides.

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-1 Surface Geology and Faults.mxd bpawling 6/5/2018

Legend

- Cross Sections
- Wasatch Fault line
- Approximate Occurrence of Springs (East Side Springs Area)
- Pre-RI Estimation of AOU-1

Geologic Units

Unit Symbol, Name, Age

Paleozoic Era

- Pz, Palezoic sedimentary rocks, Cambrian to Permian

Mesozoic Era

- Mz, Mesozoic sedimentary rocks, Triassic to Cretaceous

Cenozoic Era

Tertiary Period

- Tn, Tertiary sedimentary and volcanic rocks, Neogene
- Tp, Tertiary sedimentary and volcanic rocks, Paleogene

Quaternary Period (Pleistocene and Holocene deposits)

- 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
- af2, Fan alluvium 2, middle Holocene to uppermost Pleistocene
- af4, Fan alluvium 4, upper middle Pleistocene
- afb, Fan alluvium related to transgressive phase, upper Pleistocene
- ca, Colluvium and alluvium, undivided, Holocene to middle 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
- 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
- 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

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
PCE = tetrachloroethylene
RI = Remedial Investigation

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

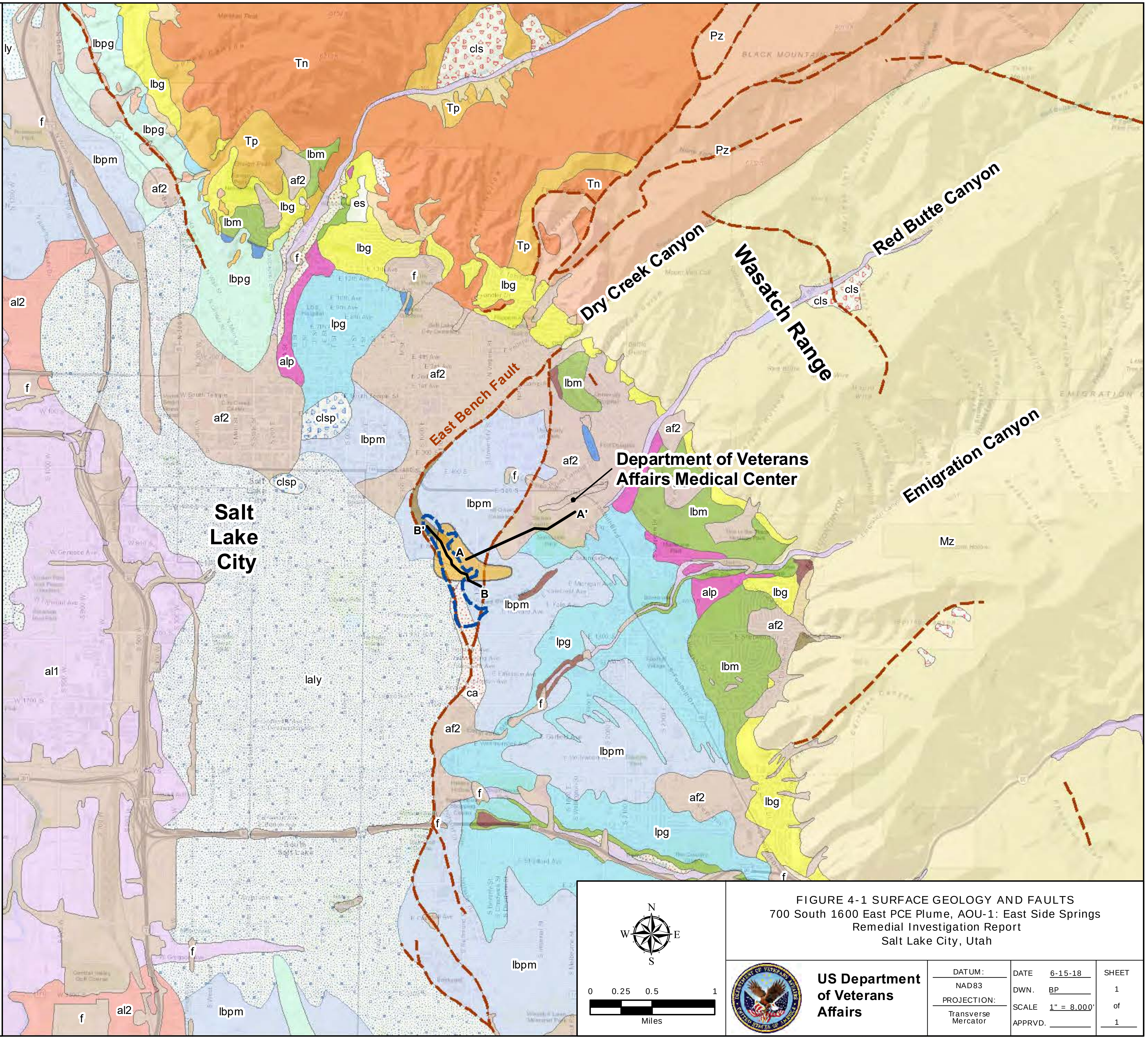
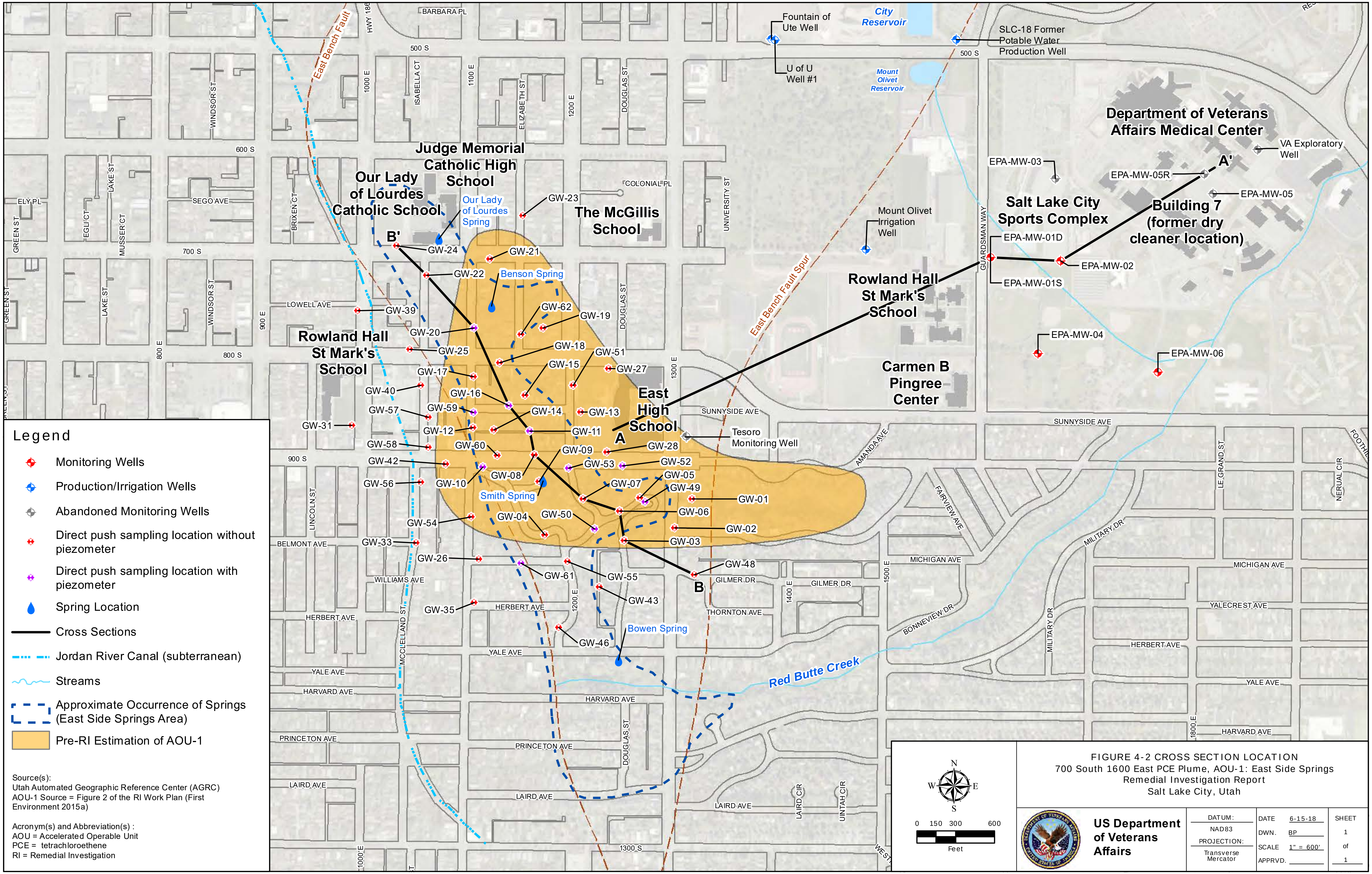


FIGURE 4-1 SURFACE GEOLOGY AND FAULTS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 6-15-18
DWN. BP
SCALE 1" = 8,000'
APPRVD.
SHEET 1 of 1



Legend

- 🔴 Monitoring Wells
- 🔵 Production/Irrigation Wells
- ⊕ Abandoned Monitoring Wells
- ◆ Direct push sampling location without piezometer
- ◆ Direct push sampling location with piezometer
- 💧 Spring Location
- ━ Cross Sections
- ┅ Jordan River Canal (subterranean)
- ～ Streams
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)
- 🟧 Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

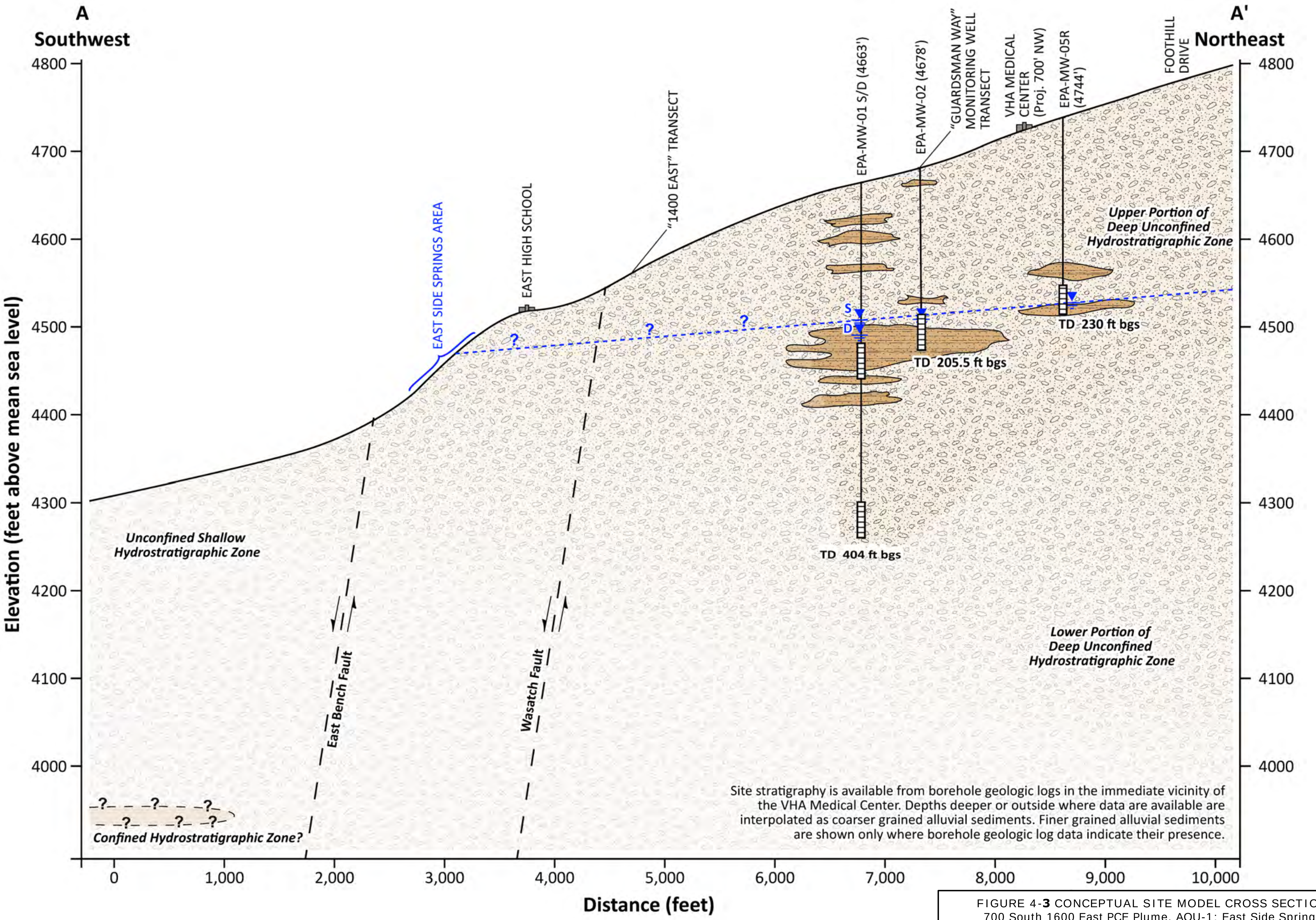
Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
PCE = tetrachloroethene
RI = Remedial Investigation

FIGURE 4-2 CROSS SECTION LOCATION
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:	NAD83
PROJECTION:	Transverse Mercator
DATE	6-15-18
DWN.	BP
SCALE	1" = 600'
APPRVD.	
SHEET	1 of 1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-2 Shallow Cross Section Location.mxd bpawling 6/8/2018



Site stratigraphy is available from borehole geologic logs in the immediate vicinity of the VHA Medical Center. Depths deeper or outside where data are available are interpolated as coarser grained alluvial sediments. Finer grained alluvial sediments are shown only where borehole geologic log data indicate their presence.

Legend

EPA monitoring well

Water Level

▨ Finer grained alluvial sediments classified as clay (CL), gravelly clay (GC), or sandy clay (SC)

▨ Coarser grained alluvial sediments

TD = total depth

ft bgs = feet below ground surface

? = Uncertainty

(4355') = Elevation in feet above mean sea level

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
EPA = Environmental Protection Agency
PCE = tetrachloroethene

100'
8X VERTICAL EXAGGERATION
800'
North

NOTES:

1. Water level data from April 2016 (EA 2017a).

FIGURE 4-**3** CONCEPTUAL SITE MODEL CROSS SECTION
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE 6-15-18	SHEET
PROJECTION: Transverse Mercator	DWN. BP	1
	SCALE	of
	APPRVD.	1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-2 Conceptual Site Model Cross Section.mxd eyan 3/12/2018

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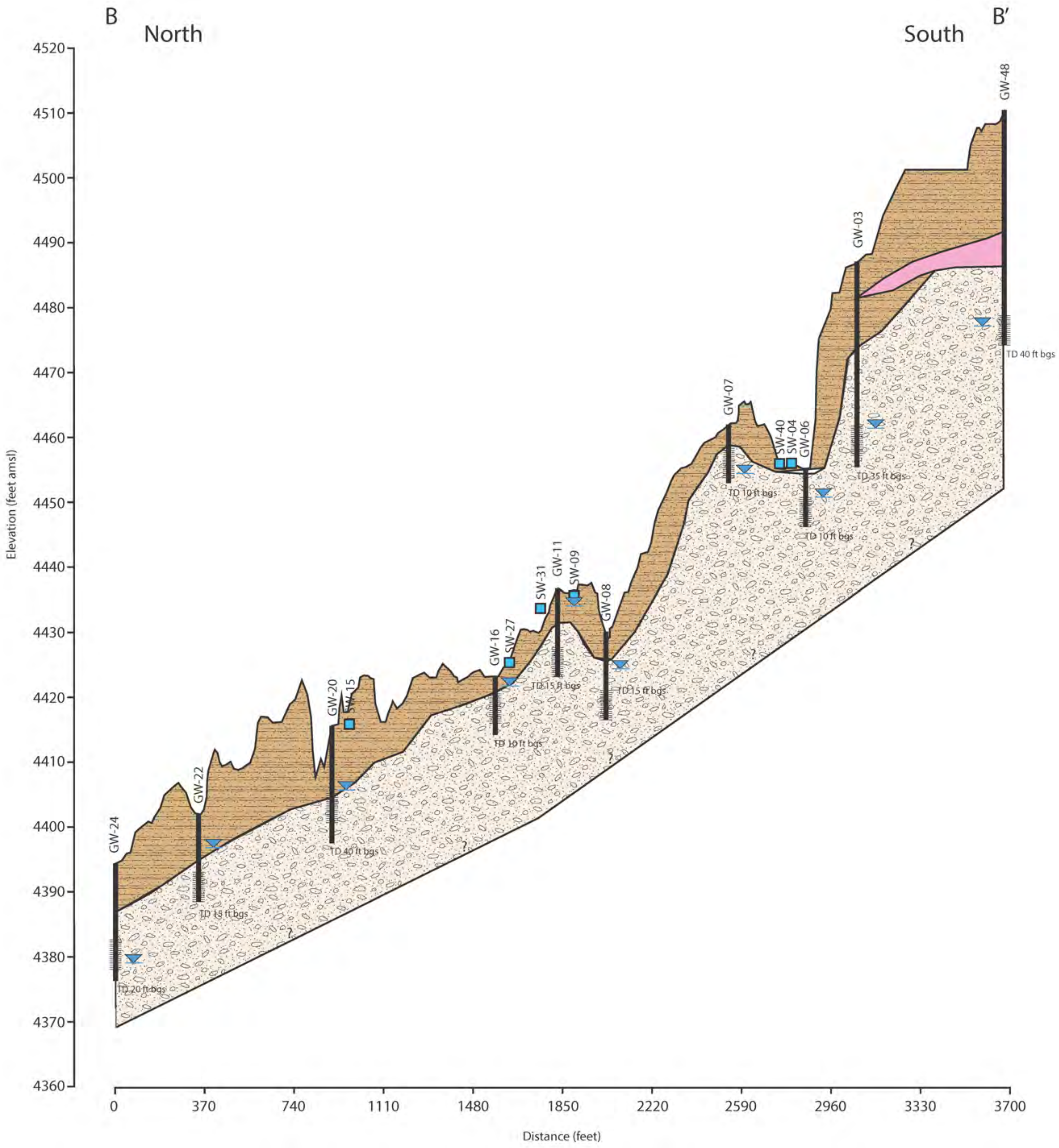
File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-4 East Side Springs Shallow Cross Section.mxd eyan 3/12/2018



Legend

- 🟦 Surface Water Sample
- ▽ Water Level
- ▨ Finer grained alluvial sediments classified as clay (CL), gravelly clay (GC), or sandy clay (SC)
- ▨ Coarser grained alluvial sediments
- 🟪 Pink Clay Deposits: Pink clay horizon found in wells GW-03 and GW-48

100'
8X
VERTICAL
EXAGGERATION
800'

AOU = Accelerated Operable Unit
PCE = Tetrachloroethene
TCE = Trichloroethene
DCE = cis-1,2-Dichloroethene
? = Uncertainty

Data collected from March 2016 to September 2016
(Section 6 Tables 6-16 to 6-18)

FIGURE 4-4 EAST SIDE SPRINGS SHALLOW CROSS SECTION
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:	DATE 6-15-18	SHEET
NAD83	DWN. BP	1
PROJECTION:	SCALE	of
Transverse Mercator	APPRVD.	1

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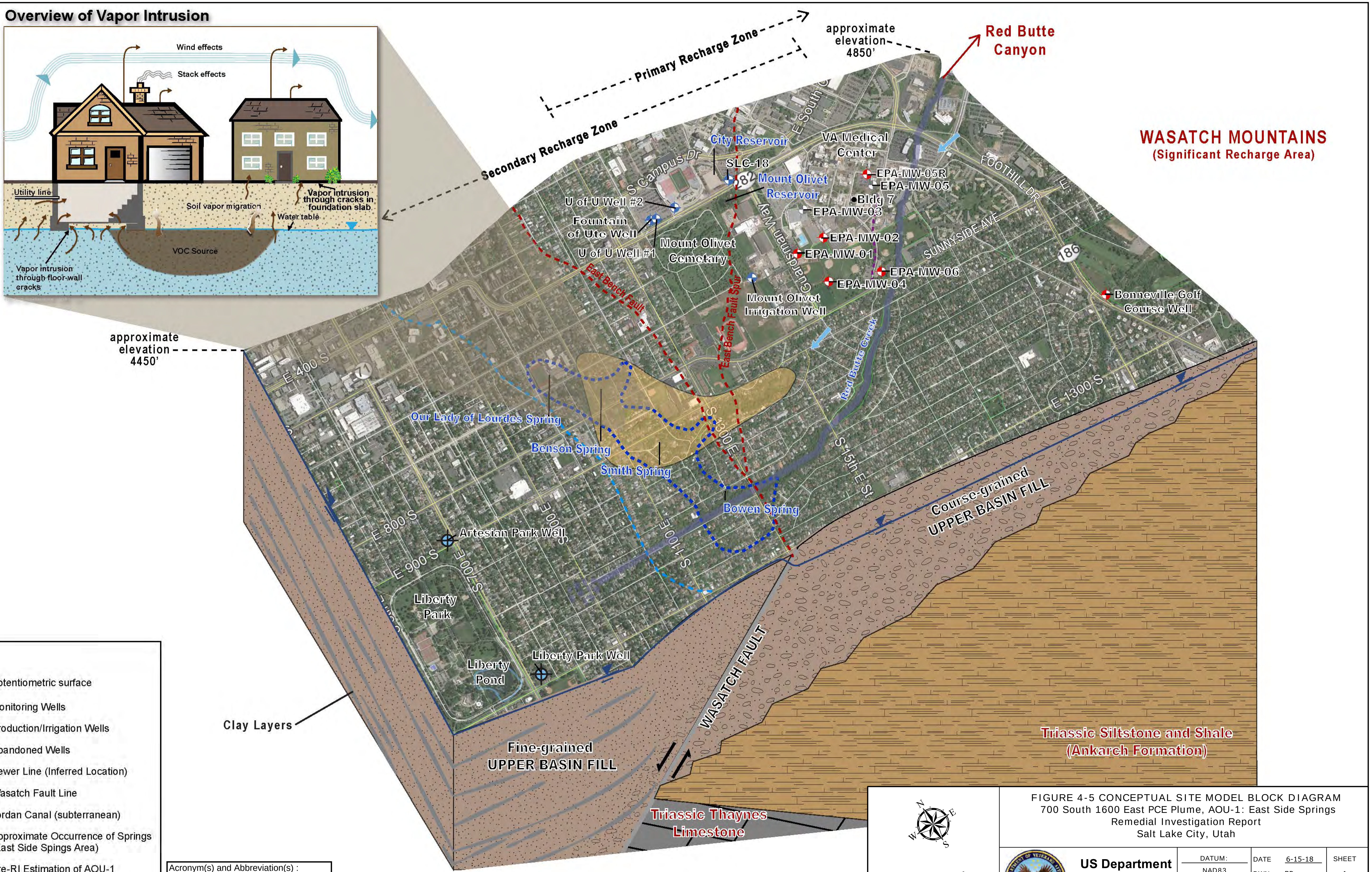

Legend

- Potentiometric surface
- Monitoring Wells
- Production/Irrigation Wells
- Abandoned Wells
- Sewer Line (Inferred Location)
- Wasatch Fault Line
- Jordan Canal (subterranean)
- Approximate Occurrence of Springs (East Side Spings Area)
- Pre-RI Estimation of AOU-1
- Approximate groundwater flow direction

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
PCE = tetrachloroethene
RI = Remedial Investigation

Not to Scale

FIGURE 4-5 CONCEPTUAL SITE MODEL BLOCK DIAGRAM
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 6-15-18
DWN. BP
SCALE NA
APPRVD.
SHEET 1 of 1

File: Denver EA \\lovetongis\gisdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-5 Conceptual Site Model Block Diagram.mxd eyan 3/12/2018

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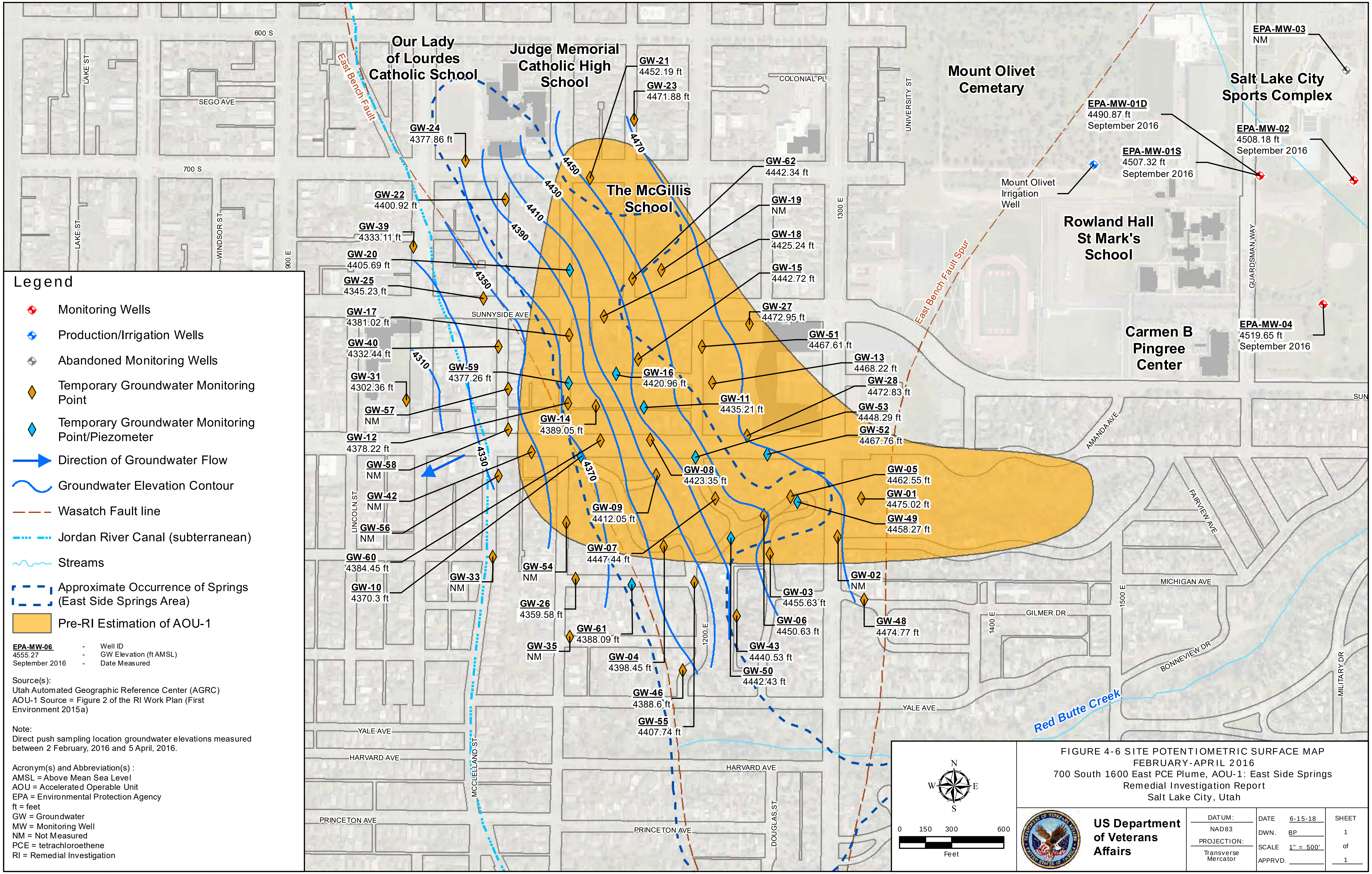

Legend

- ✦ Monitoring Wells
- ✦ Production/Irrigation Wells
- ✦ Abandoned Monitoring Wells
- ◆ Temporary Groundwater Monitoring Point
- ◆ Temporary Groundwater Monitoring Point/Piezometer
- → Direction of Groundwater Flow
- ⌒ Groundwater Elevation Contour
- - - Wasatch Fault line
- -·· Jordan River Canal (subterranean)
- ~ Streams
- - - Approximate Occurrence of Springs (East Side Springs Area)
- 🟧 Pre-RI Estimation of AOU-1

EPA-MW-06	-	Well ID
4555.27	-	GW Elevation (ft AMSL)
September 2016	-	Date Measured

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Note:
Direct push sampling location groundwater elevations measured between 2 February, 2016 and 5 April, 2016.

Acronym(s) and Abbreviation(s) :
AMSL = Above Mean Sea Level
AOU = Accelerated Operable Unit
EPA = Environmental Protection Agency
ft = feet
GW = Groundwater
MW = Monitoring Well
NM = Not Measured
PCE = tetrachloroethene
RI = Remedial Investigation

FIGURE 4-6 SITE POTENTIOMETRIC SURFACE MAP
FEBRUARY-APRIL 2016
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE	6-15-18	SHEET 1
PROJECTION: Transverse Mercator	DWN.	BP	of
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File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-6 Site Potentiometric Surface Map February-April 2016.mxd bpawling 6/8/2018

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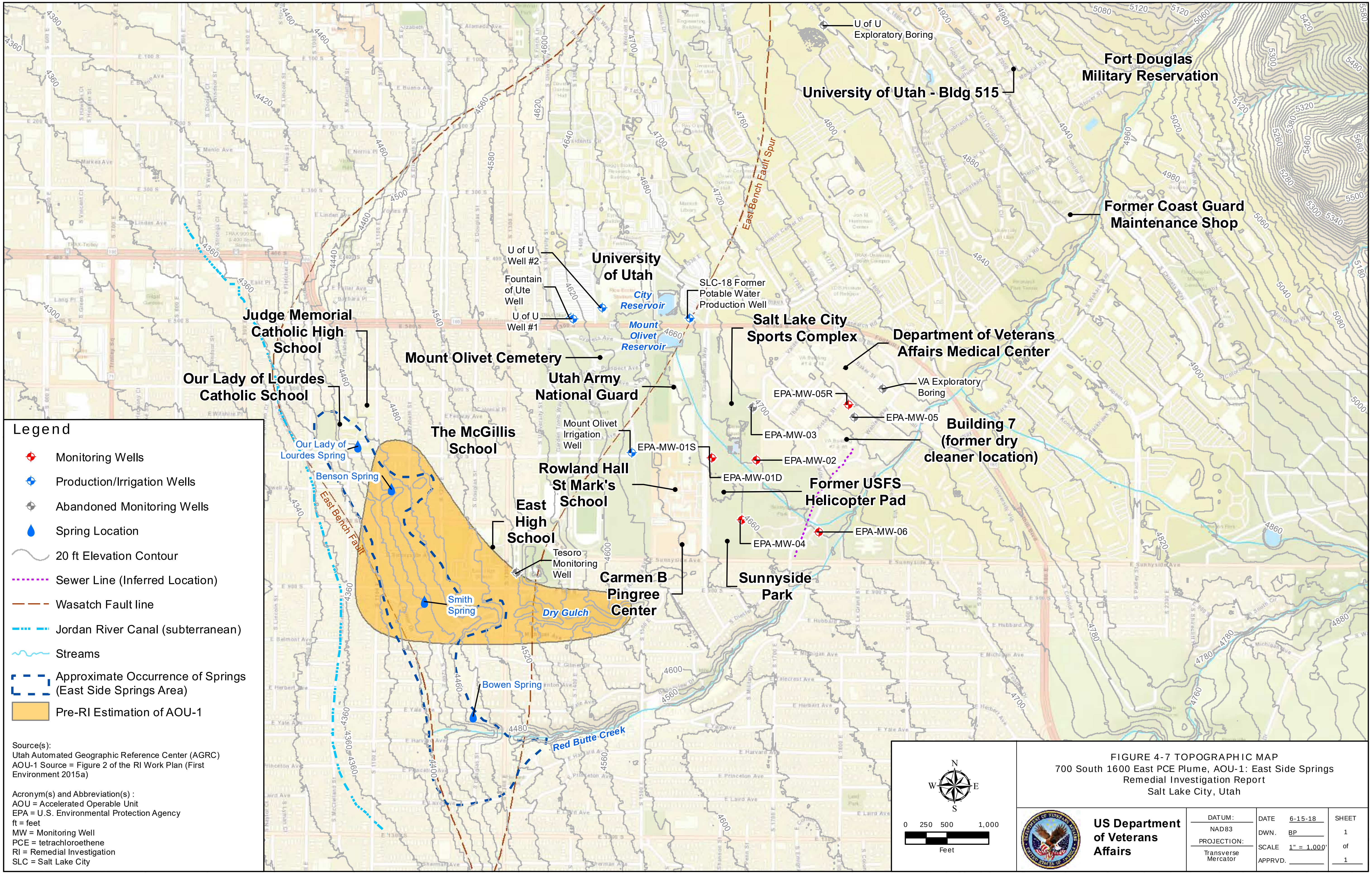

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
ft = feet
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation
SLC = Salt Lake City

FIGURE 4-7 TOPOGRAPHIC MAP
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
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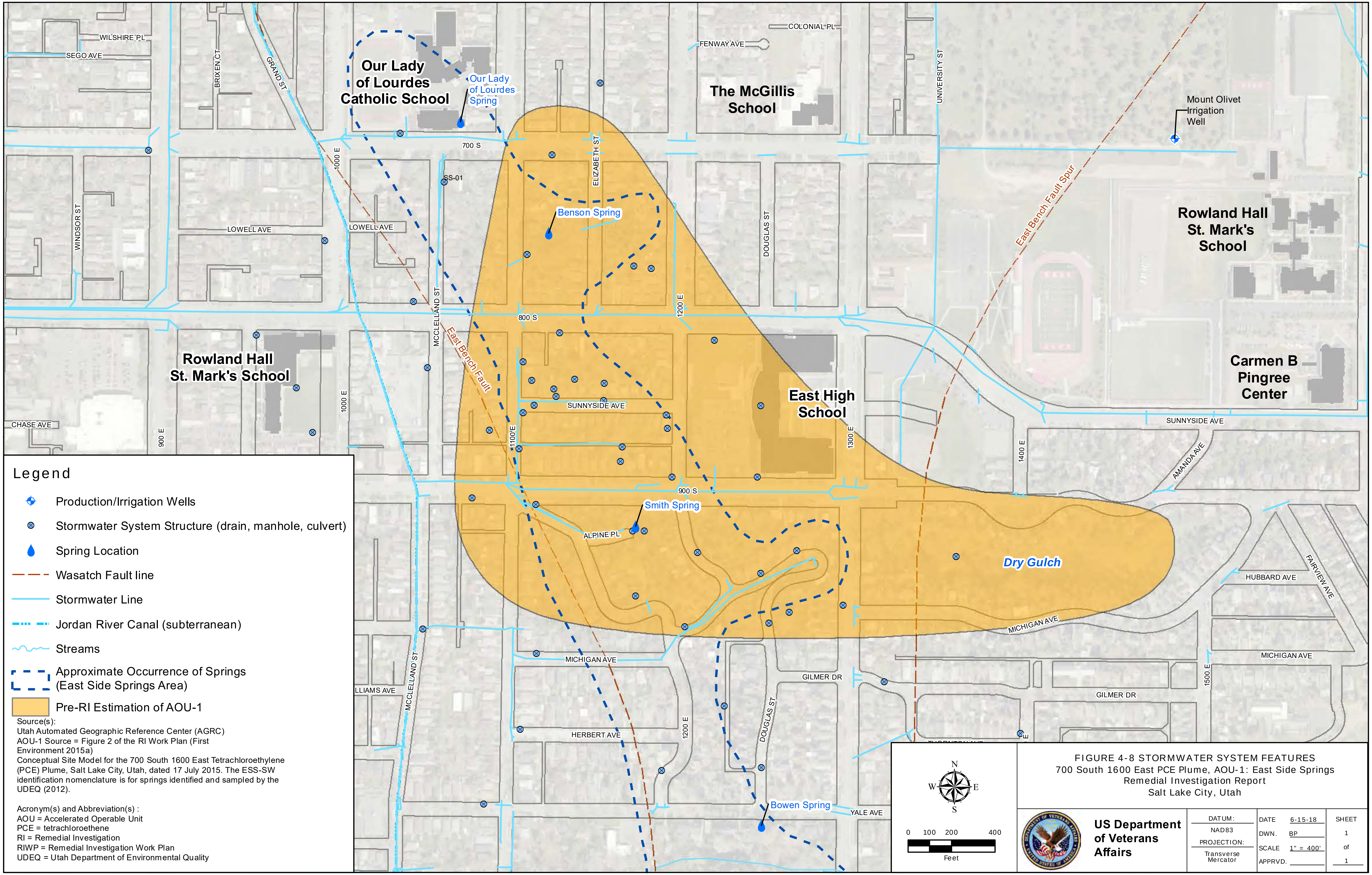

Legend

⌖	Production/Irrigation Wells
⊗	Stormwater System Structure (drain, manhole, culvert)
💧	Spring Location
— —	Wasatch Fault line
—	Stormwater Line
━ ┅ ━	Jordan River Canal (subterranean)
∿	Streams
⬚	Approximate Occurrence of Springs (East Side Springs Area)
🟧	Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)
Conceptual Site Model for the 700 South 1600 East Tetrachloroethylene (PCE) Plume, Salt Lake City, Utah, dated 17 July 2015. The ESS-SW identification nomenclature is for springs identified and sampled by the UDEQ (2012).

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
PCE = tetrachloroethene
RI = Remedial Investigation
RIWP = Remedial Investigation Work Plan
UDEQ = Utah Department of Environmental Quality

0 100 200 400
Feet

FIGURE 4-8 STORMWATER SYSTEM FEATURES
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator

DATE 6-15-18
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SCALE 1" = 400'
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File: \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 4-8 Stormwater System Feautures.mxd bpawling 6/8/2018 9:45:02 AM

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5.0 Remedial Investigation Field Activities

The purpose of this section is to describe the AOU-1 RI field activities. The collection of groundwater, surface water, stormwater, soil, indoor air, outdoor air, and soil gas samples was conducted in accordance with the RI Work Plan (FE 2015a) as amended by the following list of documents approved by VA, EPA, and UDEQ.

- Quality Assurance Project Plan (QAPP) Update Revision 1 (EA 2016c)
- QAPP Update Revision 2 (VA 2017)
- Errata sheets (EA 2016a,b)
- Minor Field Modifications (MFM), Numbers 1 through 18 (EA 2016d,e,f,g; EA 2017c)
- 2016 VI Sampling Plan for supplemental VI sampling (EA 2015c).

Results of the RI sampling are presented in Section 6.0.

5.1 Property Access and Owner Interviews

Prior to the start of field activities, property access agreements in the form of access permission forms were obtained by VA for sample locations that were on private property. VA sent access request letters to residents and organizations, including schools and owners of commercial buildings that agreed to participate in sampling events. These letters described the activities VA and its contractors would undertake to evaluate indoor and outdoor air, soil gas, soil, surface water, and groundwater for the presence of PCE. The letters also included questionnaires that 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. Questionnaires included information such as which products or chemicals were stored or in use at each residence, as well as resident activities that have the potential to impact indoor air VOC concentrations such as painting or bringing dry-cleaned garments into the home. Property owners received a second letter for authorizing VA and its contractors to collect environmental samples on their properties. VA and contractors visited property owners to identify and address, if possible, any concerns they might have and answer their questions before field work began. A summary of the residential parcels that were inspected for potential VI or surface water intrusion is included in Table 5-1 and a summary of the parcels for which property access agreements were obtained and the type of VI sampling conducted is included as Table 5-2.

For the installation of soil borings and temporary groundwater monitoring points in public right of ways, a “Permit to Work in the Public Way” was acquired from the Salt Lake City Division of Engineering prior to drilling. In accordance with the Permit, an assigned city inspector was contacted prior to commencing work and was updated regularly on the status of the project. The permit also specified that the permittee would restore all public way facilities modified by the permittee to a condition comparable to or better than the condition that existed prior to the commencement of the work. After installation, the assigned inspector deemed the final site conditions at all the boring locations to be acceptable and in compliance with Salt Lake City standards.

No permits were required to sample stormwater, but SLCDPU granted access to the municipal stormwater conveyance system. SLCDPU workers opened the stormwater sewer manholes for the contractor and closed them at the conclusion of sample collection.

5.2 Groundwater Investigation

To assess the nature and extent of PCOPCs in the portion of the Site that occurs within 50 ft of ground surface, temporary, small-diameter, groundwater monitoring points were installed throughout the ESS area of AOU-1. Information collected from these groundwater monitoring points was also used to better characterize the geology, hydrostratigraphy, and hydrogeology of the shallow aquifer. Temporary groundwater monitoring points were installed via a Geoprobe® rig. The maximum depth to groundwater encountered during the Geoprobe® investigation was at 37 ft bgs. Refusal was encountered due to cobblestone at six of the proposed groundwater locations prior to reaching the saturated interval so additional locations were identified. Groundwater sampling was conducted at the temporary well points from 22 February to 6 April 2016. Thirty-four of the temporary groundwater monitoring points were abandoned immediately after sampling and ten temporary monitoring points were left in place as piezometers to allow future groundwater sampling. Appendix B includes the construction logs for the 10 piezometers. The piezometers were sampled during two additional events: 11-12 July 2016 and 19-20 September 2016.

The AOU-1 shallow subsurface geology was better defined through the following activities including: collection of detailed lithology descriptions (Appendix B) during installation of Geoprobe® temporary well points; development of initial cross sections of the shallow AOU-1 subsurface stratigraphy (as presented in Section 4); determination of the thickness of the vadose zone in AOU-1 to the extent possible; and characterization of the vadose zone in AOU-1 to evaluate the local migration of PCE from the upgradient source area to groundwater discharging in seeps and springs to support evaluation of VI risk.

The Dry Gulch area on the eastern margin of AOU-1 is not currently known to contain seeps or springs. The RI activities for the Dry Gulch portion of AOU-1 assessed the depth of the gulch relative to the water table to determine whether any subsurface contaminants or surface water discharges related to the Plume could extend to that area. The only temporary groundwater monitoring point installed within the Dry Gulch was GW-01, with an approximate depth to water of 12 ft bgs.

5.2.1 Screening Samples

Groundwater samples for screening of contaminants were collected during the Geoprobe® investigation to direct the placement of temporary groundwater monitoring points. The screening results were utilized, in consultation with VA, to select placement of temporary groundwater monitoring points GW-27 through GW-62 (Figure 5-1). Temporary monitoring points were stepped out further from the ESS area if VOCs were detected, or stepped in if VOCs were not detected, in order to further delineate the PCE plume. Samples were collected in certified clean containers with appropriate preservative, as defined in the approved QAPP, and delivered to ALS Environmental in Salt Lake City for expedited analysis of a short list of VOCs, including the PCOPCs PCE, TCE, cis-1,2-DCE, and VC. Low groundwater yield at temporary groundwater monitoring points GW-07 and GW-17 did not provide enough sample volume for screening purposes. A summary of the screening groundwater sample results is included in Appendix I.

5.2.2 Temporary Groundwater Monitoring Point Installation

Blue Stakes of Utah was notified at least two full business days prior to any subsurface installations to allow utility companies to mark their lines. The Utah Division of Water Rights was notified prior to drilling temporary groundwater monitoring points to a depth greater than 30 ft via a Start Card. The official well driller's reports were filed with the Utah Division of Water Rights within 30 days of the completion of regulated work on the temporary groundwater monitoring points. The Start Cards and well driller's reports are included in Appendix C.

A total of 50 boring locations were drilled using a Geoprobe® 6620DT drill rig with 2.25-inch rods during the period of 22 February to 8 March 2016. Two of the 50 borings, GW-01 and GW-15, were installed manually via hand auger since the parcels were inaccessible to the drill rig. All 50 of these borings were drilled in either public right of ways, school property, or private property.

Because one of the purposes of this investigation was to better define the nature and extent of PCOPCs in the shallow aquifer that could contribute to VI, borings were drilled until the first saturated interval was encountered. Detailed lithologies were recorded on soil boring logs for 26 of the locations (boring locations GW-01 through GW-26) where PCE was previously detected above the screening level in indoor air samples and shallow groundwater, and at 50 percent of the remaining 24 boring locations. These boring logs are included in Appendix B.

Locations of the borings were selected as follows:

- The first 26 boring locations were positioned based on recommendations in the RI Work Plan (FE 2015a) to screen the area for the presence of chlorinated organic compounds and were either shifted to avoid underground utilities or to refine the resolution of groundwater concentrations within the area of detected PCE.

- The remaining 24 locations were positioned in order to determine the extent of the shallow PCE plume. Based on the first round of groundwater screening data, 12 of these borings were renumbered and repositioned in order to refine characterization of the PCE plume. When groundwater monitoring point locations not specified in the RI Work Plan were repositioned or not drilled, their associated location identifications were discarded and not used. The next sequential location identification was used for subsequent borings. Therefore, there are more than 60 groundwater location identification numbers (i.e., GW-62 etc.), but there are only 50 groundwater monitoring point locations.

Due to presence of gravel and cobbles at 6 of the 50 groundwater monitoring point locations (GW-02, GW-33, GW-35, GW- 42, GW-57, and GW-58), the direct push rig hit refusal prior to reaching groundwater. At these locations, no temporary groundwater monitoring points were installed, and the boreholes were backfilled with soil cuttings. At the remaining 44 locations, 34 of the temporary groundwater monitoring points were installed to allow groundwater sampling and abandoned immediately after, and the remaining 10 temporary monitoring points (GW-10, GW-11, GW-16, GW-20, GW-49, GW-50, GW-52, GW-53, GW-59, and GW-61) were left in place as piezometers for additional groundwater sampling in July and September 2016. The locations of the piezometers were selected based on the detection of PCOPCs in the groundwater screening samples, their spatial distribution within the PCE plume, and their groundwater recharge rates. Temporary groundwater monitoring point and piezometer locations are shown on Figure 5-1.

The temporary groundwater monitoring points were constructed of 3/4-inch diameter Schedule 40 polyvinyl chloride flush-thread-jointed casing and screen with polyvinyl chloride end caps. The temporary groundwater monitoring point screens were machine-slotted with a slot size of 0.010 inches and were 5 ft in length. The filter pack consisted of 10/20 silica sand that was poured into the annular space to approximately 1 ft above the top of the temporary groundwater monitoring point screen. After the filter pack was placed, approximately 1 ft of bentonite chips were placed in a similar manner on top of the sand pack and was allowed to hydrate naturally. The remaining borehole annular space was backfilled with soil cuttings. Individual temporary groundwater monitoring point construction details are summarized in Table 5-3.

5.2.3 Groundwater Sample Collection

Temporary groundwater monitoring points and piezometers were purged and sampled using a peristaltic pump with 3/8-inch diameter polyethylene tubing in accordance with the RI Work Plan (FE 2015a) and QAPP Update Revision 1 (EA 2016a). Low-flow purging and sampling techniques were utilized; however, depth to groundwater was not measured during purging due to the small diameter of the temporary groundwater monitoring points and piezometers precluding insertion of the water level indicator while tubing was in the piezometer. When the temporary groundwater monitoring points yielded insufficient water to pump or the groundwater depth was deeper than that of which a peristaltic pump could operate, a dedicated 1/2-inch diameter polyethylene bailer was used to purge and sample the temporary groundwater monitoring point.

During purging, water quality parameters (temperature, specific conductivity, DO, oxygen-reduction potential [ORP], pH, and turbidity) were measured using a portable water quality meter to characterize the geochemical conditions of the shallow saturated interval (Appendix I). Field data for pH was not collected at temporary groundwater monitoring points GW-23 and GW-39 due to a water quality meter malfunction. Purging was complete after the water quality parameters stabilized or if a minimum of three well volumes were removed. Details regarding the collection method, water quality measurements, and samples collected were recorded on groundwater sampling forms (Appendix C).

Once water quality parameters stabilized, or three well volumes of water had been purged from the temporary groundwater monitoring point, whichever occurred first, groundwater samples were collected for laboratory analysis in appropriate sample containers and preserved on ice. Three well volumes were not purged from wells that were pumped or bailed dry due to low recharge rates and were instead sampled after the groundwater recharged. Groundwater at 2 of the 44 temporary groundwater monitoring points (GW-19 and GW-54) did not recharge after purging; therefore, no groundwater samples were collected from these temporary groundwater monitoring points.

5.2.4 Laboratory Analysis

Groundwater samples for laboratory analysis were collected in certified clean containers in accordance with the approved QAPP with appropriate preservative and stored on ice for overnight transport to the laboratory. Sample chain-of-custody were recorded using the EPA SCRIBE® system for sample management and tracking. Groundwater samples were sent to the following list of laboratories for analysis:

<u>February/March 2016 Sampling Event</u>

- EPA Contract Laboratory Program (CLP) laboratory—Chemtech Consulting Group (Chemtech), Mountainside, New Jersey for analysis of VOCs, semi-volatile organic compounds (SVOCs), and total and dissolved metals in accordance with CLP method protocol
- EPA Region 8 laboratory—for analysis of anions, TDS, total alkalinity and pH
- EA Subcontract laboratory—ALS Environmental, Salt Lake City, Utah for analysis of total alkalinity.

July 2016 Sampling Event

- EPA CLP laboratory—Eurofins Spectrum Analytical, Inc. (Eurofins), North Kingston, Rhode Island for analysis of VOCs
- EPA CLP laboratory—ALS Environmental for analysis of total and dissolved metals
- EPA Region 8 laboratory—for analysis of anions, TDS, and total alkalinity (pH was measured in the field).

September 2016 Sampling Event

- EPA CLP laboratory—Chemtech for analysis of VOCs and SVOCs
- EPA CLP laboratory—Chemtex, Port Arthur, Texas for analysis of total and dissolved metals
- EPA Region 8 laboratory—for analysis of anions, TDS, and total alkalinity (pH was measured in the field).

In addition, groundwater samples were collected from GW-11 and GW-20 and analyzed for hydrogen and oxygen isotope ratios at the Stable Isotope Ratio Facility for Environmental Research (SIRFER) located at the University of Utah.

Samples were analyzed in accordance with the CLP Statement of Work for organic and inorganic methods (EPA 2015a,b) and EPA analytical methods as indicated below:

- VOCs—EPA CLP SOM02.3 (EPA 2015a)
- SVOCs—EPA CLP SOM02.3 (EPA 2015a)
- Target analyte list (TAL) metals (total and dissolved)—EPA CLP ISM02.3 (EPA 2015b)
- Anions (chloride, sulfate, nitrate/nitrite nitrogen)—EPA 300.0 (EPA 1993)
- TDS—EPA 160.1 (EPA 1983)
- Total alkalinity—EPA 310.1 (EPA 1983)
- pH—EPA 150.1 (EPA 1983).

A summary of the groundwater sampling and associated analyses is included in Table 5-4. Results of the data validation and data usability are summarized in Section 6 and included in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2016 Groundwater Data Validation Report *(*Appendix H-1*)*.

5.3 Surface Water and Stormwater Investigation

Collection of surface water samples from identified and accessible seeps, springs, sumps, and Red Butte Creek within AOU-1 was performed to assess the lateral extent of PCOPC contamination and evaluate potential risk from direct exposure. Several of the springs discharge to the municipal stormwater system; therefore, water samples were collected from selected Salt Lake City stormwater sewer manholes, located in and downgradient of AOU-1, to determine if groundwater seepage and discharge from foundation drains is conveying PCOPC-impacted water to stormwater lines. Surface water and stormwater samples were collected from 26 February to 11 May 2016.

The first 19 surface water and stormwater locations (SW-01 through SW-19) were placed based on recommendations in the RI Work Plan (FE 2015a) with minimum repositioning where seeps and springs were not present on the property, if access was not granted from property owners, or to fill data gaps. Surface water and stormwater sampling locations are presented on Table 5-5 and Table 5-6, respectively.

Surface water and stormwater samples for laboratory analysis were collected in certified clean containers in accordance with the approved QAPP, with appropriate preservative and stored on ice for transport to the laboratory. Sample chain-of-custody was recorded using the EPA SCRIBE® system for sample management and tracking. Surface water and stormwater samples were sent to EPA designated CLP laboratory (Chemtech) for analysis of VOCs in accordance with CLP method protocol. Samples from 20 percent of these locations were analyzed for SVOCs, TAL total metals, TDS, and anions (chloride, sulfate, nitrate/nitrite nitrogen) at the EPA CLP laboratory and the EPA Region 8 laboratory. The 20 percent of samples collected for additional analyses were selected without knowledge of analyte concentration (to mimic a random distribution of locations), but preference was given to surface water and stormwater locations that provided adequate sample volume for the additional sample containers. Ten percent confirmation splits of the surface water and stormwater samples were collected and shipped to two different CLP laboratories (Shealy Environmental Services and Bonner Analytical Testing Company) to be analyzed for VOCs, SVOCs, and TAL total metals for independent quality assurance (QA). Although MFMs 6 and 9 (EA 2016d,e) specified that up to 10 surface water samples would be collected for hydrogen and oxygen isotope ratio analysis at the University of Utah SIRFER, all surface water and stormwater samples were collected for possible isotope analysis and held in refrigerated storage pending review of other analytical data. Due to a malfunction of the sample storage refrigerator and the potential for isotopic fractionation, it was determined the isotope samples should be disposed of and not analyzed; samples for hydrogen and oxygen isotope ratio analysis will be collected again as part of the OU-2 investigation.

Samples were analyzed in accordance with the CLP Statement of Work for organic and inorganic methods (EPA 2015a,b) and EPA analytical methods as indicated below:

- VOCs—EPA CLP SOM02.3 (EPA 2015a)
- SVOCs—EPA CLP SOM02.3 (EPA 2015a)
- TAL Metals (total)—EPA CLP ISM02.3 (EPA 2015b)
- Anions (chloride, sulfate, nitrate/nitrite nitrogen)—EPA 300.0 (EPA 1993)
- Total dissolved solids—EPA 160.1 (EPA 1983)

A summary of the surface water and stormwater sampling and associated analyses is included in Table 5-7. Results of the data validation and data usability are summarized in Section 6 and included in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2016 Surface Water and Stormwater Data Validation Report (Appendix H-2).

5.3.1 Surface Water

Several seeps and springs in AOU-1 emerge as diffuse wet areas that form small trickling streams on slopes, while others have been altered by property owners to collect and channel flowing water into landscape features or into the street away from their homes. Sump pump discharge and foundation drain discharge identified at residences during the indoor air testing was also sampled. Surface water locations are shown on Figure 5-1. Surface water samples were collected in accordance with the RI Work Plan, QAPP Update Revision 1, and MFMs 16 and 17 to the RI Work Plan (FE 2015a; EA 2016c,f,g), using a peristaltic pump with three-eighths inch diameter polyethylene tubing, or as a grab sample by filling containers directly. Prior to collecting a sample, water quality parameters (temperature, specific conductivity, DO, ORP, pH, and turbidity) were measured using a portable water quality meter (Appendix D). Details regarding the collection method, water quality measurements, and samples collected were recorded on surface water sampling forms (Appendix D). Table 5-5 summarizes the type of surface water that was sampled.

5.3.2 Stormwater and Diverted Spring Water

Stormwater sample locations consisted of mitigated spring water storm drains (diverted spring water), Salt Lake City stormwater lines, and the Jordan and Salt Lake City Canal. Stormwater locations are shown on Figure 5-1. Stormwater samples were collected at least 24 hours after a precipitation event to ensure that stormwater collected was primarily from diverted spring water and not rainwater or runoff. Stormwater samples were also collected using a peristaltic pump with three-eighths inch diameter polyethylene tubing. Prior to collecting a sample, water quality parameters (temperature, specific conductivity, DO, ORP, pH, and turbidity) were measured using a portable water quality meter (Appendix H-2). Details regarding the collection method, water quality measurements, and samples collected were recorded on stormwater sampling forms. Table 5-6 summarizes the type of stormwater that was sampled.

5.4 Soil Investigation

Three surface soil samples were collected 3-4 May 2016 from the 0 to 0.5-ft interval at locations adjacent to seeps or springs where surface water samples were also collected. Two of the soil samples, SS-09 (adjacent to SW-09) and SS-26 (adjacent to SW-26), were collected at locations where shallow groundwater samples exhibited PCE concentrations along Sunnyside Avenue. The third soil sample, SS-01 (adjacent to SW-01), was collected at a location where PCE was not detected in the shallow groundwater sample. Soil sampling locations are presented on Figure 5-1 and Table 5-8.

Surface soil samples were collected using dedicated stainless-steel spoons. The soil aliquots were homogenized in dedicated stainless-steel bowls for SVOC and metals analyses while the aliquot for VOC analysis was not homogenized in order to prevent volatilization. VOC samples were collected using 5-gram core samplers.

Soil samples were collected in certified clean containers in accordance with the approved QAPP and preserved on ice. Soil samples were shipped overnight to the EPA-designated CLP laboratory, Chemtech. Sample chain-of-custody was recorded using the EPA SCRIBE® system for sample management and tracking. Samples were analyzed in accordance with the CLP Statement of Work for organic and inorganic methods (EPA 2015a, 2015b). Samples were analyzed for the following list of analytical parameters:

- VOCs—EPA CLP SOM02.3 (EPA 2015a)
- SVOCs—EPA CLP SOM02.3 (EPA 2015a)
- TAL Metals (excluding cations)—EPA CLP ISM02.2 (EPA 2014a).

A summary of the soil sampling locations and analytical requirements is presented in Table 5-9. Results of the data validation and data usability are summarized in Section 6 and included in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2016 Soil Data Validation Report *(*Appendix H-3*)*.

5.5 Vapor Intrusion Investigation

VI investigations were conducted within AOU-1 in multiple field efforts during the period of 2015 through 2017. Structures in which VI sampling was conducted between 2015 and 2017, and the type of samples collected (i.e., indoor air, outdoor air, or soil gas), are presented on Figure 5-4 and Table 5-10.

The 2015 VI investigation activities were initiated in January 2015 and completed in April 2015 and was a broad sampling effort that included areas where previous surface water sampling indicated the presence of PCE contamination and other locations where property owners agreed to indoor air sampling. The 2015 VI investigations were conducted at 36 structures consisting of private residences, schools, and public buildings. However, due to inconsistencies in field and analytical laboratory documentation associated with the 2015 VI field investigations, not all of the data collected in 2015 was deemed usable to achieve project objectives. Table 5-11 shows where usable versus unusable data was collected in 2015. This is further discussed in Section 5.5.2 and in the 2015/2016 TO-15 Data Validation Report Addendum Technical Memorandum (Appendix H). The 2015 VI data, combined with AOU-1 hydrogeological data, facilitated the delineation of a focus area for a 2016 VI investigation and supplemental VI investigation conducted in 2017.

The 2016 VI investigation activities were conducted from February to June 2016 and targeted a portion of AOU-1 with a higher potential for VI to result in indoor air concentrations above the RBSLs. The 2016 investigation targeted 16 residential structures and one public structure (East High School) within the focus area to support preparation of the RI report, help refine the conceptual model for VI within AOU-1, evaluate potential risk and to focus future monitoring (Table 5-12). The 2016 investigation included re-sampling of 5 residences previously sampled in 2015 to assess temporal variability in potentially VI-related indoor air PCE concentrations; sampling of 10 new residences and East High School to gain additional knowledge of the spatial extent of VI-related impacts associated with AOU-1 groundwater; and sampling at 3 residences to monitor for VC. Sampling for VC was to support the previous sampling because it was determined in 2015 that the HAPSITE® could not reliably detect VC at the risk screening level.

In March and April 2017, a supplemental VI investigation was performed at 7 new residential structures located in areas that had not been previously sampled to enhance the spatial data distribution for AOU-1 and 11 previously sampled residences to address data gaps from the indoor air and soil gas sampling conducted in 2015 and 2016 (Table 5-13).

Table 5-10 lists structures were the VI investigations were conducted to obtain information on the indoor air, outdoor air, and soil gas, for the AOU-1 RI. Table 5-10 and Figure 5-2 identify where HAPSITE® data was collected that met quality requirements and was usable for qualitative and screening information. Table 5-10 and Figure 5-3 identify where air samples were collected using SUMMA® canisters for laboratory analysis per EPA Method TO-15. These usable EPA Method TO-15 analytical results, collected during the 2015–2017 VI investigations were used to update the conceptual site model describing the nature, extent, fate, and transport of PCOPCs associated with the PCE plume, specifically with respect to the potential for impacts to indoor air through the subsurface-to-indoor-air VI pathway, described in detail in Section 8, and to assess potential human health risks, described in Section 9.

5.5.1 Vapor Intrusion Sampling Protocol

The VI pathway was assessed through collection of indoor air, outdoor air, and soil gas samples using a combination of real-time VOC screening and characterization via field portable gas chromatograph/mass spectrometer instrumentation (HAPSITE®) and collection of time-weighted confirmatory samples with SUMMA® canisters for laboratory analysis of VOCs in accordance with EPA Method TO-15 (EPA 1999). Field screening using the HAPSITE® achieved detection limits in the low ppbv for target PCOPCs (PCE, TCE, cis-1,2-DCE). Real-time HAPSITE® screening was used to screen indoor air, outdoor ambient air, and soil gas against RBSLs and RALs for PCE and TCE. Indoor air confirmation sampling and laboratory analysis performed using SUMMA® canisters and EPA Method TO-15 analysis was conducted to confirm real-time results and to provide data for human health risk assessment. The VI investigational approach for AOU-1 was consistent with CERCLA and NCP requirements as described in the Interim-Final Guidance for Conducting RIs and Feasibility Studies under CERCLA (EPA 1988). The specified VI field sampling activities were conducted in accordance with the Protocol for Performing Indoor Air and Near-slab Soil Gas Assessments and MFM-01, Appendices H and K of the RI Work Plan (FE 2015a).

A summary of the steps included in the Full VI Protocol is presented below. All or partial steps of this protocol were performed during the 2015–2017 VI field investigations, depending on the purpose for the data collection activities and subsequent use of the data. Implementation of only certain steps of the protocol is referred to in this report as the Limited VI Protocol. In addition, as noted in Section 5.5, although the protocols were implemented as described below, some resulting data was deemed not usable for the RI as presented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2015/2016 TO-15 Data Validation Report Addendum Technical Memorandum (Appendix H-6) and are therefore not presented in the data tables included in this report.

1. **Survey of indoor air VOC concentrations/identification of interior background sources** – an interview with the occupant to identify potential VOC sources in the structure was performed. Testing in each room (or groups of room openly connected) by walking through the structure using the HAPSITE® in survey mode to identify the presence of elevated VOC concentrations was performed. Based on the initial results, additional localized testing was conducted (e.g., in subareas of rooms) to identify and record locations of interior background sources. This method was modified in accordance with MFM-01 and initial surveys conducted after 5 February 2015 were conducted in the quantitative mode rather than the survey mode. If VOCs were detected in the quantitative mode, the survey mode was than utilized to determine if the VOCs were attributable to a background source or potential VI as noted below. If background sources were found, the resident was requested to relocate the material from the structure and the screening was re-performed.

2. **Indoor air characterization (ambient and negative pressure)** – real-time assessment using HAPSITE® screening in quantitative/analysis mode to identify and quantitate target cVOCs, (PCE, TCE, and cis-1,2-DCE) in indoor air under ambient conditions and induced negative and positive pressures (pressure cycling) was performed. Three targeted differential pressures (-5, -10 and 5 pascals [Pa]) were achieved during pressure cycling. Approximately 2.5 air volumes were exchanged during each pressure step. Real-time indoor air samples during ambient characterization and pressure cycling were collected within in the breathing zone (3 to 5 ft above the floor) within the basement and living areas. If the structure was divided into discrete areas, the portion of the building interior identified as having the greatest potential for VI was placed under negative pressure. Continuous quantitative sampling was conducted during initial depressurization, followed by quantitative sampling using the HAPSITE® on all other floors while the building was under negative pressure.

3. **Positive Pressure Real Time Quantitative Sampling** – after negative pressure testing, the building was placed under positive pressure and continuous quantitative sampling was conducted using the HAPSITE® in the same locations that negative pressure sampling was conducted. If the structure was divided into discrete areas, the same portion of the interior where depressurization was previously performed was placed under positive pressure. The same sampling procedures were used as those used during the negative depressurization.

4. **Indoor air verification** – indoor air sampling was performed using SUMMA® canisters equipped with flow regulators to collect 24-hour time-averaged samples in structures where concentrations of the PCOPCs exceeded the Regional Screening Levels (RSLs) during the

previous steps. Samples were analyzed at the laboratory using EPA Method TO-15 and TO-15 selective ion monitoring (SIM) as appropriate to achieve project reporting limits.

5. **Ambient outdoor (background) samples** – outdoor air samples were also collected concurrent with the indoor air monitoring activities at an upwind location adjacent to the structure using the HAPSITE® in quantitative mode to identify presence of target VOCs.

6. **Near-slab soil gas characterization** – soil gas sampling was conducted concurrently with the indoor air characterization to identify and characterize cVOCs present in soils adjacent to tested structures. Soil vapor probes are driven adjacent to the structure foundation to a depth approximately 6 inches below the base of the foundation or to the top of the water table, whichever occurred first. Samples were collected with a vacuum pump and Tedlar® bags then field-screened with a photoionization detector (PID) and multigas meter for detections of VOCs. A second sample was collected in the same manner from the same location and screened using the HAPSITE® in quantitative mode to quantify soil gas cVOC concentrations. At locations where groundwater was not encountered at the base of the foundation, the probe rod was driven another 5 ft after the initial sample is collected, if soil conditions allow, to obtain another sample for soil gas vertical delineation data.

7. **Near-slab soil gas** characterization verification - soil gas samples were collected in SUMMA® canisters and analyzed at the laboratory using EPA Method TO-15, at locations where soil gas characterization samples exceed the PCE screening level or where other detected VOCs in soil gas were found to exceed 10 times the RSL. Additional samples were collected where VOCs were not detected using HAPSITE® screening to confirm non-detect results.

8. **Open-field soil gas** – collected concurrent or immediately following the initial indoor air quality characterization steps and near-slab soil gas characterization. Soil vapor sampling points are installed in the vadose zone near historically cVOC-impacted seeps and springs and in selected locations adjacent to streets/sidewalks (open field samples) in AOU-1. The samples are collected in Tedlar® bags for HAPSITE® screening for cVOCs. Additional open-field soil gas samples may be collected for EPA Method TO-15 analysis as deemed necessary.

5.5.2 2015 Vapor Intrusion Sampling and Analysis Activities

Initial VI investigation activities were conducted within AOU-1 from 13 January to 14 April 2015 at 36 structures and multiple locations within each structure. However, based on a data assessment evaluation for usability, it was determined that the HAPSITE® real-time screening data was still usable for its intended purpose (as screening data to determine whether PCOPC concentrations exceeded the RBSLs). The data was reviewed qualitatively, and some locations were targeted for sampling in subsequent mobilizations to obtain usable data (meeting data quality objectives [DQOs]) as indicated in Tables 5-12 and 5-13. Valid usable EPA Method TO-15 data for risk assessment is only available for 5 of the 36 structures sampled in 2015. The 5 structures are private residences (locations 0003-H, 0008-H, 0026-H, 0030-H and 0036-H). The list of structures sampled during the 2015 field effort is presented in Table 5-11 and the 5 structures where usable EPA Method TO-15 data were collected are identified.

The structures for the 2015 VI sampling were selected by VA from owners that voluntarily requested testing at public outreach meetings in 2014 and from subsequent volunteers that came forward after commencement of the 2015 field activities. The Full VI Protocol defined in Appendix H of the RI Work Plan, as amended by MFM-01 and summarized above, was utilized for the 2015 VI investigation. The five structures were screened using the VI screening protocol including sampling of indoor air under ambient, negative and positive pressure conditions; outdoor ambient air, near-slab and open field soil gas. Field screening results that exceeded the risk screening levels for PCE or TCE were subject to confirmation sampling and submitted for laboratory analysis of VOCs using EPA Method TO-15. Cis-1,2-DCE was also included in the field screening; however, there are no EPA RSLs for this VOC. Although VC was to be included in the field screening, it was determined prior to the start of field sampling that the HAPSITE® could not reliably detect VC at the risk screening level so VC was confirmed using EPA Method TO-15 laboratory analysis. Provisions for collection of additional SUMMA® canisters for EPA Method TO-15 analysis specifically to assess VC were developed to ensure the HAPSITE® detection level did not compromise the objectives of the AOU-1 RI. MFM-02 (Appendix L of FE 2015a) indicated samples would be collected where groundwater was within 10 to 20 ft bgs, as follows:

1. One sample outside the plume where PCE, TCE, and cis-1,2-DCE in the indoor air are below the RBSLs or the detection limit of the HAPSITE® instrument.

2. Three samples inside the area of the plume where PCE and TCE are equal to or less than their respective risk screening levels, but above the instrument detection limits.

Data were used to confirm the absence of VC, and if VC was not present, non-detect HAPSITE® data for VC would be considered representative. The sample collected in 2015 from location 0003-H was determined to have met the first criterion. Samples collected in 2016 (see Section 5.5.3) met the second criterion. The EPA Method TO-15 sample results confirmed the absence of VC.

5.5.2.1 Vapor Intrusion HAPSITE® Screening

The 2015 VI investigation included HAPSITE® screening for indoor air, outdoor ambient air, and near-slab soil gas samples. Due to inconsistencies with the field sampling documentation and associated field files it was determined through a data assessment evaluation that 2015 HAPSITE® screening data does not meet DQOs; however, the 2015 HAPSITE® data was usable for its intended purpose as screening data to determine whether PCOPC concentrations exceeded the RBSL. The data was not used for quantitative evaluation or in the risk assessment. However, the data was used to provide qualitative information about the sampling structures. For example, some locations were targeted for additional sampling in subsequent mobilizations to verify HAPSITE® real-time detections or non-detections of PCOPCs as indicated in Table 5-12. Additional details regarding the unusable sample data is presented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2015/2016 TO-15 Data Validation Report Addendum Technical Memorandum (Appendix H-6). For reference purposes only, Table 5-11 lists the structures where 2015 HAPSITE® screening was conducted and the specific location where that screening was conducted (e.g., indoors, outdoors, or soil gas). Figure 5-2 shows locations where accepted HAPSITE® screening data was obtained during the RI, but none of the 2015 HAPSITE® screening data is shown on this figure because it does not meet DQOs. Field documentation for the 2015 VI investigation activities and data collection is presented in Appendix E.

5.5.2.2 Vapor Intrusion SUMMA® Canister Sampling

As described above, selection of locations for SUMMA® canister sampling was informed by the qualitative review of HAPSITE® field screening results to identify potential structures for sampling, based on the reported presence, or absence, of PCE and TCE. EPA has no established RSL for cis-1,2-DCE, and therefore no RBSLs or RALs are identified. The RBSLs and RALs for indoor air were originally identified in the Vapor Intrusion Screening Levels and Removal Action Levels technical memorandum included in Appendix F of the RI Work Plan (FE 2015a) and approved by EPA and UDEQ. These same values are presented in Table 3-6. Sites with HAPSITE® screening results for PCE or TCE above the RBSLs and/or RALs (Table 3-6) were subject to further confirmation sampling using SUMMA® canisters and EPA Method TO-15 laboratory analysis as described in the following subsections. SUMMA® canister samples were also collected to further verify screening accuracy at 11 locations where screening results were below the RBSLs, and to collect VC data. Table 5-11 identifies structures where SUMMA® canister samples were collected, the specific location of the sample (i.e., indoor air, soil gas, or outdoor air), the objective of the intended sample, and which of the EPA Method TO-15 analytical results are valid for use. Figure 5-3 shows the locations were usable EPA Method TO-15 data was obtained.

The confirmatory samples were collected using laboratory supplied stainless steel SUMMA® canisters and analyzed for VOCs by a State of Utah certified laboratory using EPA Method TO-15. In addition to the EPA Method TO-15 analyses, a total of six samples from three sites were also selected for SVOC sample collection using polyurethane foam sorbent tubes and analyzed using EPA Method TO-13A. However, as a result of the field and laboratory documentation discrepancies, the TO-13A data was deemed not usable to achieve project objectives and is not presented in this report.

5.5.2.3 Indoor Air TO-15 Investigation

As explained above, confirmatory samples for EPA Method TO-15 laboratory analysis were collected to further evaluate indoor air quality at sites where the HAPSITE® results exceeded the indoor air screening levels for PCE and/or TCE. EPA Method TO-15 data collected at 5 structures (0003-H, 0008-H, 0026-H, 0030-H and 0036-H) is usable data to support the RI (Table 5-11). Samples were also collected to confirm concentrations of VC in indoor air at 4 of these 5 structures (0003-H, 0008-H, 0026-H, 0030-H) (Table 5-11). Finally, additional confirmatory samples were collected at 4 of the 5 locations where screening results were below the RBSLs to further verify screening accuracy (0008-H, 0026-H, 0030-H and 0036-H) (Table 5-11, Figure 5-3). Concurrent measurements for differential air pressure (inside and outside) were taken during collection of confirmatory samples, to assure samples were representative of conditions that create VI.

5.5.2.4 Outdoor Ambient Air Investigation

To identify the outdoor presence of target VOCs, ambient outdoor (background) air was assessed using the HAPSITE® in analyze mode, at upwind locations adjacent to all but two of the structures that were evaluated in 2015 (Table 5-11). Following the outdoor HAPSITE® screening, SUMMA® canister samples were collected at six locations. The EPA Method TO-15 data for 2 of these 6 locations is deemed to be valid to achieve project objectives (0026-H and 0030-H) (Table 5-11, Figure 5-3).

5.5.2.5 Near-Slab Soil Gas Investigation

Near-slab soil gas characterization was implemented concurrently with the indoor air characterization. Soil vapor probes were driven adjacent to the structure foundation to a depth of approximately 6 inches below the base of the foundation or to the top of the water table, whichever occurred first. Samples were collected with a peristaltic pump and Tedlar® bags, field-screened with a PID and multigas meter. Then, a second sample was collected in the same manner and field-screened in real-time with the HAPSITE® in analyze mode to identify and quantify PCE, TCE, and cis-1,2-DCE present in soil pore space adjacent to structures. At locations where groundwater was not encountered, the probe rod was driven another 5 ft, if soil conditions allowed, and the sampling process repeated to obtain vertical delineation data for soil gas.

For characterization verification, soil gas samples were collected in SUMMA® canisters and submitted for EPA Method TO-15 analysis at near-slab locations adjacent to structures where indoor air HAPSITE® screening results exceeded RBSLs or where soil gas vapors were found to be elevated 10 times the RBSL for the detected VOC. Soil gas sample locations with usable EPA Method TO-15 data were collected at 0003-H, 0008-H, 0026-H, 0030-H (Table 5-11, Figure 5-3).

In addition, two locations were sampled to confirm results where the HAPSITE® did not detect VOCs above the soil gas RBSLs. In addition to confirmatory VOC analyses, three locations within the PCE plume area were selected for additional SVOC analyses using EPA method TO-13A, however this data was deemed not usable to achieve project objectives.

5.5.2.6 Open-field Soil Gas Investigation

In areas where near-slab sampling was not possible near historically chlorinated VOC-impacted seeps and springs, and in selected locations adjacent to streets/sidewalks, open-field soil gas samples were collected (Figure 5-2, Table 5-11). Open field locations were defined as any location more than 5-ft from an occupied structure. As with near-slab samples, these were used to delineate the extent of vapor-phase VOCs above the groundwater Plume. Ten open-field sampling locations were tested at four sites, with no exceedances of screening levels therefore, no EPA Method TO-15 samples were collected for the open-field soil gas investigation. As stated previously, the HAPSITE® data is not usable to achieve project objectives but may be used qualitatively as described above.

5.5.3 2016 Vapor Intrusion Sampling and Analysis Activities

While only a portion of the 2015 VI data was suitable for use in the risk assessment, the VI data collected in 2015 was used in a qualitative manner to identify a portion of AOU-1 with a higher potential for VI to result in indoor air concentrations above RBSLs. This information, combined with AOU-1 hydrogeological data collected in 2015 and in prior years, facilitated the delineation of a focus area for the 2016 VI sampling as specified in the 2016 Vapor Intrusion Sampling Plan for AOU-1: East Side Springs 700 South 1600 East PCE Plume Technical Memorandum (EA 2015).

The 2016 AOU-1 VI investigation activities were conducted from February to June 2016 to supplement the 2015 VI investigation, support refining the conceptual model of VI within AOU-1, and further evaluate potential risk. Sampling was conducted at 11 new structures (not previously sampled in 2015) which included ten residential structures and a school. The Full VI Protocol was implemented at these 11 structures. Five previously sampled structures in an area where higher potential for VI was indicated based on the 2015 sampling results were also sampled to assess temporal variability in potentially VI-related indoor air PCE concentrations. Additional samples were also collected to complete the assessment for the absence of VC that was initiated with the 2015 sampling in accordance with MFM-02. The VC data collected in 2015 from 0003-H was supplemented with data collected in 2016 from 00017-H and 0023-H. The Limited VI Protocol was implemented at the previously sampled and VC confirmation locations.

A summary of the 2016 VI investigation activities and data collection is presented in the Final 2016 Vapor Intrusion Investigation Field Data Report (EA 2018). Table 5-12 presents the structure location and type of sampling conducted during the 2016 VI investigation.

HAPSITE® screening samples were analyzed for PCE, TCE, and cis-1,2-DCE. The 2016 VI samples that were submitted for laboratory analysis via EPA Method TO-15 were analyzed for the PCOPCs (PCE, TCE, cis-1,2-DCE, VC, and 1,4-dioxane). The following subsections describe the locations and methods for each sampling goal. All VI data from the 2016 sampling event are usable. Locations where 2016 HAPSITE® screening samples were collected are included on Figure 5-2 and where 2016 EPA Method TO-15 analytical data were obtained are included on Figure 5-3.

5.5.3.1 Previously Sampled Structures

As shown on Figure 5-4, some structures were re-sampled in 2016. The objective of resampling 5 structures in 2016, that were originally sampled in 2015, was to obtain valid EPA Method TO-15 data to assess temporal variability of indoor air and VI-related VOC concentrations (EA 2016h). The additional samples were collected to provide data where potential vapor sources were present within the structure based on the 2015 data. As described above, the HAPSITE® data, and much of the EPA Method TO-15 data collected in 2015, was determined to be not usable to achieve DQOs (shown in Table 5-11); additional data was collected in 2016 and 2017 to be used for risk assessment purposes and is described in detail in the following subsections.

The 5 structures that were re-sampled in 2016 include 0011-H, 0017-H, 0018-H, and 0037-H, where EPA Method TO-15 sampling was conducted in 2015 (along with the HAPSITE® sampling), and analytical laboratory results, although rejected, indicated PCE may exceed the RBSL. In addition, structure 0023-H was re-sampled, where only HAPSITE® sampling was conducted in 2015, because qualitative review of this HAPSITE® data indicated relatively high concentrations of PCE in the basement. In 3 of these structures, (0011-H, 0018-H, and 0037-H), re-sampling was conducted where 2015 PCE concentrations detected above the RBSL (11.0 $\mu g/m^3$) in rooms that may regularly be inhabited, and therefore a potential VI exposure pathway had been identified. The remaining 2 structures that were re-sampled in 2016 had PCE concentrations detected in uninhabited rooms near groundwater collection sumps: at structure 0017-H where EPA Method TO-15 results for PCE were detected above the RBSL near a sump in a basement closet and at 0023-H where qualitative HAPSITE® results above the RBSL were observed in the basement furnace room (EA 2016h). The additional samples were collected to provide data where potential vapor sources were present within the structure.

The confirmation samples collected in 2016 were collected utilizing a Limited VI Protocol (rather than the Full VI Protocol described in Section 5.5.1). The Limited VI Protocol was documented in MFM-18 and included the following steps:

1. Abbreviated interview with occupant and initial structure survey using HAPSITE® screening of indoor air to identify potential interior background sources (no pressure cycling)

2. Collection of 24-hour SUMMA® canister samples of indoor air in each of the 5 structures at one location per structure, for analysis using EPA Method TO-15 SIM. The indoor air samples were collected in the basement living space at four structures and in the storage area off the garage at the fifth location.

Table 5-12 presents the sample purpose, structure location identification, and type of sampling conducted for the five structures confirmation structures sampled in 2016. The five structures that were re-sampled are included on Figure 5-3.

5.5.3.2 Sampling of New Structures

The objective of sampling structures not previously sampled during the 2015 event was to gain a better understanding of the spatial extent of VI-related impacts associated with AOU-1 shallow groundwater. The new structures that were sampled in 2016 are listed on Table 5-12. One of the target structures was East High School (designated 0045-S) and the remainder of the 10 structures were residences (designated with an "-H" suffix on Table 5-12). Following the collection of additional information about the East High School building layout and use, three individual rooms within East High School were selected for sampling following the Full VI Protocol. Selection of rooms was based on proximity to PCE-impacted groundwater (where the vadose zone is thinnest and which are closer to the approximate inferred axis of the PCE plume) and habitable occupied smaller rooms (less air available for mixing and dilution). The rooms were located on the ground level toward the southwest area of the building.

The Full VI Protocol guided the data collection at these structures including HAPSITE® indoor air survey, HAPSITE® indoor air characterization under ambient, negative and positive pressure, screening of near-slab soil gas, and EPA Method TO-15 analysis if HAPSITE® screening data exceeded RBSLs. Based on screening results, indoor air samples were collected at 2 structures (0040-H and 0051-H), and soil gas and indoor air was collected at 1 structure (0053-H) and sent to the laboratory for EPA Method TO-15 analysis. No EPA Method TO-15 samples were collected at the other 7 structures or East High School due to either no exceedance of screening values or the presence of a background source. Table 5-12 presents the sample purpose, structure location identification, and type of sampling conducted at each location for the new structures sampled in 2016. The HAPSITE® screening locations are included on Figure 5-2. The locations where SUMMA® canisters were collected for EPA Method TO-15 analysis are included on Figure 5-3.

5.5.3.3 Vinyl Chloride Confirmation Sampling

During the 2015 indoor air and near-structure soil gas screening process, the field team determined the HAPSITE® was unable to reliably quantify VC at concentrations below the instrument calibration level which was greater than the RBSL (0.17 $\mu g/m^3$). VC was subsequently removed from the HAPSITE® calibration procedure (see MFM-02, Appendix L of the RI Work Plan [FE 2015a]). EPA concurred that additional indoor air samples be collected and submitted for VC analysis using EPA Method TO-15. Between 2015 and 2017, 55 different structures were sampled (Figure 5-4). Indoor air samples were collected at 23 of the 55 structures using SUMMA® canisters for EPA Method TO-15 analysis. VC analysis was also included as part of the EPA Method TO-15 analysis at each of these 23 structures. This data is presented in Section 6 and is shown on Figure 6-6. This laboratory VC data is used in this RI Report to identify the presence of VC rather than relying on HAPSITE® field screening methods.

5.5.3.4 Deviations from the Remedial Investigation Work Plan

During the 2016 VI investigation activities, one deviation from the Sampling and Analysis Plan (SAP), Appendix A of the RI Work Plan (FE 2015a) was noted. This deviation was associated with the sample naming convention outlined in SAP Table 3. This naming convention was not followed during 2016 VI sampling, although a similar sample naming convention was applied (see Section 5.8). Table 5-15 lists the naming convention used in 2016 along with the corresponding identifier name based on the convention outlined in the RI Work Plan.

5.5.4 2017 Vapor Intrusion Sampling and Analysis Program

Supplemental VI sampling activities were conducted within AOU-1 from March to April 2017. The 2017 supplemental VI investigation consisted of sampling 8 new structures (not previously sampled as part of the 2015 and 2016 effort) and 10 previously sampled structures (previously sampled in 2015) in an area identified as having a higher potential for VI. The 8 new structures were selected to improve the spatial data distribution within the AOU-1 area. The 10 previously sampled structures were re-sampled in 2017 to confirm and supplement the 2015 indoor air results of which many results were deemed not usable to achieve DQOs. A summary of the 2017 VI investigation activities and data collection is presented in the Final 2017 Vapor Intrusion Investigation Field Data Report (Appendix H-4). Assessment of temporal variability is also based on data collected in a supplemental field effort conducted in 2017. Table 5-13 lists the number and type of samples collected at the 10 previously sampled structures and 8 new structures in 2017. The locations of these structures are shown on Figure 5-2. All VI data from the 2017 sampling event are usable to achieve project objectives as documented in the Quality Control Summary Report 2017 Indoor Air Sampling (Appendix B of the Final 2017 Vapor Intrusion Investigation Field Data Report [Appendix H-4]).

5.5.4.1 Previously Sampled Structures

Ten of the structures sampled in 2015 were re-sampled in 2017 following the Limited VI Protocol (detailed in Section 5.5.2.1). Sampling was conducted to confirm and supplement the 2015 indoor air results. These 10 structures were also selected based on review of the 2016 groundwater and surface water data. Structures were selected for confirmation sampling if they were located where PCE was detected in groundwater and surface water and where groundwater was less than 50 ft below ground surface (EA 2017c). Confirmatory samples were collected per Attachment 1 of MFM-18 (EA 2017c), utilizing the Limited VI Protocol that includes HAPSITE® screening of indoor air to identify interior background source(s) (no pressure cycling) and collection of 2, 24-hour SUMMA® canister sample of indoor air per structure for laboratory analysis using EPA Method TO-15/TO-15 SIM. Samples for EPA Method TO-15 analysis were collected in the basement living space for all structures.

Other components of the Full VI Protocol (FE 2015a), such as detailed building surveys, were not repeated. Instead, an abbreviated interview and building survey were performed to identify any major changes that could have affected the 2017 sampling and data evaluation (recent remodels or household chemical storage). The determination of where samples were collected and conditions under which additional samples were warranted is described in the MFM-18 and sampling locations presented on Figures 5-2 (for HAPSITE®) and Figure 5-3 (for EPA Method TO-15) and listed on Table 5-13.

5.5.4.2 Sampling of New Structures

VI assessment of 8 new structures was conducted in 2017 using the Full VI Protocol sampling as outlined in MFM-18 (EA 2017c). In addition, one new structure was included for the Limited VI Protocol sampling of indoor air per the occupant request. Results from the HAPSITE® screening did not indicate indoor air concentrations attributable to VI in exceedance of the RBSL; therefore, no indoor air or near-slab soil gas samples for EPA Method TO-15 analyses were collected. Sampling locations are presented on Figures 5-2 (for HAPSITE®) and Figure 5-3 (for EPA Method TO-15) and listed on Table 5-13.

5.6 Ecological Survey

An ecological checklist was completed for each surface water and stormwater location in order to obtain qualitative information about ecological components (terrestrial and aquatic life) and habitat. Questions on the checklist included: the sample location site use description (residential, industrial, etc.); type of surface water (seeps, springs, etc.) located at the site; descriptions of the surrounding area/habitat to the site; type and density of vegetation at site; and observations regarding the presence or absence of insects or wildlife at the site. The checklists are included in Appendix C.

5.7 Investigation-Derived Waste Management and Disposal

Groundwater purged from temporary groundwater monitoring points and decontamination solutions (tap water, nonionic detergent solution, and distilled water rinsate) were collected in labeled 5-gallon containers during the sampling activities. These containers were transported to the designated storage area on the George E. Wahlen VA Medical Center campus and the contents were transferred to 55-gallon steel drums for temporary storage until the waste could be characterized and arrangements made for disposal. Soil cuttings from the installation of temporary groundwater monitoring points were placed in separate 55-gallon steel drums from those that contained water. All soil and groundwater drums were labeled with VA and contractor's point of contact names and phone number on the container. Because there was no knowledge that indicated the generated wastes exhibited a hazardous characteristic or contained listed wastes, all wastes generated during these investigatory activities were considered to be non-regulated investigation-derived waste.

All general refuse (e.g., paper towels, plastic tubing, paper, etc.) was disposed of as municipal waste and placed in dumpsters located on the George E. Wahlen VA Medical Center campus.

5.8 Deviations from the Remedial Investigation Work Plan

During the implementation of the groundwater, surface water, soil, and VI sampling activities, situations occurred that required deviation from the RI Work Plan and/or its appendices. The deviations, work plan reference, and rationale for the deviation are included in Table 5-14. In addition, some sample designations that were issued to the laboratories were identified differently than the protocol identified in the RI Work Plan. The sample identification numbers used in the field and a cross reference to RI Work Plan-compliant sample identification numbers are included in Table 5-15.

In addition to deviations associated with the field activities, deviations occurred during the sample analyses at the CLP laboratories, EPA Region 8 laboratory, and ALS Environmental. These deviations are noted below:

1. 1,4-dioxane was analyzed using the CLP SVOC method. The validation of the data resulted in rejection of the 1,4-dioxane results in the groundwater samples based on the associated quality control (QC) data. This potentially presents a data gap for the groundwater data as 1,4-dioxane was requested to be included with the analysis by the EPA due to its use as a stabilizer for 1,1,1-TCA.

2. Analytical method deviations were noted from those listed in the QAPP.

    a. The CLP laboratories implemented the more current versions of the CLP Statement of Work analytical methods for VOCs, SVOCs, and metals than were included in the QAPP. The methods SOM02.3 and ISM02.3 were used in lieu of SOM02.2 and ISM02.2 however, this does not impact the data quality or usability.

    b. Nitrate nitrogen was requested for analysis for the groundwater samples by EPA Method 300.0 to be analyzed at the EPA Region 8 laboratory. The data reported was analyzed for nitrate/nitrite nitrogen by EPA Method 300.0. The data may be biased slightly high due to inclusion of nitrite however, is still usable to achieve project objectives.

    c. Total dissolved solids analysis by Standard Methods SM2540C was requested of the EPA Region 8 laboratory, however the laboratory reported the data by EPA Method 160.1. The data is still usable to achieve the project objectives.

    d. Alkalinity was requested to be analyzed at ALS Environmental using Standard Methods SM2320B however, upon receipt of the data report it was documented that ALS Environmental analyzed the samples using the EPA Method 310.1. This data is still usable to achieve project objectives.

3. The sample identification numbers for 16 HAPSITE® samples collected at structure 0050-H were incorrectly labeled in the 2016 VI investigation report (refer to Table 8 in the 2016 Vapor Intrusion Investigation Field Data Report (EA 2018). There was a typographical error, in the sample identification numbers indicating that the samples (collected on 23 March 2016) were collected at structure 0051-H rather than 0050-H. For example, sample 0051H-OA-OA1-20160323-BL-001, should have been labeled 0050H-OA-OA1-20160323-BL-001. The identification numbers were corrected in the updated Final 700 South 1600 East PCE Plume AOU-1: East Side Springs, 2016 Vapor Intrusion Investigation Field Data Report (EA 2018).

4. Section 6.2.1.4 of the RI Work Plan indicates indoor air samples will be collected from previously sampled structures in May or June timeframe. However, since groundwater elevations remain high in spring months and cool weather months create the most conservative sampling scenarios due to temperature and pressure differentials associated with residential heating, although indoor air sampling was conducted at the same structure at different times over the course of one or two years (i.e., 0003-H and 0026-H); the samples were collected only during cool weather months (March).

TABLE 5-1

Properties Assessed for Possible Vapor Intrusion and Surface Water Intrusion

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Standing Water Outside?	Well or Cistern?	Crawlspace on Property?	Basement on Property?	Basement Moisture Problem?	Basement Flooding?	Sump in Basement?
0001-H	Yes	Yes (well)	No	Yes	Yes (3 or more times a year)	Yes (1-2 times a year)	Yes
0002-H	Yes	No	Yes	Yes	No	No	No
0003-H	Yes	No	No	Yes	Yes (3 or more times a year)	Yes (less than 1 time a year)	No
0004-H	No	No	Yes	Yes	No	No	No
0005-H	No	No	No	Yes	Yes (3 or more times a year)	No	No
0006-H	No	No	No	Yes	No	No	No
0007-H	No	No	No	Yes	No	No	No
0008-H	No	No	No	Yes	No	No	No
0009-H	No	No	No	Yes	No	Yes (less than 1 time a year)	No
0010-H	No	No	No	Yes	No	No	No
0011-H	No	No	Yes	Yes	Yes	No	No
0012-H	--	No	No	Yes	Yes (less than 1 time a year)	No	No
0013-H	No	No	No	Yes	No	No	No
0014-H	No	No	Yes	Yes	No	No	No
0015-H	No	No	No	Yes	No	Yes (less than 1 time a year)	No
0016-H	N/A	No	No	Yes	--	--	--
0017-H	No	Yes (cistern)	No	Yes	No	Yes (less than 1 time a year)	Yes
0018-H	Yes	Yes (cistern)	No	Yes	Yes (1-2 times a year)	Yes (less than 1 time a year)	No
0019-B	No	No	No	Yes	Yes (1-2 times a year)	Yes (1-2 times a year)	Yes
0020-C	No	No	No	Yes	No	No	No
0021-S	No	No	No	No	--	--	--
0022-S	No	No	Yes	Yes	Yes (1-2 times a year)	No	No
0023-H	No	No	No	Yes	Yes (3 or more times a year)	No	Yes
0024-H	No	No	No	Yes	Yes (less than 1 time a year)	No	No
0025-H	No	No	Yes	Yes	No	No	No

TABLE 5-1
Properties Assessed for Possible Vapor Intrusion and Surface Water Intrusion
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Standing Water Outside?	Well or Cistern?	Crawlspace on Property?	Basement on Property?	Basement Moisture Problem?	Basement Flooding?	Sump in Basement?
0026-H	Yes	Yes (well)	No	Yes	Yes (3 or more times a year)	Yes (3 or more times a year)	No
0027-H	No	No	No	Yes	Yes (1-2 times a year)	No	Yes
0028-S	No	No	No	No	--	--	--
0029-H	No	No	Yes	Yes	No	Yes (less than 1 time a year)	No
0030-H	No	No	Yes	Yes	No	No	No
0031-S	No	No	No	No	--	--	--
0032-H	No	No	Yes	Yes	Yes (less than 1 time a year)	Yes (less than 1 time a year)	No
0033-H	No	No	No	Yes	Yes (1-2 times a year)	No	No
0034-H	No	No	No	Yes	No	No	No
0035-H	No	No	No	Yes	No	No	No
0036-H	Yes	No	Yes	Yes	Yes (less than 1 time a year)	No	No
0037-H	No	No	No	Yes	No	No	No
0038-H (2)	No	No	No	Yes	No	No	No
0040-H	Yes	No	No	Yes	Yes (less than 1 time a year)	No	Yes
0041-H (2)	No	No	Yes	Yes	No	No	Yes
0045-S (1,2)	--	--	--	--	--	--	--
0047-H (2)	Yes	No	No	Yes	Yes (less than 1 time a year)	No	No
0050-H (2)	No	No	No	Yes	Yes (3 or more times a year)	No	Yes
0051-H	No	Yes (well)	No	Yes	Yes (1-2 times a year)	No	No
0052-H	No	No	Yes	Yes	No	No	No
0053-H	No	No	Yes	Yes	Yes (1-2 times a year)	Yes (less than 1 time a year)	No
0054-H	No	No	No	Yes	Yes (3 or more times a year)	No	Yes
0055-H	No	No	No	Yes	No	No	Yes
0056-H (1)	--	--	--	--	--	--	--
0057-H	Yes	No	No	No	--	--	--

TABLE 5-1

Properties Assessed for Possible Vapor Intrusion and Surface Water Intrusion

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Standing Water Outside?	Well or Cistern?	Crawlspace on Property?	Basement on Property?	Basement Moisture Problem?	Basement Flooding?	Sump in Basement?
0058-H	No	No	No	Yes	No	No	No
0059-H	Yes	No	No	Yes	Yes (3 or more times a year)	No	No
0060-H	Yes	No	No	Yes	No	No	No
0061-H	No	No	Yes	Yes	No	No	No
0062-H	No	Yes (well)	Yes	Yes	No	No	No
0063-H	No	No	No	Yes	No	No	No
0064-H	Yes	No	Yes	No	--	--	--

NOTES:

1. Occupied Dwelling or Academic/Commercial/Industrial Building Questionnaires were not completed for these properties.
2. Breaks in the sequence of structure numbers are where access to the property could not be obtained.

C = Commercial/Industrial.
H = Home.
ID = Identification.
S = School.

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TABLE 5-2

Properties Accessed for Indoor Air, Soil Gas, and Outdoor Ambient Air Sampling

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID (1)	**HAPSITE® Indoor Air**		**TO-15 Indoor Air**		**HAPSITE® Outdoor Ambient Air**		**TO-15 Outdoor Ambient Air**		**HAPSITE® Soil Gas**		**TO-15 Soil Gas**	
0001-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0002-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0003-H	X	2015	X	**2015, 2016**	X	2015			X	2015	X	**2015**
0004-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0005-H	X	2015			X	2015			X	2015		
0006-H	X	2015			X	2015			X	2015		
0007-H	X	2015	X	2015					X	2015		
0008-H	X	2015	X	**2015**	X	2015			X	2015	X	**2015**
0009-H	X	2015			X	2015			X	2015		
0010-H	X	2015			X	2015			X	2015		
0011-H	X	2015	X	2015, **2016**	X	2015	X	2015	X	2015	X	2015
0012-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0013-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0014-H	X	2015			X	2015			X	2015		
0015-H	X	2015			X	2015			X	2015		
0016-H	X	2015			X	2015			X	2015		
0017-H	X	2015	X	2015, **2016**	X	2015	X	2015	X	2015	X	2015
0018-H	X	2015	X	2015, **2016**	X	2015	X	2015	X	2015	X	2015
0019-B	X	2015	X	2015	X	2015			X	2015		
0020-C	X	2015			X	2015			X	2015		
0021-S	X	2015			X	2015			X	2015		
0022-S	X	2015	X	2015	X	2015			X	2015		
0023-H	X	2015	X	**2016**	X	2015			X	2015		
0024-H	X	2015			X	2015			X	2015		
0025-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0026-H	X	2015, **2017** (2)	X	**2015, 2017**	X	2015, **2017**	X	**2015**	X	2015	X	**2015** (3)
0027-H	X	2015, **2017** (2)	X	2015, **2017**	X	2015, **2017**	X	2015	X	2015		
0028-S	X	2015	X	2015	X	2015			X	2015		
0029-H	X	2015, **2017** (2)	X	**2017**	X	2015, **2017**			X	2015		
0030-H	X	2015	X	**2015**	X	2015	X	**2015**	X	2015	X	**2015** (4)
0031-S	X	2015							X	2015	X	2015
0032-H	X	2015			X	2015			X	2015		
0033-H	X	2015			X	2015			X	2015		
0036-H	X	2015	X	**2015**	X	2015			X	2015		

TABLE 5-2

Properties Accessed for Indoor Air, Soil Gas, and Outdoor Ambient Air Sampling

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID (1)	**HAPSITE® Indoor Air**		**TO-15 Indoor Air**		**HAPSITE® Outdoor Ambient Air**		**TO-15 Outdoor Ambient Air**		**HAPSITE® Soil Gas**		**TO-15 Soil Gas**	
0037-H	X	2015	X	2015, **2016**	X	2015			X	2015	X	2015
0038-H	X	2015, **2017** (2)	X	**2017**	X	2015						
0040-H	X	**2016**	X	**2016**					X	**2016**		
0041-H	X	**2016**							X	**2016**		
0045-S	X	**2016**							X	**2016**		
0047-H	X	**2016**							X	**2016**		
0050-H	X	**2016**							X	**2016**		
0051-H	X	**2016**	X	**2016**					X	**2016**		
0052-H	X	**2016**							X	**2016**		
0053-H	X	**2016**	X	**2016**					X	**2016**	X	**2016**
0054-H	X	**2016**							X	**2016**		
0055-H	X	**2016**							X	**2016**		
0056-H	X	**2016**			X	**2016**			X	**2016**		
0057-H	X	**2017**							X	**2017**		
0058-H	X	**2017**			X	**2017**			X	**2017**		
0059-H	X	**2017**			X	**2017**			X	**2017**		
0060-H	X	**2017**			X	**2017**			X	**2017**		
0061-H	X	**2017**			X	**2017**			X	**2017**		
0062-H	X	**2017**			X	**2017**			X	**2017**		
0063-H	X	**2017**			X	**2017**			X	**2017**		
0064-H	X	**2017**	X	**2017**								
55 Total Structures Investigated												

NOTES:
1. Where numbering is not sequential, access to the property was not available.
2. Sampling performed using the Limited Vapor Intrusion Protocol.
3. Two soil gas samples were collected at structure 0026-H in 2015 for TO-15 analysis: near the slab and in the open field. The TO-15 data for the near-slab soil gas sample was deemed unusable. The TO-15 data from the open field sample was determined to be usable.
4. The 2015 TO-15 soil gas sample collected at structure 0030-H was collected in the open field.

ID = Identification.
NA = Not applicable.
20xx = Blue bold font indicates the data was deemed to be usable.

TABLE 5-3

Temporary Groundwater Monitoring Point and Piezometer Construction Information

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Installation Date	Abandonment Date	Piezometer Completion Date	Latitude (1)	Longitude (1)	Elevation Top of Casing (2) (ft amsl)	Water Table Elevation (2) (ft amsl)			Screen Interval (ft)	Total Boring Depth (ft bgs)	Well Diameter (inches)	Location Deviates From RI Work Plan? (3)	Reason for Deviation in Sample Location
							February/ March 2016	July 2016	September 2016					
GW-01	03/02/16	04/05/16	NA	40.7489943	-111.853302	4486.95	4475.02	NA	NA	8.0 – 13.0	13.0	0.75	Yes	Unable to gain access to property
GW-02	02/24/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set.								NA	40.0	NA	Yes	Utility lines; moved to other side of street
GW-03	02/24/16	04/05/16	NA	40.7481034	-111.855183	4484.03	4455.63	NA	NA	28.0 – 33.0	35.0	0.75	No	
GW-04	02/26/16	04/06/16	NA	40.7482076	-111.857389	4415.71	4398.45	NA	NA	20.0 – 25.0	25.0	0.75	Yes	Access issue – homeowner did not want monitoring point in front of property
GW-05	02/25/16	04/05/16	NA	40.7490131	-111.854764	4465.01	4462.55	NA	NA	3.5 – 8.5	15.0	0.75	No	
GW-06	02/25/16	04/06/16	NA	40.7487218	-111.855318	4455.29	4450.63	NA	NA	5.0 – 10.0	10.0	0.75	No	
GW-07	02/25/16	04/06/16	NA	40.7489754	-111.856326	4456.07	4447.44	NA	NA	4.0 – 9.0	10.0	0.75	Yes	Access issue – homeowner did not want monitoring point in front of property
GW-08	02/27/16	04/05/16	NA	40.7498921	-111.857694	4430.31	4423.35	NA	NA	10.0 – 15.0	15.0	0.75	Yes	Access issue – homeowner did not want monitoring point in front of property
GW-09	02/26/16	04/06/16	NA	40.7493292	-111.857562	4416.96	4412.05	NA	NA	5.0 – 10.0	10.0	0.75	No	
GW-10	02/26/16	NA	04/05/16	40.7496230	-111.859130	4382.52	4370.30	4369.21	4369.17	13.0 – 18.0	20.0	0.75	No	
GW-11	02/25/16	NA	04/05/16	40.7503997	-111.857826	4437.77	4435.21	4435.02	4434.79	10.0 – 15.0	15.0	0.75	No	
GW-12	03/01/16	04/05/16	NA	40.7504542	-111.859407	4382.57	4378.22	NA	NA	5.0 – 10.0	10.0	0.75	Yes	Utility lines; moved down the street
GW-13	03/04/16	04/05/16	NA	40.7508103	-111.856415	4489.66	4468.22	NA	NA	20.0 – 25.0	25.0	0.75	Yes	Access issue – homeowner did not want monitoring point in front of property
GW-14	03/02/16	04/05/16	NA	40.7504123	-111.858828	4399.05	4389.05	NA	NA	15.0 – 20.0	20.0	0.75	Yes	Access issue – homeowner did not want monitoring point in front of property
GW-15	02/27/16	03/08/16	NA	40.7511576	-111.857964	4443.22	4442.72	NA	NA	0.0 – 5.0	5.0	0.75	No	
GW-16	02/27/16	NA	04/05/16	40.7509267	-111.858417	4422.96	4420.96	4421.26	4421.27	3.0 – 8.0	10.0	0.75	No	
GW-17	03/01/16	04/05/16	NA	40.7515298	-111.859403	4395.42	4381.02	NA	NA	10.0 – 15.0	15.0	0.75	No	
GW-18	03/01/16	04/05/16	NA	40.7518339	-111.858680	4433.39	4425.24	NA	NA	5.0 – 10.0	10.0	0.75	No	
GW-19	02/29/16	03/08/16	NA	Well set, but groundwater did not recharge. Not sampled or surveyed.						7.0 – 12.0	30.0	0.75	No	
GW-20	02/29/16	NA	04/05/16	40.7525556	-111.859404	4417.16	4405.69	4405.52	4405.72	11.5 – 16.5	20.0	0.75	No	
GW-21	02/29/16	03/08/16	NA	40.7540186	-111.858996	4462.16	4452.19	NA	NA	12.0 – 17.0	20.0	0.75	Yes	Issue with access of drill rig; monitoring point moved to front of property
GW-22	02/29/16	04/05/16	NA	40.7536645	-111.860744	4406.25	4400.92	NA	NA	10.0 – 15.0	15.0	0.75	No	

TABLE 5-3
Temporary Groundwater Monitoring Point and Piezometer Construction Information
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Installation Date	Abandonment Date	Piezometer Completion Date	Latitude (1)	Longitude (1)	Elevation Top of Casing (2) (ft amsl)	Water Table Elevation (2) (ft amsl)			Screen Interval (ft)	Total Boring Depth (ft bgs)	Well Diameter (inches)	Location Deviates From RI Work Plan? (3)	Reason for Deviation in Sample Location
							February/ March 2016	July 2016	September 2016					
GW-23	02/22/16	03/08/16	NA	40.7549456	-111.858090	4480.78	4471.88	NA	NA	8.5 – 13.5	20.0	0.75	No	
GW-24	02/23/16	03/08/16	NA	40.7542761	-111.861584	4394.76	4377.86	NA	NA	13.0 – 18.0	20.0	0.75	No	
GW-25	02/29/16	04/05/16	NA	40.7521000	-111.861190	4368.33	4345.23	NA	NA	25.0 – 30.0	30.0	0.75	Yes	Utility lines; moved to other side of street
GW-26	02/26/16	04/06/16	NA	40.7476847	-111.859216	4376.06	4359.58	NA	NA	15.0 – 20.0	20.0	0.75	No	
GW-27	03/04/16	04/05/16	NA	40.7517325	-111.855656	4493.18	4472.95	NA	NA	25.0 – 30.0	30.0	0.75	NA	
GW-28	03/04/16	04/05/16	NA	40.7499706	-111.855680	4491.28	4472.83	NA	NA	20.0 – 25.0	25.0	0.75	NA	
GW-31	02/27/16	03/08/16	NA	40.7504814	-111.862766	4334.23	4302.36	NA	NA	30.0 – 35.0	35.0	0.75	NA	
GW-33	02/23/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set								NA	40.0	NA	NA	
GW-35	02/23/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set								NA	45.0	NA	NA	
GW-39	02/22/16	03/08/16	NA	40.7529075	-111.862650	4349.59	4333.11	NA	NA	17.7 – 22.7	25.0	0.75	NA	
GW-40	03/01/16	04/05/16	NA	40.7513409	-111.860866	4366.97	4332.44	NA	NA	35.0 – 40.0	40.0	0.75	NA	
GW-42	03/01/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set								NA	40.0	NA	NA	
GW-43	03/03/16	04/05/16	NA	40.7471177	-111.855858	4471.03	4440.53	NA	NA	28.0 – 33.0	35.0	0.75	NA	
GW-46	02/24/16	03/08/16	NA	40.7462486	-111.856967	4418.18	4388.60	NA	NA	30.0 – 35.0	35.0	0.75	NA	
GW-48	02/24/16	03/08/16	NA	40.7473947	-111.853223	4511.11	4474.77	NA	NA	35.0 – 40.0	40.0	0.75	NA	
GW-49	02/25/16	NA	04/05/16	40.7489291	-111.854616	4465.84	4458.27	4458.53	4458.35	7.5 – 12.5	15.0	0.75	NA	
GW-50	02/26/16	NA	04/06/16	40.7483434	-111.856004	4445.12	4442.43	4442.67	4442.67	4.0 – 9.0	10.0	0.75	NA	
GW-51	03/04/16	04/05/16	NA	40.7513681	-111.856637	4480.08	4467.61	NA	NA	10.0 – 15.0	15.0	0.75	NA	
GW-52	03/02/16	NA	04/06/16	40.7496775	-111.855253	4490.60	4467.76	4467.80	4467.45	25.0 – 30.0	30.0	0.75	NA	
GW-53	03/02/16	NA	04/05/16	40.7496231	-111.856746	4459.05	4448.29	4448.07	4448.21	10.0 – 15.0	15.0	0.75	NA	
GW-54	03/03/16	03/08/16	NA	Well set, but groundwater did not recharge. Not sampled or surveyed.						8.3 – 13.3	13.3	0.75	NA	
GW-55	03/03/16	04/06/16	NA	40.7476446	-111.856747	4429.71	4407.74	NA	NA	10.0 – 15.0	15.0	0.75	NA	
GW-57	03/05/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set.								NA	33.0	NA	NA	
GW-58	03/05/16	Drilled to refusal, groundwater not reached - no temporary groundwater monitoring point set.								NA	40.0	NA	NA	
GW-59	03/04/16	NA	04/05/16	40.7507703	-111.859399	4385.84	4377.26	4378.43	4378.60	10.0 – 15.0	15.0	0.75	NA	
GW-60	03/08/16	04/05/16	NA	40.7498778	-111.858728	4394.15	4384.45	NA	NA	10.0 – 15.0	15.0	0.75	NA	
GW-61	03/05/16	NA	04/06/16	40.7475988	-111.858042	4399.80	4388.09	4387.89	4387.60	15.0 – 20.0	20.0	0.75	NA	
GW-62	03/08/16	04/05/16	NA	40.7524309	-111.858097	4455.16	4442.34	NA	NA	15.0 – 20.0	20.0	0.75	NA	

NOTES:
1. Coordinate system is North American Datum of 1983 High Accuracy Reference Network.
2. Coordinate system is National Geodetic Vertical Datum of 1929 (feet).
3. Deviations for location IDs GW-27 through GW-62 are identified as not applicable (NA) because these points were not assigned positions in the RI Work Plan (FE 2015a).

amsl = Above mean sea level.
bgs = Below ground surface.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.

TABLE 5-3
Temporary Groundwater Monitoring Point and Piezometer Construction Information
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

RI = Remedial Investigation.
Blue shaded cells represent locations completed as a temporary groundwater monitoring point.
Totals:
Temporary monitoring points attempted with Geoprobe = 50
Refusal/no groundwater encountered = 6
Temporary monitoring point set, but no groundwater recharge = 2
One-time shallow groundwater sample collected = 42
Piezometers installed = 10

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TABLE 5-4

Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab				EPA Region 8 Lab			ALS Environmental	SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Metals		pH	TDS	Anions	Alkalinity	Isotopes (1)		
							Total	Dissolved							
GW-01	03/04/16	1310	A-GW-001	H0009	X										
			A-GW-001-D	H0304	X									X	
GW-03	02/26/16	1010	A-GW-003	H0011	X										
GW-04	02/26/16	1500	A-GW-004	H0015	X										
GW-05	02/26/16	1120	A-GW-005	H0012	X										
GW-06	02/26/16	1205	A-GW-006	H0014	X										
GW-07	02/28/16	0900	A-GW-007	H0016	X										
GW-08	02/27/16	1600	A-GW-008	H0021	X										
GW-09	02/26/16	1620	A-GW-009	H0019	X										
GW-10	02/27/16	1110	A-GW-010	H0020	X										
			A-GW-010-D	H0AA5	X									X	
	07/12/16	0850	A-GW-010	H7009	X	X									
				MH7017			X								
				MH7018				X							
				--						X	X				
	09/20/16	0930	A-GW-010	H9001	X	X									
				MH9001				X							
				MH9002			X								
				--						X	X				
GW-11	02/27/16	1220	A-GW-011	H0022	X										
				--									X		
	07/11/16	1140	A-GW-011	H7010	X	X									
				MH7019			X								
				MH7020				X							
				--						X	X				
	09/19/16	1115	A-GW-011	H9002	X	X									
				MH9003			X								
				MH9004				X							
				--						X	X				
GW-12	03/02/16	1000	A-GW-012	H0029	X										
GW-13	03/04/16	1545	A-GW-013	H0025	X										

TABLE 5-4

Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Date Sampled**	**Time Sampled**	**Sample ID**	**CLP Sample ID**	**Analyses**									**Quality Control**	
					CLP Lab				**EPA Region 8 Lab**			**ALS Environmental**	**SIRFER**	**Duplicate**	**MS/MSD**
					VOCs	**SVOCs**	**Metals**		**pH**	**TDS**	**Anions**	**Alkalinity**	**Isotopes** [(1)]		
							Total	**Dissolved**							
GW-14	03/02/16	1345	A-GW-014	H0028	X										
				H0203		X									
				MH0201				X							
				MH0202			X								
GW-14	03/02/16	1345	A-GW-014	--					X	X	X	X			
GW-15	02/29/16	1000	A-GW-015	H0023	X										X
				H0087		X									X
				MH0088			X								X
				MH0095				X							X
				--					X	X	X	X			X
			A-GW-015-D	H1001	X									X	
				H0081		X								X	
				MH0082			X							X	
				MH0089				X						X	
				--					X	X	X	X		X	
GW-16	02/28/16	1135	A-GW-016	H0024	X										
	07/11/16	1050	A-GW-016	H7011	X	X									
				MH7021			X								
				MH7022				X							
				--						X	X				
	09/19/16	1032	A-GW-016	H9004	X	X									
				MH9005				X							
				MH9006			X								
				--						X	X				
GW-17	03/02/16	1200	A-GW-017	H0044	X										
GW-18	03/02/16	1130	A-GW-018	H0043	X										

TABLE 5-4
Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Date Sampled**	**Time Sampled**	**Sample ID**	**CLP Sample ID**	**Analyses**									**Quality Control**	
					CLP Lab				**EPA Region 8 Lab**			**ALS Environmental**	**SIRFER**	**Duplicate**	**MS/MSD**
					VOCs	**SVOCs**	**Metals**		**pH**	**TDS**	**Anions**	**Alkalinity**	**Isotopes** [(1)]		
							Total	**Dissolved**							
GW-20	03/01/16	1110	A-GW-020	H0040	X										
				H0099		X									
				MH0100			X								
				MH0107				X							
				--					X	X	X	X	X		
	07/11/16	0750	A-GW-020	H7012	X	X									X
				MH7023			X								X
				MH7024				X							X
				--						X	X				X
	09/19/16	0750	A-GW-020	H9005	X	X									X
				MH9007				X							X
				MH9008			X								X
				--						X	X				X
GW-21	03/01/16	1525	A-GW-021	H0031	X										
GW-22	03/01/16	0930	A-GW-022	H0039	X										
GW-23	02/22/16	1425	A-GW-023	H0001	X										X
GW-24	02/25/16	0920	A-GW-024	H0002	X										
GW-25	02/29/16	1505	A-GW-025	H0041	X										
GW-26	02/28/16	1045	A-GW-026	H0018	X										
GW-27	03/05/16	1115	A-GW-027	H0027	X										X
GW-28	03/05/16	1310	A-GW-028	H0026	X										
GW-31	02/28/16	1000	A-GW-031	H0004	X										
GW-39	02/23/16	1115	A-GW-039	H0003	X										
GW-40	03/03/16	1220	A-GW-040	H0042	X										
GW-43	03/03/16	1630	A-GW-043	H0046	X										
GW-46	02/24/16	1520	A-GW-046	H0007	X										
GW-48	03/03/16	1015	A-GW-048	H0008	X										

TABLE 5-4

Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab				EPA Region 8 Lab			ALS Environmental	SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Metals		pH	TDS	Anions	Alkalinity	Isotopes $^{(1)}$		
							Total	Dissolved							
GW-49	02/25/16	1325	A-GW-049	H0013	X										X
				H0075		X									X
				MH0076			X								X
				MH0083				X							X
				--					X	X	X	X			X
			A-GW-049-D	H0051										X	
	07/12/16	1115	A-GW-049	H7013	X	X									
				MH7025			X								
				MH7026				X							
				--						X	X				
	09/19/16	1142	A-GW-049	H9008	X	X									
				MH9014				X							
				MH9015			X								
				--						X	X				
GW-50	02/29/16	1330	A-GW-050	H0017	X										
				H0093		X									
				MH0094			X								
				MH0101				X							
				--					X	X	X	X			
	07/12/16	0940	A-GW-050	H7014	X	X									
				MH7027			X								
GW-50	07/12/16	0940	A-GW-050	MH7028				X							
				--						X	X				
	09/20/16	1022	A-GW-050	H9009	X	X									
				MH9015				X							
				MH9016			X								
				--						X	X				
GW-51	03/04/16	1840	A-GW-051	H0401	X										

TABLE 5-4

Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab				EPA Region 8 Lab			ALS Environmental	SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Metals		pH	TDS	Anions	Alkalinity	Isotopes $^{(1)}$		
							Total	Dissolved							
GW-52	03/03/16	1350	A-GW-052	H0302	X										X
			A-GW-052-D	H0303	X									X	
	07/12/16	0735	A-GW-052	H7015	X	X									
				MH7029			X								
				MH7030				X							
				--						X	X				
			A-GW-052-D	H7024	X	X								X	
				MH7039				X						X	
				MH7040			X							X	
				--						X	X			X	
	09/20/16	0758	A-GW-052	H9010	X	X									
				MH9017				X							
				MH9018			X								
				--						X	X				
			A-GW-052-D	H9011	X	X								X	
				MH9019				X						X	
				MH9020			X							X	
				--						X	X			X	
GW-53	03/03/16	1605	A-GW-053	H0301	X										
	07/11/16	1225	A-GW-053	H7016	X	X									
				MH7031			X								
				MH7032				X							
				--						X	X				
	09/19/16	1205	A-GW-053	H9012	X	X									
				MH9021				X							
				MH9022			X								
				--						X	X				
GW-55	03/05/16	0800	A-GW-055	H0402	X										
GW-59	03/05/16	1620	A-GW-059	H0403	X										
	07/11/16	0955	A-GW-059	H7017	X	X									
				MH7033			X								
				MH7034				X							
				--						X	X				
	09/19/16	0935	A-GW-059	H9013	X	X									

TABLE 5-4

Groundwater Sampling Summary – Temporary Groundwater Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab				EPA Region 8 Lab			ALS Environmental	SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Metals		pH	TDS	Anions	Alkalinity	Isotopes (1)		
							Total	Dissolved							
				MH9023				X							
				MH9024			X								
				--						X	X				
GW-60	03/08/16	1330	A-GW-060	H0405	X										
GW-61	03/05/16	1505	A-GW-061	H0404	X										
	07/12/16	1215	A-GW-061	H7018	X	X									
				MH7035			X								
				MH7036				X							
				--						X	X				
	09/20/16	1245	A-GW-061	H9014	X	X									
				MH9025				X							
				MH9026			X								
				--						X	X				
GW-62	03/08/16	1425	A-GW-062	H0406	X										

NOTES:

1. Analyzed for deuterium and oxygen-18.

-- = Not applicable.
CLP = EPA Contract Laboratory Program.
EPA = U.S. Environmental Protection Agency.
ID = Identification.
MS/MSD = Matrix spike/matrix spike duplicate.
SIRFER = Stable Isotope Ratio Facility for Environmental Research, University of Utah.
SVOC = Semivolatile organic compound.
TDS = Total dissolved solids.
VOC = Volatile organic compound.
X = Analyzed.

TABLE 5-5

Surface Water Sampling Locations

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Type of Surface Water Sampled	Sample Location Specified in RI Work Plan (1)	Sample Location Deviates From RI Work Plan (1)?	Reason for Moving Sample Location
SW-01	Seep	Spring SL33	Yes	Homeowner indicated there were no seeps or springs on property, therefore the location was moved to a property with an active seep or spring
SW-04	Spring-fed ponds	Spring SL30	No	NA
SW-06	Spring-fed sump	Spring SL28	No	NA
SW-07	Spring box	Spring SL85	Yes	Homeowner indicated there were no seeps or springs on property, therefore the location was moved to a property with an active seep or spring
SW-08	Seep	Spring SL25	Yes	Homeowner indicated there were no seeps or springs on property, therefore the location was moved to a property with an active seep or spring
SW-09	Seep	Spring SL28, near residential sampling location IA-13/SG-13	Yes	Based on the RIWP figure, this location should be collocated with SL23 or SL24
SW-11	Seep	Spring SL82, near residential sampling location IA-15/SG-15	No	NA
SW-12	Spring	Spring SL18, near residential sampling location IA-14/SG-14	No	NA
SW-13	Seep	Spring SL88, near residential sampling location IA-16/SG-16	Yes	Moved sample near SL27 because it was closer to indoor air sampling location 0001H on parcel to the north
SW-14	Spring-fed sump	Spring SL100	No	NA
SW-15	Seep	Benson Spring	No	NA
SW-16	Spring (Our Lady of Lourdes)	Our Lady of Lourdes Spring	No	NA
SW-19	Spring (Bowen)	Spring SL35	Yes	Homeowner indicated there were no seeps or springs on property, therefore the location was moved to a property with an active seep or spring that was confirmed as Bowen Spring
SW-21	Spring-fed sump	NA	NA	NA
SW-22	Spring-fed sump	NA	NA	NA
SW-23	Spring-fed sump	NA	NA	NA

TABLE 5-5

Surface Water Sampling Locations

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Type of Surface Water Sampled	Sample Location Specified in RI Work Plan (1)	Sample Location Deviates From RI Work Plan (1)?	Reason for Moving Sample Location
SW-26	Seep	NA	NA	NA
SW-27	Seep	NA	NA	NA
SW-29	Spring	NA	NA	NA
SW-30	Spring (Smith)	NA	NA	NA
SW-31	Seep	NA	NA	NA
SW-33	Seep	NA	NA	NA
SW-34	Spring	NA	NA	NA
SW-35	Seep	NA	NA	NA
SW-36	Seep	NA	NA	NA
SW-40	Spring-fed sump	NA	NA	NA
SW-42	Spring	NA	NA	NA
SW-43	Spring	NA	NA	NA
SW-44	Spring	NA	NA	NA
SW-46	Spring	NA	NA	NA
SW-47	Creek (Red Butte)	NA	NA	NA
SW-48	Spring (Benson)	NA	NA	NA
SW-50	Spring	NA	NA	NA

NOTES:

1. First Environment. 2015a. Final Remedial Investigation Work Plan, AOU-1: East Side Springs, 700 South 1600 East PCE Plume, Salt Lake City, Utah. July.

ID = Identification.
NA = Not applicable. Sample locations were not defined within the RI Work Plan.
RIWP = Remedial Investigation.

TABLE 5-6
Stormwater Sampling Locations
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Type of Stormwater Sampled	Flow Direction	Sample Location Specified in RI Work Plan (1)	Sample Location Deviates From RI Work Plan (1)?	Reason For Moving Sample Location
SW-02	Stormwater and mitigated spring water (2)	East to West	Spring SL34	Yes	Due to close proximity to SW-01, this location was allocated to stormwater line sampling
SW-03	Stormwater and mitigated spring water (2)	East to West	Spring SL32	Yes	Homeowner indicated there were no seeps or springs on property
SW-05	Stormwater and mitigated spring water (2)	East to West	Storm sewer manhole	Yes	Location was moved to manhole or grate near 1100 East and 900 South for better distribution along stormwater line
SW-10	Stormwater	East to West	Spring SL86	Yes	Homeowner indicated there were no seeps or springs on property
SW-17	Jordan and Salt Lake City Canal	Southwest to Northeast	Spring SL11	Yes	Location outside of apparent tetrachloroethylene impacted area, therefore reallocated to assess stormwater
SW-18	Mitigated spring water (2)	North to South	Spring SL77	Yes	Location outside of apparent tetrachloroethylene impacted area, therefore reallocated to assess stormwater
SW-20	Stormwater	East to West	NA	NA	NA
SW-24	Stormwater	East to West	NA	NA	NA
SW-25	Mitigated spring water (2)	North to South	NA	NA	NA
SW-28	Mitigated spring water (2)	North to South	NA	NA	NA
SW-32	Mitigated spring water (2)	Northeast to Southwest	NA	NA	NA
SW-37	Mitigated spring water (2)	Southeast to Northwest	NA	NA	NA
SW-38	Stormwater and mitigated spring water (2)	East to West	NA	NA	NA
SW-39	Mitigated spring water (2)	North to South	NA	NA	NA
SW-41	Mitigated spring water (2)	South to North	NA	NA	NA
SW-45	Jordan and Salt Lake City Canal	Southwest to Northeast	NA	NA	NA
SW-49	Jordan and Salt Lake City Canal	South to North	NA	NA	NA

TABLE 5-6
Stormwater Sampling Locations
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

NOTES:
1. First Environment. 2015a. Final Remedial Investigation Work Plan, AOU-1: East Side Springs, 700 South 1600 East PCE Plume, Salt Lake City, Utah. July.
2. Mitigated spring water is spring water that has been diverted off of private property through a drainage system into storm drains.
ID = Identification.
NA = Not applicable. Sample locations were not defined within the RI Work Plan.
RI = Remedial Investigation.

TABLE 5-7

Surface Water and Stormwater Samples, Laboratories, Analytical Suites, and Quality Control Summary

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab			EPA Region 8 Lab		CLP Confirmation Labs			SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Total Metals	TDS	Anions	VOCs	SVOCs	Total Metals	Isotopes (1)		
Surface Water															
SW-01	05/04/16	1400	A-SW-001	H4091	X										
				--									X[1]		
			A-SW-001-D	H4019	X									X	
SW-04	05/02/16	1340	A-SW-004	H4094	X										
				--									X[1]		
SW-06	05/04/16	1700	A-SW-006	H4096	X										
				--									X[1]		
			A-SW-006-D	H4018	X									X	
SW-07	05/04/16	1100	A-SW-007	H4097	X	X									
				MH4097			X								
				--				X	X				X[1]		
			A-SW-007-D	H4013	X	X								X	
				MH4005			X							X	
				--				X	X					X	
SW-08	05/04/16	1010	A-SW-008	H4098	X										
				--									X[1]		
			A-SW-008-D	H4016	X									X	
SW-09	05/03/16	0855	A-SW-009	H4099	X										
				--									X[1]		
SW-11	05/03/16	1230	A-SW-011	H4101	X										
				--									X[1]		
SW-12	05/03/16	1030	A-SW-012	H4102	X	X									
				H4202						X					
				MH4202			X								
				--				X	X				X[1]		
SW-13	05/03/16	1430	A-SW-013	H4103	X										
				--									X[1]		
SW-14	05/04/16	0900	A-SW-014	H4104	X										
				--									X[1]		
SW-15	05/04/16	1130	A-SW-015	H4105	X	X									
				MH4107			X								
				--				X	X				X[1]		

TABLE 5-7
Surface Water and Stormwater Samples, Laboratories, Analytical Suites, and Quality Control Summary
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab			EPA Region 8 Lab		CLP Confirmation Labs			SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Total Metals	TDS	Anions	VOCs	SVOCs	Total Metals	Isotopes (1)		
SW-16	05/04/16	1320	A-SW-016	H4106	X	X									
				MH4106			X								
				--				X	X				X^{1}		
SW-19	05/04/16	0820	A-SW-019	H4109	X										
				--									X^{1}		
SW-21	05/03/16	1320	A-SW-021	H4111	X	X									
				H4211						X					
				MH4211			X								
				--				X	X				X^{1}		
SW-22	05/03/16	1550	A-SW-022	H4112	X										
				--									X^{1}		
SW-23	05/03/16	0930	A-SW-023	H4113	X	X									
				H4213						X	X				
				MH4213								X			
				MH4113			X								
				--				X	X				X^{1}		
			A-SW-023-MS	H4113MS	X	X									X
				H4213MS						X	X				X
				MH4113S			X								X
				MH4213S								X			X
				--				X	X						X
			A-SW-023-MSD	H4113MSD	X	X									X
				H4213MSD						X	X				X
				MH4113D			X								X
				MH4213D								X			X
				--				X	X						X
SW-26	05/03/16	1345	A-SW-026	H4116	X	X									
				MH4116			X								
				--				X	X				X^{1}		
SW-27	05/03/16	1120	A-SW-027	H4117	X	X									
				H4217						X					
				MH4217			X								
				--				X	X				X^{1}		
SW-29	05/11/16	0935	A-SW-029	H4119	X										
				--									X^{1}		

TABLE 5-7
Surface Water and Stormwater Samples, Laboratories, Analytical Suites, and Quality Control Summary
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab			EPA Region 8 Lab		CLP Confirmation Labs			SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Total Metals	TDS	Anions	VOCs	SVOCs	Total Metals	Isotopes $^{(1)}$		
SW-30	05/03/16	1630	A-SW-030	H4120	X										
				--									X^{1}		
SW-31	05/02/16	1510	A-SW-031	H4121	X										
				--									X^{1}		
SW-33	05/02/16	1400	A-SW-033	H4123	X										
				--									X^{1}		
SW-34	05/02/16	1430	A-SW-034	H4124	X										
				--									X^{1}		
SW-35	05/04/16	0930	A-SW-035	H4125	X										
				--									X^{1}		
SW-36	05/03/16	1730	A-SW-036	H4126	X										
				--									X^{1}		
SW-40	05/05/16	1745	A-SW-040	H4130	X										
				--									X^{1}		
SW-42	05/02/16	1420	A-SW-042	H4132	X										
				--									X^{1}		
SW-43	05/02/16	1315	A-SW-043	H4133	X										
				--									X^{1}		
SW-44	05/04/16	1430	A-SW-044	H4134	X										
				--									X^{1}		
			A-SW-044-MS	H4134MS	X										X
			A-SW-044-MSD	H4134MSD	X										X
SW-46	05/05/16	1730	A-SW-046	H4136	X										
				--									X^{1}		
SW-47	05/04/16	0840	A-SW-047	H4137	X	X									
				MH4137			X								
				--				X	X				X^{1}		
SW-48	05/04/16	0950	A-SW-048	H4138	X										
				--									X^{1}		
			A-SW-048-MS	H4138MS	X										X
			A-SW-048-MSD	H4138MSD	X										X
SW-50	02/26/16	1515	A-SW-001	H0901	X										
				--									X^{1}		

TABLE 5-7
Surface Water and Stormwater Samples, Laboratories, Analytical Suites, and Quality Control Summary
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Date Sampled	Time Sampled	Sample ID	CLP Sample ID	Analyses									Quality Control	
					CLP Lab			EPA Region 8 Lab		CLP Confirmation Labs			SIRFER	Duplicate	MS/MSD
					VOCs	SVOCs	Total Metals	TDS	Anions	VOCs	SVOCs	Total Metals	Isotopes (1)		
Stormwater															
SW-02	05/11/16	0910	A-SW-002	H4092	X										
				--									X[1]		
SW-03	05/11/16	0920	A-SW-003	H4093	X										
				--									X[1]		
SW-05	05/11/16	0757	A-SW-005	H4095	X										
				--									X[1]		
SW-10	05/11/16	0840	A-SW-010	H4100	X										
				--									X[1]		
SW-17	05/11/16	1018	A-SW-017	H4107	X										
				--									X[1]		
			A-SW-017-MS	H4107MS	X										X
			A-SW-017-MSD	H4107MSD	X										X
SW-18	05/05/16	0910	A-SW-018	H4108	X										
				--									X[1]		
			A-SW-018-D	H4021	X									X	
SW-20	05/05/16	1030	A-SW-020	H4110	X										
				--									X[1]		
SW-24	05/11/16	0925	A-SW-024	H4114	X										
				--									X[1]		
SW-25	05/05/16	1800	A-SW-025	H4115	X										
				--									X[1]		
SW-28	05/03/16	1200	A-SW-028	H4118	X	X									
				H4218						X					
				MH4218			X								
				--				X	X				X[1]		
SW-32	05/05/16	1120	A-SW-032	H4122	X										
				--									X[1]		
SW-37	05/05/16	1815	A-SW-037	H4127	X										
				--									X[1]		
SW-38	05/11/16	0810	A-SW-038	H4128	X										
				--									X[1]		
SW-39	05/03/16	1700	A-SW-039	H4129	X										
				--									X[1]		

TABLE 5-7
Surface Water and Stormwater Samples, Laboratories, Analytical Suites, and Quality Control Summary
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Date Sampled**	**Time Sampled**	**Sample ID**	**CLP Sample ID**	**Analyses**									**Quality Control**	
					CLP Lab			**EPA Region 8 Lab**		**CLP Confirmation Labs**			**SIRFER**	**Duplicate**	**MS/MSD**
					VOCs	**SVOCs**	**Total Metals**	**TDS**	**Anions**	**VOCs**	**SVOCs**	**Total Metals**	**Isotopes (1)**		
SW-41	05/05/15	1100	A-SW-041	H4131	X										
				--									X[1]		
SW-45	05/05/16	1000	A-SW-045	H4135	X										
				--									X[1]		
SW-49	05/05/16	1040	A-SW-049	H4139	X										
				--									X[1]		

NOTES:
1. Samples for isotope analysis were collected for future analysis; however, these have since been disposed of due to refrigerator storage malfunction.

-- = Not applicable.
CLP = EPA Contract Laboratory Program.
EPA = U.S. Environmental Protection Agency.
ID = Identification.
MS/MSD = Matrix spike/matrix spike duplicate.
SIRFER = University of Utah Stable Isotope Ratio Facility for Environmental Research.
SVOC = Semivolatile organic compound.
TDS = Total dissolved solids.
VOC = Volatile organic compound.

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TABLE 5-8

Soil Sampling Locations

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location/ Sample ID	Adjacent Surface Water	Sample Location Deviates From RI Work Plan(1)?	Reason For Moving Sample Location
SW-01/ SS-01	Seep	Yes	Collected at a location where PCE was not detected in the shallow groundwater sample.
SW-09/ SS-09	Seep	No	NA
SW-26/ SS-26	Seep	No	NA

NOTES:

1. First Environment. 2015a. *Final Remedial Investigation Work Plan, AOU-1: East Side Springs, 700 South 1600 East PCE Plume*, Salt Lake City, Utah. July.

ID = Identification.
NA = Not applicable.
PCE = Tetrachloroethene.
RI = Remedial Investigation.

TABLE 5-9

Soil Samples, Laboratories, Analytical Suites, and Quality Control Summary

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Date Sampled**	**Time Sampled**	**Sample ID**	**CLP Sample ID**	**Analyses**			**Quality Control**	
					CLP Lab			**Duplicate**	**MS/MSD**
					VOCs	**SVOCs**	**Total Metals**		
SW-01	05/04/16	1340	A-SS-01	H4086	X	X			
				MH4030			X		
			A-SS-01-D	H4082	X	X		X	
				MH4029			X	X	
SW-09	05/03/16	0855	A-SS-09	H4061	X	X			
				MH4025			X		
			A-SS-09-MS	H4061MS	X	X			X
				MH4025S			X		X
			A-SS-09-MSD	H4061MSD	X	X			X
				MH4025D			X		X
SW-26	05/03/16	1345	A-SS-26	H4076	X	X			
				MH4028			X		

NOTES:

Blank cell = Not analyzed.
CLP = U.S. Environmental Protection Agency Contract Laboratory Program.
ID = Identification.
MS/MSD = Matrix spike/matrix spike duplicate.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
X = Analyzed.

TABLE 5-10

Vapor Intrusion Sampling Summary

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure Location ID	**HAPSITE® Sampling**			**Laboratory Analysis (Method TO-15)**		
	Indoor Air	**Outdoor Air**	**Soil Gas**	**Indoor Air**	**Outdoor Air**	**Soil Gas**
0001-H	X	X		X		
0002-H	X	X		X		
0003-H				X		X
0004-H	X	X		X		
0008-H				X		X
0011-H				X		
0012-H	X	X		X		
0013-H	X	X		X		
0017-H				X		
0018-H				X		
0023-H				X		
0025-H	X	X		X		
0026-H	X	X		X	X	X
0027-H	X	X		X		
0029-H	X	X		X		
0030-H				X	X	X
0036-H				X		
0037-H				X		
0038-H	X			X		
0040-H	X	X	X	X		
0041-H	X	X	X			
0045-S	X	X	X			
0047-H	X	X	X			
0050-H	X	X	X			
0051-H	X	X	X	X		
0052-H	X	X	X			
0053-H	X	X	X	X		X
0054-H	X	X	X			
0055-H	X	X	X			
0056-H	X	X	X			
0057-H	X		X			
0058-H	X	X	X			
0059-H	X	X	X			
0060-H	X	X	X			
0061-H	X	X	X			
0062-H	X	X	X			
0063-H	X	X	X			
0064-H	X			X		
Totals 38 Structures	**29**	**26**	**18**	**23**	**2**	**5**

NOTES:

ID = Identification.

VI = Vapor intrusion.

This table identifies samples that resulted in validated, acceptable data from 2015, 2016, and 2017.

Color coding corresponds to symbols used for sample locations on Figure 5-2 and Figure 5-3.

TABLE 5-11

2015 Vapor Intrusion Sample Locations, HAPSITE® and TO-15

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure Number	HAPSITE® Indoor Air Real-Time Screening Conducted (1)	HAPSITE® Outdoor Air Real-Time Screening Conducted (1)	HAPSITE® Soil Gas Real-Time Screening Conducted (1)	TO-15 Indoor Air Sample Collected	TO-15 Outdoor Air Sample Collected	TO-15 Soil Gas Sample Collected, Near Slab	TO-15 Soil Gas Sample Collected, Open Field	Reason for Collection of the TO-15 Sample in 2015
0001-H [7]	X	X	X					
0002-H [7]	X	X	X					
0003-H [3]	X	X	X	X		X		HAPSITE® data exceeded RBSLs; obtain VC data
0004-H [7]	X	X	X					
0005-H	X	X	X					
0006-H	X	X	X					
0007-H	X		X	X				HAPSITE® values below RBSLs; obtain VC data; verify HAPSITE® values.
0008-H	X	X	X	X		X		HAPSITE® data exceeded RBSLs; verify HAPSITE® values below RBSLs
0009-H	X	X	X					
0010-H	X	X	X					
0011-H [4]	X	X	X	X	X	X		HAPSITE® data exceeded RBSLs; obtain VC data
0012-H [7]	X	X	X					
0013-H [7]	X	X	X					
0014-H	X	X	X					
0015-H	X	X	X					
0016-H	X	X	X					
0017-H [4]	X	X	X	X	X	X		HAPSITE® data exceeded RBSLs; obtain VC data; verify HAPSITE® values below RBSLs
0018-H [4]	X	X	X	X	X		X	HAPSITE® data exceeded RBSLs; obtain VC data
0019-B	X	X	X	X				Obtain VC data; verify HAPSITE® values below RBSLs
0020-C	X	X	X					
0021-S	X	X	X					
0022-S	X	X	X	X				Obtain VC data; HAPSITE® data exceeded RBSLs
0023-H [5]	X	X	X					
0024-H	X	X	X					
0025-H [7]	X	X	X					

TABLE 5-11

2015 Vapor Intrusion Sample Locations, HAPSITE® and TO-15

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure Number	HAPSITE® Indoor Air Real-Time Screening Conducted (1)	HAPSITE® Outdoor Air Real-Time Screening Conducted (1)	HAPSITE® Soil Gas Real-Time Screening Conducted (1)	TO-15 Indoor Air Sample Collected	TO-15 Outdoor Air Sample Collected	TO-15 Soil Gas Sample Collected, Near Slab	TO-15 Soil Gas Sample Collected, Open Field	Reason for Collection of the TO-15 Sample in 2015
0026-H [7]	X	X	X	X	X	X	X	HAPSITE® data exceeded RBSLs; obtain VC data; verify HAPSITE® values below RBSLs
0027-H [7]	X	X	X	X	X			Verify HAPSITE® values below RBSLs; obtain VC data
0028-S	X	X	X	X				Verify HAPSITE® values below RBSLs; obtain VC data
0029-H [7]	X	X	X					
0030-H	X	X	X	X	X		X	Verify HAPSITE® values below RBSLs; obtain VC data
0031-S	X		X				X	Verify HAPSITE® values below RBSLs; obtain VC data
0032-H	X	X	X					
0033-H	X	X	X					
0036-H	X	X	X	X				Verify HAPSITE® values below RBSLs
0037-H [6]	X	X	X	X		X		HAPSITE® data exceeded RBSLs; obtain VC data; verify HAPSITE® values below RBSLs
0038-H [8]	X	X						

NOTES:

1. Due to documented field and laboratory discrepancies with the HAPSITE® data, it is not considered usable for this RI. This table only reflects <u>where</u> this data was collected in the field at the 36 structures investigated in 2015, for the purposes of illustrating <u>where</u> follow-up SUMMA® canister samples were collected for TO-15 analysis.
2. Details regarding the rationale and location for each confirmatory sample are provided in the Sampling and Analysis Plan (Appendix A of FE 2015a).
3. An additional SUMMA® canister sample was collected at Structure 0003-H for vinyl chloride analysis using Method TO-15.
4. In 2016, additional SUMMA® canister samples were collected for analysis using method TO-15 because of a 2015 laboratory detection of PCE above the RBSL within an inhabitated room.
5. In 2016, additional SUMMA® canister sample was collected for analysis using method TO-15 because of a 2015 HAPSITE field screening detection of PCE, an order of magnitude above the RBSL, near an uninhabitated basement sump.
6. In 2016, additional SUMMA® canister sample was collected for analysis using method TO-15 because of a 2015 laboratory detection of PCE above the RBSL near an uninhabitated basement sump.
7. In 2017, additional HAPSITE® samples were collected (indoor and outdoor) and a SUMMA® canister sample was collected (indoors) for TO-15 analysis, to confirm 2015 detections.
8. In 2017, additional HAPSITE® samples were collected (indoors) and a SUMMA® canister sample was collected (indoors) for TO-15 analysis, to confirm 2015 detections.

RBSL = Risk-based screening level.
RI = Remedial investigation.
VC = Vinyl chloride.
VI = Vapor intrusion.

Data that is usable for the Remedial Investigation is shown in blue.

TABLE 5-12

2016 Vapor Intrusion Sample Locations, HAPSITE® and TO-15

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure Number	HAPSITE® Indoor Air Real-Time Screening Conducted	HAPSITE® Outdoor Air Real-Time Screening Conducted	HAPSITE® Soil Gas Real-Time Screening Conducted	TO-15 Indoor Air Sample Collected	TO-15 Outdoor Air Sample Collected	TO-15 Soil Gas Sample Collected Near Slab	TO-15 Soil Gas Sample Collected Open Field	Reason for Collection of the 2016 Sample
0011-H [1]				X	None collected in 2016		None collected in 2016	Confirmation sampling of indoor air sampled in 2015; vinyl chloride analysis also conducted.
0017-H [1]				X				Confirmation sampling of indoor air sampled in 2015; vinyl chloride analysis also conducted.
0018-H [1]				X				Confirmation sampling of indoor air sampled in 2015; vinyl chloride analysis also conducted.
0023-H [2]				X				Confirmation sampling of indoor air sampled in 2015; vinyl chloride analysis also conducted.
0037-H [3]				X				Confirmation sampling of indoor air sampled in 2015; vinyl chloride analysis also comducted.
0040-H	X	X	X	X				Sampling new structure; vinyl chloride analysis indoor air.
0041-H	X	X	X					Sampling new structure
0045-S	X	X	X					Sampling new structure
0047-H	X	X	X					Sampling new structure
0050-H	X	X	X					Sampling new structure
0051-H	X	X	X	X				Sampling new structure; vinyl chloride analysis indoor air.
0052-H	X	X	X					Sampling new structure
0053-H	X	X	X	X		X		Sampling new structure; vinyl chloride analysis indoor air.
0054-H	X	X	X					Sampling new structure
0055-H	X	X	X					Sampling new structure
0056-H	X	X	X					Sampling new structure
0003-H				X				Vinyl chloride confirmation

NOTES:

Data that is usable fof the RI is shown in blue. All 2016 data is usable.

1. 2015 laboratory detection of PCE above the RBSL within an inhabitated room (EA 2016h).
2. 2015 HAPSITE field screening detection of PCE an order of magnitude above the RBSL near an uninhabitated basement sump.
3. 2015 laboratory detection of PCE above the RBSL near an uninhabitated basement sump.

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TABLE 5-13

2017 Vapor Intrusion Sample Locations, HAPSITE® and TO-15

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure Number	HAPSITE® Indoor Air Real-Time Screening Conducted	HAPSITE® Outdoor Air Real-Time Screening Conducted	HAPSITE® Soil Gas Real-Time Screening Conducted	TO-15 Indoor Air Sample Collected (3)	TO-15 Outdoor Air Sample Collected	TO-15 Soil Gas Sample Collected Near Slab	TO-15 Soil Gas Sample Collected Open Field	Reason for Collection of the 2017 Sample (2)
0001-H (1)	X	X		X	None collected in 2017	None collected in 2017	None collected in 2017	SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0002-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0004-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0012-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0013-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0025-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0026-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0027-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0029-H (1)	X	X		X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0038-H (1)	X			X				SUMMA® confirmation sampling (resampling previously sampled structures) using limited VI protocol; vinyl chloride and 1,4-dioxane analysis included.
0057-H (2)	X		X					New structure (supplemental data) using full VI protocol; location selected to fill data gap
0058-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0059-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0060-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0061-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0062-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0063-H (2)	X	X	X					New structures (supplemental data) using full VI protocol
0064-H (4)	X			X				New structures (supplemental data) using limited VI protocol); vinyl chloride and 1,4-dioxane analysis included

NOTES:

1. HAPSITE® monitoring was conducted with no pressure control. Location selected based on 2016 groundwater and surface water data (i.e., presence of PCE in groundwater, depth to groundwater < 50-ft bgs, and PCE present in surface water) (EA 2017c)
2. HAPSITE® monitoring was conducted both with pressure control and under ambient conditions. Location selected to fill data gaps.
3. Both TO-15 and TO-15 SIM were used to analyze these SUMMA® canister samples. TO-15 and TO-15 SIM confirmation samples were only to be collected at full VI protocol structures (new structures) if a residential indoor air screening level and/or soil gas screening
4. Structure added to samplgin program per resident request.

VI = Vapor intrusion.

Data that is usable fof the RI is shown in blue. All 2017 data is usable.

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TABLE 5-14
Field Deviations from the Remedial Investigation Work Plan
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
Change in the sample naming convention for VI samples collected in 2015 and 2016.	The sample naming convention is delineated in Table 3 of the Sampling and Analysis Plan that is included in Appendix A of the RI Work Plan.	RI Work Plan(1)	Although a similar sample naming convention was followed, it did not comply fully with the RI Work Plan requirements. The RI Work Plan-compliant sample IDs are included in Table 5-18 for cross reference. There were no deviations from the sample naming convention in 2017.	None.
Change in sample naming convention for groundwater, surface water and soil. A parcel code and date code were not included in the sample identification. The sample identification included the "A" for AOU-1, the sample type "GW, SW, or SS" and a sequential number-01, -02, etc., with the exception of soil samples. Soil sample identification used a number that corresponded to the adjacent surface water sample number.	"Sample identification and tracking procedures will incorporate the sample numbering system outlined in Table 3. "	RI Work Plan(1)	Although a similar sample naming convention was followed, it did not comply fully with the RI Work Plan requirements. The RI Work Plan-compliant sample IDs are included in Table 5-15 for cross reference.	None.
Changes to the proposed locations for some temporary groundwater monitoring points	Original locations were identified on Figure 10 in the RI Work Plan	RI Work Plan**(1)**	Borings GW-01, GW-02, GW-04, GW-07, GW-08, GW-12, GW-13, GW-14, GW-21, and GW-25 were shifted from their proposed locations to either avoid underground utilities or to better define the PCE groundwater plume.	None.

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
Changes to the timing for collection of groundwater and surface water samples.	“The field investigation for surface water and very shallow groundwater will commence in the vicinity of the 11 spring and seep locations (pending owner approval to access) previously sampled in 2010 and 2011, then proceed to spring and seep locations identified, but not tested during previous investigations (pending access approval), and for groundwater continue at properties whose owners have already requested indoor air pathway evaluation.”	QAPP(2)	The timeline for collection of groundwater and surface water samples was based on access and availability of properties rather than the specific sequence identified in the QAPP.	None.
Change to the number of manually-collected groundwater samples.	"Up to 25 shallow temporary groundwater sample points will be manually installed through the water table near ponds, seeps, or springs adjacent to residences or occupied structures...An additional 35 temporary shallow groundwater sampling points will be installed mechanically to depths up to 50 ft using a truck or tractor-mounted GeoProbe® Tool."	RI Work Plan(1)	Only two temporary groundwater monitoring points were manually installed (via hand auger). The remaining temporary groundwater monitoring points were installed using a Geoprobe® direct push technology.	None.

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
Water level stabilization prior to collection of groundwater at temporary groundwater monitoring points.	"Monitor static water level to ensure that the drawdown is minimal, preferably less than 0.3 foot at a purge rate of 0.2 to 2 liters per minute."	RI Work Plan(1)	The depth to groundwater was not measured during purging of temporary groundwater monitoring points due to the small diameter of the well precluding insertion of the water level indicator while the tubing is present. Initial (pre-pump) ground water levels were obtained. In addition, some monitoring points were sampled after	None. Other parameters (i.e., pH, conductivity, etc.) was used to evaluate stability and representativeness prior to sample collection. Furthermore, due to the small capacity of the well points and annular space, there is high confidence that the water entering the well point was representative of the shallow aquifer. However, slow recharge and inability to purge without drawdown may result in increased turbidity and dissolved oxygen.
No pH data collected at GW-23 and GW-39.	"To the extent possible, the purge water will be routed through a flow cell to measure pH, electrical conductivity, oxygen-reduction potential, turbidity, and dissolved oxygen with field water quality meters."	RI Work Plan(1)	Field data for pH was not collected at temporary groundwater monitoring points GW-23 and GW-39 due to a malfunction of the pH probe on the water quality meter.	None.
Samples were not collected for VOC screening at groundwater monitoring Geoprobe® points GW-07 and GW-17	Groundwater samples for screening of VOC contaminants were collected during the Geoprobe® investigation to direct the placement of temporary groundwater monitoring points.	RI Work Plan(1)	Low groundwater yield at temporary groundwater monitoring points GW-07 and GW-17 did not provide enough sample volume for screening of VOCs.	None. Groundwater samples from GW-07 and GW-17 were collected and analyzed by the CLP lab.
Surface water locations SW-01, SW-02, SW-03, SW-05, SW-07, SW-08, SW-09, SW-10, SW-13, SW-17, SW-18, and SW-19 were repositioned.	Proposed locations for surface water locations SW-01 through SW-19 shown on Figure 10 in the RI Work Plan	RI Work Plan(1)	Repositioning was necessary when seeps and springs were not present on the property as originally expected, if access was not granted from property owners, or to fill data gaps.	None.
Surface soil and surface water samples were not surveyed	"All outdoor sampling locations will be located for GIS input using GPS survey techniques. A GPS with sub-meter accuracy and software to perform post-processing data correction will be used to survey soil gas sampling locations,	RI Work Plan(1)	The small parcel sizes allowed for physical description of the location of the spring, which was then georeferenced using GIS.	None.

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
	surface water sampling locations; temporary groundwater monitoring points, and surface soil sample locations."			
Two surface water samples were analyzed for stable isotopes - deuterium and oxygen-18 instead of 10.	"Up to ten surface water samples will be collected and submitted to the University of Utah Stable Isotope Ratio Facility for Environmental Research for deuterium and oxygen-18 analysis."	Minor Field Modification #3 - #6 to the RIWP (March 2016)	Due to the VA storage refrigerator malfunction, and the potential for isotope fractionation to have occurred due to the elevated temperature of the samples, it was determined the surface water samples should be disposed of and not analyzed.	None. Samples for isotope ratio analysis will be collected as part of the OU-2 groundwater investigation.
Only two soil samples were collected at locations where groundwater exhibited the highest PCE concentrations along Sunnyside Avenue. The third soil sample was collected at a location where PCE was not detected in the groundwater to serve as a baseline sample.	"Three soil samples will be collected from the 0 to 0.5 ft soil interval at locations determined to be associated with elevated soil gas levels or near surface water springs/seeps containing elevated target cVOC concentrations."	RI Work Plan(1)	It was decided that baseline soil data was necessary to serve as a reference, so one of the three soil samples was relocated for this purpose.	None.
Near-slab soil gas sampling was not performed at one location with indoor air exceedances (0022-S), three locations without indoor air exceedances and selected as additional VC concentration confirmation sites (0007-H, 0027-H, and 0036-H), and two locations where indoor air confirmation was requested by VA (0019-B and 0028-S).	"Samples will be collected from locations adjacent to structures where PCE or TCE or indoor air exceeded their respective RSLs or where soil gas vapors are found to exceed their RSLs for the detected cVOC. In addition, SUMMA® samples will be collected in select locations where the field portable GC/MS did not detect cVOCs in soil gas, in order to ensure that the VC is not missed and to confirm the portable GC/MS results."	RI Work Plan(1)	The near-slab sample at 0022-S was inadvertently not collected due to the soil gas screening being conducted the day after indoor screening and indoor SUMMA® placement.	None

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
TO-15 SIM method was initially used in lieu of the full TO-15 method for indoor air samples.	"Samples will be sent to ALS-Global in Salt Lake City, Utah, a UDEQ-certified laboratory, for full volatile (TO-15) analytical suite analyses."	QAPP(2)	The laboratory MDLs for Method TO-15 were not specified in the QAPP and the initial RSLs developed subsequent to QAPP approval by regulators were lower than typical TO-15 lab MDLs. This issue was identified at the start of the field effort, and the TO-15 SIM method was initially used in lieu of the full TO-15 method to confirm indoor air PCE, TCE, 1,2-DCE, and VC screening results.	None
Open-field samples were only collected at sites 0018-H, 0019-B, 0026-H, and 0031-S.	"It is anticipated that the first soil gas samples to be collected will be from adjacent to the six spring locations identified during the previous investigations as containing PCE, and then at the six spring locations that did not contain PCE, and the sampling program expanded as additional spring locations within the study area are identified during field activities, up to an expected total of 50 samples."	RI Work Plan**(1)**	The number of open-field soil gas sample locations along street right-of-ways and near any seeps and springs observed on the 36 sites was limited. Large cobbles and boulders in sandy soil intervals, tight clays, and the close spacing of residences and their associated pavements and landscaping greatly limited the manual installation of open-field soil gas sample probes. In addition, much of the public roadside right-of-ways were narrow and underlain by numerous utility lines and large trees.	None
Near-slab soil gas sampling probes could not be installed at two sites, 00032-H and 0038-H.	"To identify and characterize cVOC vapors present in soils adjacent to tested structures, near-slab soil gas sampling will occur concurrently with the indoor air testing and at the same locations where indoor air testing is being conducted."	RI Work Plan **(1)**	Near-slab soil gas sampling probes could not be installed after numerous attempts, due to very shallow refusal on large cobbles or boulders; however, these two sites did not have any elevated detections of indoor air cVOCs.	None
HAPSITE® samples collected at Structure 050-H on 23 March 2016, were inadvertently misidentified in the 2016 Vapor Intrusion Investigation Field	Section 5.13.1 of the RI Work Plan states that sample identification numbers are to reflect the parcel of street ID code generated by the VA tracking database.	RI Work Plan **(1)**	NA. The deviation was inadvertent.	None. The sample numbers were corrected in the data set used for the AOU-1 RI, to document that these HAPSITE® results are from Structure 0050-H, not 0051-H.

TABLE 5-14
Field Deviations from the Remedial Investigation Work Plan
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Description of Deviation	Original Requirement	Reference	Rationale	Impact on Data Usability
Data Report and subsequently corrected (EA 2018b). Instead of reflecting that the samples were collected at 0050-H, there was a typographical error in the sample identification numbers indicating that the samples were collected at 0051-H.				

NOTES:

1. First Environment. 2015a. Final Remedial Investigation Work Plan, AOU-1: East Side Springs, 700 South 1600 East PCE Plume, Salt Lake City, Utah. July.
2. EA Engineering, Science, and Technology, Inc., PBC. 2016c. Final Quality Assurance Project Plan for 700 South 1600 East Tetrachloroethylene Plume, Accelerated Operable Unit 1: East Side Springs, Revision 1, Salt Lake City, Utah. February.

cVOC = Chlorinated volatile organic compound.
DCE = Dichloroethene.
ft = Feet(feet).
GC/MS = Gas chromatography/mass spectrometry.
GIS = Geographic Information System.
GPS = Global Positioning System.
ID = Identification.
MDL = Method detection limit.
NA = Not applicable.
PCE = Tetrachloroethylene.
QAPP = Quality Assurance Project Plan.
RI = Remedial Investigation.
RSL = U.S. Environmental Protection Agency Regional Screening Levels.
SIM = Selective Ion Monitoring.
TCE = Trichloroethene.
TO-15 = Toxic Organics (in reference to Analytical Method 15).
UDEQ = Utah Department of Environmental Quality.
VA = U.S. Department of Veterans Affairs.
VC = Vinyl Chloride.
VI = Vapor intrusion.

TABLE 5-15

Cross Reference to Remedial Investigation Work Plan-Compliant Sample IDs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Media	Actual Designation	Planned Designation
Indoor Air/ Soil Gas	0008H-041015-SG-001A-4	A-0008H-041015-SG-001A-4
	0008H-041015-SG-001B-4	A-0008H-041015-SG-001B-4
	0026H-040815-SG-002-4	A-0026H-040815-SG-002-4
	0026H-040815-SG-003-4	A-0026H-040815-SG-003-4
	0026H-040815-TO-001-PAN	A-0026H-040815-TO-001-PAN
	0026H-040815-TO-003-OUT	A-0026H-040815-TO-003-OUT
	0030H-041115-TO-001-LAU	A-0030H-041115-TO-001-BAS
	0030H-041115-TO-002-OUT	A-0030H-041115-TO-002-OUT
	0030H-041115-TO-003-AAA	A-0030H-041115-TO-003-OUT
	0030H-041114-SG-001A	A-0030H-041115-SG-001A-6
	0036H-040415-TO-001	A-0036H-040415-TO-001-BAS
	A-0003H-030316-IA-BAS	A-0003H-030316-IA-001-BAS
	A-0017H-031616-IA-BAS	A-0017H-031616-IA-001-BAS
	A-0018H-031616-IA-BAS	A-0018H-031616-IA-001-BAS
	A-0023-031616-IA-BA1	A-0023-031616-IA-001-BA1
	A-0037H-030816-IA-LAU	A-0037H-030816-IA-001-LAU
	A-0040H-031216-IA-BAS	A-0040H-031216-IA-001-BAS
	A-0040H-031216-IA-BAS-D	A-0040H-031216-IA-001-BAS-D
	A-0040H-031216-IA-KIT	A-0040H-031216-IA-001-KIT
	A-0051-031616-IA-BAS	A-0051-031616-IA-001-BAS
	A-0051-031616-IA-BAS-D	A-0051-031616-IA-001-BAS-D
	A-0053H-052316-SG-001-6'(0037)	A-0053H-052316-SG-001-6
	A-0053H-052316-SG-001-6'(0050)	A-0053H-052316-SG-002-6
	A-0053H-052416-IA-BAS	A-0053H-052416-IA-001-BAS
	A-0053H-052416-IA-BAS-D	A-0053H-052416-IA-001-BAS-D
Groundwater	A-GW-001	A-GW-001-030416-001
	A-GW-001-D	A-GW-001-030416-001-D
	A-GW-003	A-GW-002-022616-001
	A-GW-004	A-GW-004-022616-001
	A-GW-005	A-GW-005-022616-001
	A-GW-006	A-GW-006-022616-001
	A-GW-007	A-GW-007-022816-001
	A-GW-008	A-GW-008-022716-001
	A-GW-009	A-GW-009-022616-001
	A-GW-010	A-GW-010-022716-001
		A-GW-010-071216-001
		A-GW-010-092016-001

TABLE 5-15
Cross Reference to Remedial Investigation Work Plan-Compliant Sample IDs
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Sample Media	Actual Designation	Planned Designation
Groundwater (cont'd.)	A-GW-010-D	A-GW-010-022716-001-D
	A-GW-011	A-GW-011-022716-001
		A-GW-011-071116-001
		A-GW-011-091916-001
	A-GW-012	A-GW-012-030216-001
	A-GW-013	A-GW-013-030416-001
	A-GW-014	A-GW-014-030216-001
	A-GW-015	A-GW-015-022916-001
	A-GW-015-D	A-GW-015-022916-001-D
	A-GW-016	A-GW-016-022816-001
		A-GW-016-071116-001
		A-GW-016-091916-001
	A-GW-017	A-GW-017-030216-001
	A-GW-018	A-GW-018-030216-001
	A-GW-020	A-GW-020-030116-001
		A-GW-020-071116-001
		A-GW-020-091916-001
	A-GW-021	A-GW-021-030116-001
	A-GW-022	A-GW-022-030116-001
	A-GW-023	A-GW-023-022216-001
	A-GW-024	A-GW-024-022516-001
	A-GW-025	A-GW-025-022916-001
	A-GW-026	A-GW-026-022816-001
	A-GW-027	A-GW-027-030516-001
	A-GW-028	A-GW-028-030516-001
	A-GW-031	A-GW-031-022816-001
	A-GW-039	A-GW-039-022316-001
	A-GW-040	A-GW-040-030316-001
	A-GW-043	A-GW-043-030316-001
	A-GW-046	A-GW-046-022416-001
	A-GW-048	A-GW-048-030316-001
	A-GW-049	A-GW-049-022516-001
		A-GW-049-071216-001
		A-GW-049-091916-001
	A-GW-049-D	A-GW-049-022516-001-D
	A-GW-050	A-GW-050-022916-001
		A-GW-050-071216-001

TABLE 5-15

Cross Reference to Remedial Investigation Work Plan-Compliant Sample IDs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Media	Actual Designation	Planned Designation
Groundwater (cont'd.)		A-GW-050-092016-001
	A-GW-051	A-GW-051-030416-001
	A-GW-052	A-GW-052-030316-001
		A-GW-052-071216-001
		A-GW-052-092016-001
	A-GW-052-D	A-GW-052-030316-001-D
		A-GW-052-071216-001-D
		A-GW-052-092016-001-D
	A-GW-053	A-GW-053-030316-001
		A-GW-053-071116-001
		A-GW-053-091916-001
	A-GW-055	A-GW-055-030516-001
	A-GW-059	A-GW-059-030516-001
		A-GW-059-071116-001
		A-GW-059-091916-001
	A-GW-060	A-GW-060-030816-001
	A-GW-061	A-GW-061-030516-001
		A-GW-061-071216-001
		A-GW-061-092016-001
	A-GW-062	A-GW-062-030816-001
Surface Water/ Stormwater	A-SW-001	A-SW-001-050416-001
	A-SW-001-D	A-SW-001-050416-001-D
	A-SW-002	A-SW-002-051116-001
	A-SW-003	A-SW-003-051116-001
	A-SW-004	A-SW-004-050216-001
	A-SW-005	A-SW-005-051116-001
	A-SW-006	A-SW-006-050416-001
	A-SW-006-D	A-SW-006-050416-001-D
	A-SW-007	A-SW-007-050416-001
	A-SW-007-D	A-SW-007-050416-001-D
	A-SW-008	A-SW-008-050416-001
	A-SW-008-D	A-SW-008-050416-001-D
	A-SW-009	A-SW-009-050316-001
	A-SW-010	A-SW-010-051116-001
	A-SW-011	A-SW-011-050316-001
	A-SW-012	A-SW-012-050316-001
	A-SW-013	A-SW-013-050316-001

TABLE 5-15

Cross Reference to Remedial Investigation Work Plan-Compliant Sample IDs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Media	Actual Designation	Planned Designation
Surface Water/ Stormwater (cont'd.)	A-SW-014	A-SW-014-050416-001
	A-SW-015	A-SW-015-050416-001
	A-SW-016	A-SW-016-050416-001
	A-SW-017	A-SW-017-051116-001
	A-SW-018	A-SW-018-050516-001
	A-SW-018-D	A-SW-018-050516-001-D
	A-SW-019	A-SW-019-050416-001
	A-SW-020	A-SW-020-050516-001
	A-SW-021	A-SW-021-050316-001
	A-SW-022	A-SW-022-050316-001
	A-SW-023	A-SW-023-050316-001
	A-SW-024	A-SW-024-051116-001
	A-SW-025	A-SW-025-050516-001
	A-SW-026	A-SW-026-0503-16-001
	A-SW-027	A-SW-027-050316-001
	A-SW-028	A-SW-028-050316-001
	A-SW-029	A-SW-029-051116-001
	A-SW-030	A-SW-030-050316-001
	A-SW-031	A-SW-031-050216-001
	A-SW-032	A-SW-028-050316-001
	A-SW-033	A-SW-033-050216-001
	A-SW-034	A-SW-034-050216-001
	A-SW-035	A-SW-035-050416-001
	A-SW-036	A-SW-036-050316-001
	A-SW-037	A-SW-037-050516-001
	A-SW-038	A-SW-038050116-001
	A-SW-039	A-SW-039-050316-001
	A-SW-040	A-SW-040-050516-001
	A-SW-041	A-SW-041-050515-001
	A-SW-042	A-SW-042-050216-001
	A-SW-043	A-SW-043-050216-001
	A-SW-044	A-SW-044-050416-001
	A-SW-045	A-SW-045-050516-001
	A-SW-046	A-SW-046-050516-001
	A-SW-047	A-SW-047-050416-001
	A-SW-048	A-SW-048-050416-001
	A-SW-049	A-SW-049-050516-001

TABLE 5-15

Cross Reference to Remedial Investigation Work Plan-Compliant Sample IDs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Media	Actual Designation	Planned Designation
Surface Water/ Stormwater (cont'd.)	A-SW-050	A-SW-050-022616-001
Soil	A-SS-01	A-SS-001-050416-001
	A-SS-01-D	A-SS-001-050416-001-D
	A-SS-09	A-SS-009-050316-001
	A-SS-26	A-SS-026-050316-001

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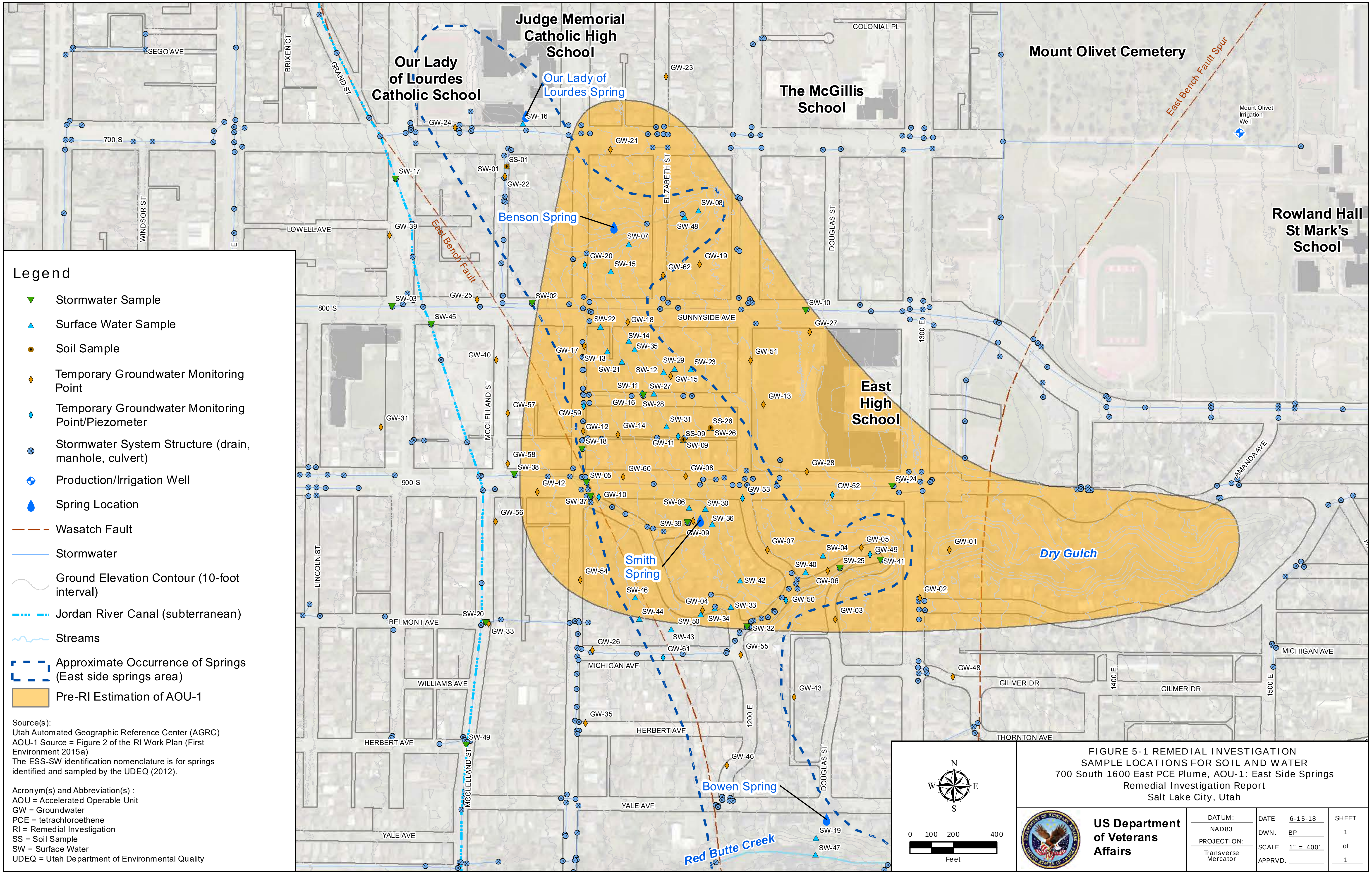

Legend

- ▼ Stormwater Sample
- ▲ Surface Water Sample
- ● Soil Sample
- ◆ Temporary Groundwater Monitoring Point
- ◆ Temporary Groundwater Monitoring Point/Piezometer
- ⊗ Stormwater System Structure (drain, manhole, culvert)
- ⊕ Production/Irrigation Well
- 💧 Spring Location
- Wasatch Fault
- Stormwater
- Ground Elevation Contour (10-foot interval)
- Jordan River Canal (subterranean)
- Streams
- Approximate Occurrence of Springs (East side springs area)
- 🟧 Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)
The ESS-SW identification nomenclature is for springs identified and sampled by the UDEQ (2012).

Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
GW = Groundwater
PCE = tetrachloroethene
RI = Remedial Investigation
SS = Soil Sample
SW = Surface Water
UDEQ = Utah Department of Environmental Quality

FIGURE 5-1 REMEDIAL INVESTIGATION
SAMPLE LOCATIONS FOR SOIL AND WATER
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 6-15-18
DWN. BP
SCALE 1" = 400'
APPRVD.
SHEET 1 of 1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 5-1 RI Sample Locations for Soil and Water.mxd bpawling 6/8/2018

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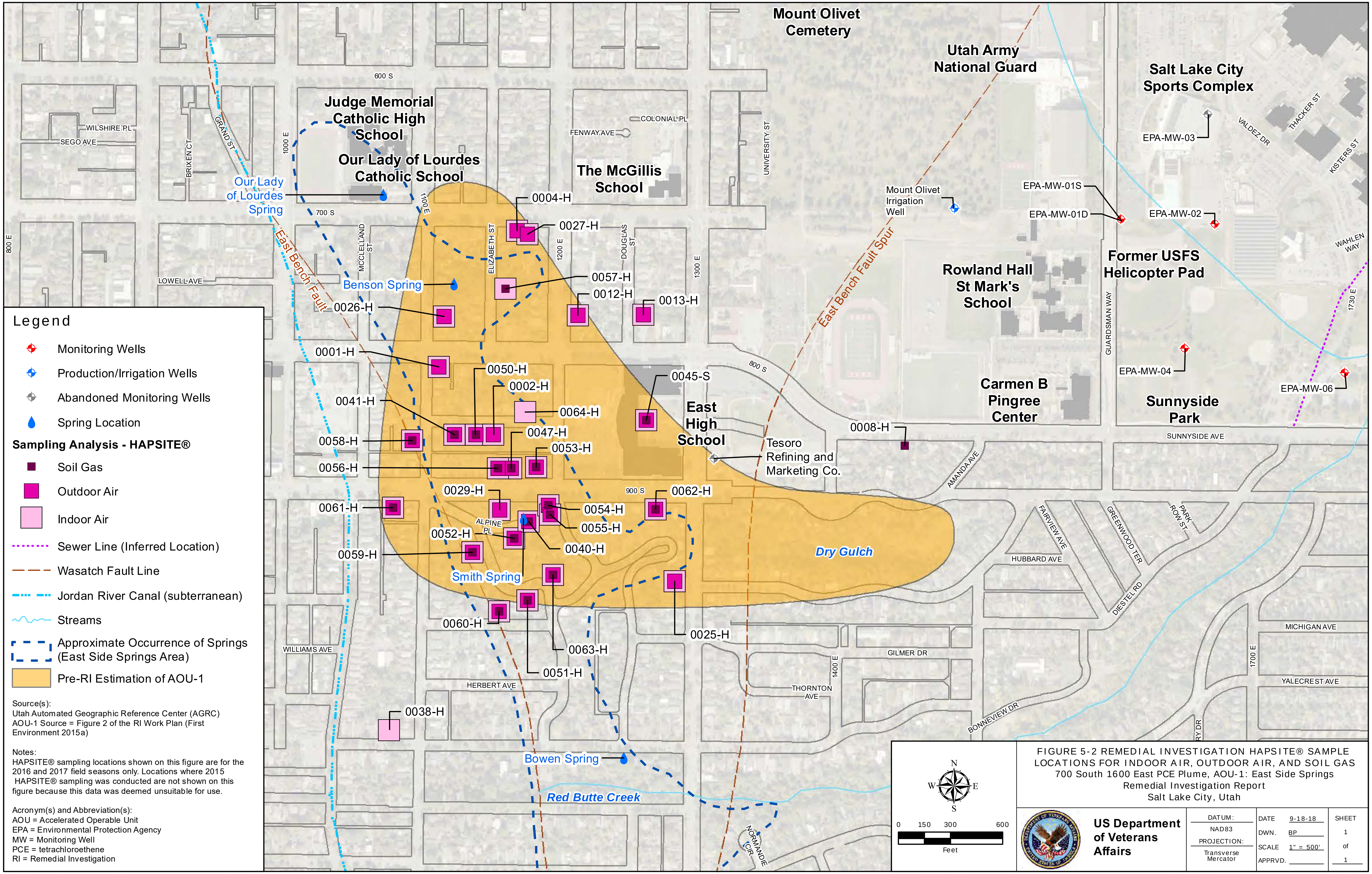

Legend

- ✦ Monitoring Wells
- ✦ Production/Irrigation Wells
- ✦ Abandoned Monitoring Wells
- 💧 Spring Location

Sampling Analysis - HAPSITE®

- ■ Soil Gas
- ■ Outdoor Air
- ■ Indoor Air
- ⋯ Sewer Line (Inferred Location)
- – – Wasatch Fault Line
- –·– Jordan River Canal (subterranean)
- ~ Streams
- ▭ Approximate Occurrence of Springs (East Side Springs Area)
- ▨ Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Notes:
HAPSITE® sampling locations shown on this figure are for the 2016 and 2017 field seasons only. Locations where 2015 HAPSITE® sampling was conducted are not shown on this figure because this data was deemed unsuitable for use.

Acronym(s) and Abbreviation(s):
AOU = Accelerated Operable Unit
EPA = Environmental Protection Agency
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation

FIGURE 5-2 REMEDIAL INVESTIGATION HAPSITE® SAMPLE LOCATIONS FOR INDOOR AIR, OUTDOOR AIR, AND SOIL GAS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 9-18-18
DWN. BP
SCALE 1" = 500'
APPRVD.
SHEET 1 of 1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 5-2 Hapsite Sampling Locations For Indoor Air, Outdoor Air, And Soil Gas.mxd bpawling 9/18/2018

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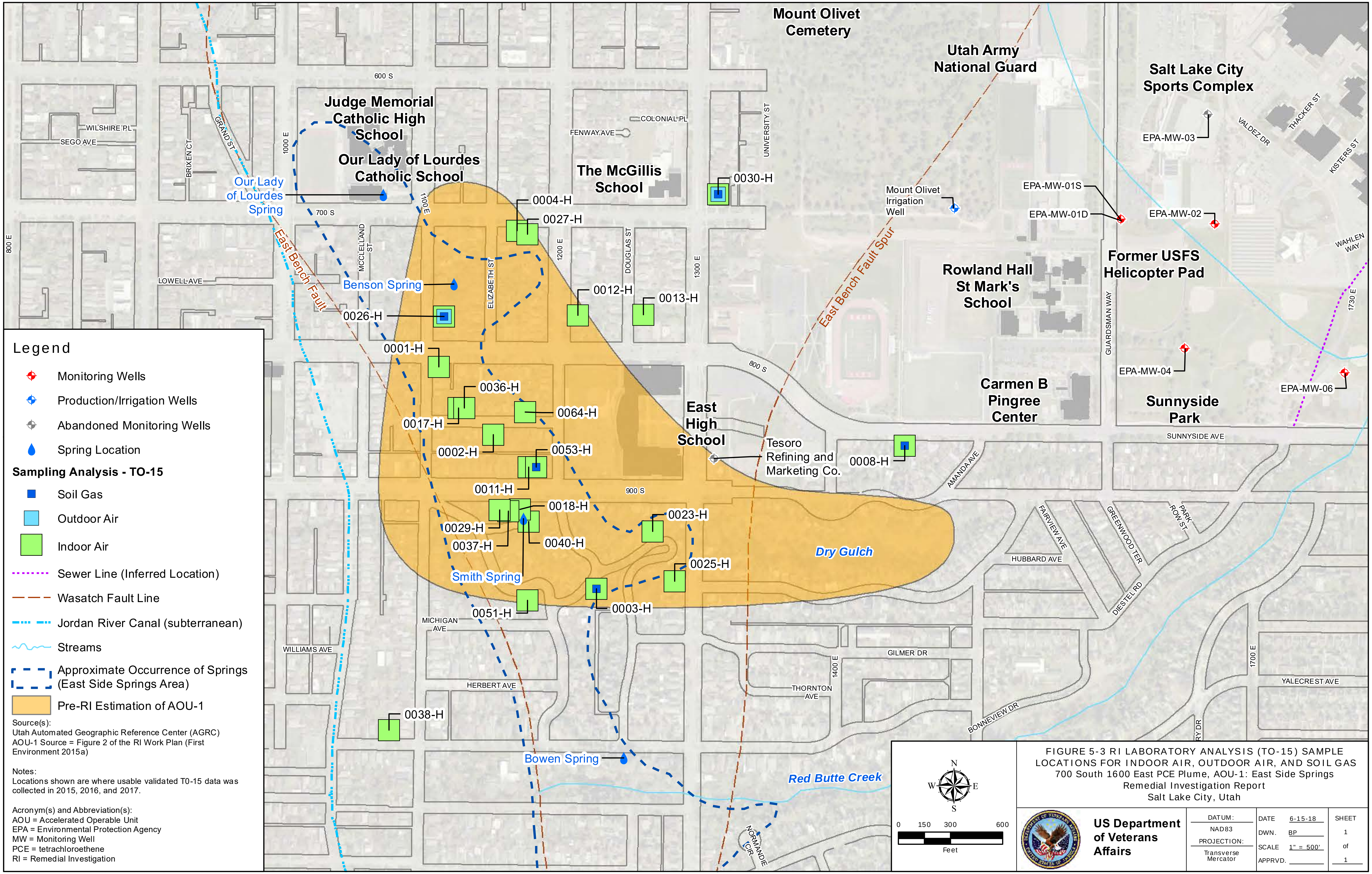


Legend

- 🔴 Monitoring Wells
- 🔵 Production/Irrigation Wells
- ⚪ Abandoned Monitoring Wells
- 💧 Spring Location

Sampling Analysis - TO-15

- ■ Soil Gas
- 🟦 Outdoor Air
- 🟩 Indoor Air
- ⋯ Sewer Line (Inferred Location)
- – – Wasatch Fault Line
- -·- Jordan River Canal (subterranean)
- ~ Streams
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)
- 🟧 Pre-RI Estimation of AOU-1

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Notes:
Locations shown are where usable validated T0-15 data was collected in 2015, 2016, and 2017.

Acronym(s) and Abbreviation(s):
AOU = Accelerated Operable Unit
EPA = Environmental Protection Agency
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation

N W E S

0 150 300 600
Feet

FIGURE 5-3 RI LABORATORY ANALYSIS (TO-15) SAMPLE LOCATIONS FOR INDOOR AIR, OUTDOOR AIR, AND SOIL GAS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

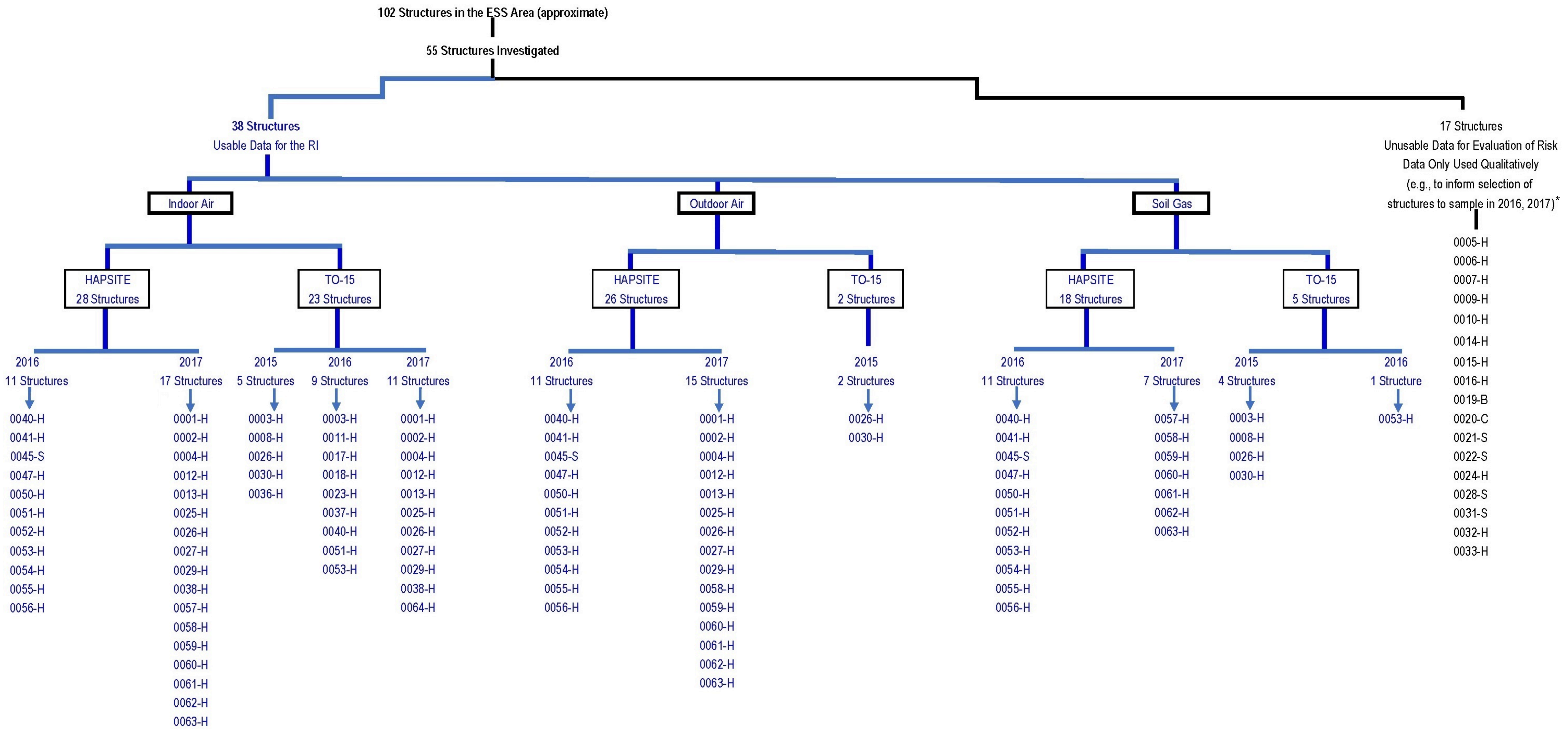
US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 500'
APPRVD.

SHEET
1
of
1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 5-3 Laboratory Analysis (To15) Sampling Locations For Indoor Air, Outdoor Air, And Soil Gas.mxd bpawling 6/8/2018



Note:
* Additionally, 0001H, 0002H, 0004H, 0011H, 0012H, 0013H, 0017H, 0018H, 0023H, 0025H, 0027H, 0029H, 0037H, and 0038H were sampled in 2015, and this data was determined to be unusable. However, these structures were resampled in either 2016 or 2017, and usable data was obtained from these structures for use in the RI.

FIGURE 5-4 VI INVESTIGATION STRUCTURES 2015-2017
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NA
PROJECTION: NA
DATE 11-21-18
DWN. BP
SCALE NA
APPRVD.
SHEET 1 of 1

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 5-4 Investigation History Diagram.mxd bpawling 9/17/2018 4:20:47 PM

6.0 Nature and Extent of Contamination

6.1 Summary of PCOPCs and Potentially Contaminated Media

This RI was conducted specifically for the ESS area (AOU-1) of the Site. The potentially contaminated media detailed in the RI Work Plan (FE 2015a) was shallow groundwater, surface water, stormwater, soil, soil gas, and vapor as VI. Based on previous CSMs for the Site, potentially contaminated groundwater was daylighting at the surface as seeps and springs and potentially adsorbing onto soil. The PCOPCs in the groundwater could also potentially volatilize and be held in soil gas or intrude into overlying structures via VI.

Based on previous investigations at the Site, the PCOPCs include cVOCs - PCE, TCE, cis-DCE and VC, as well as 1,4-dioxane.

The following sections present the results of the RI activities performed in the ESS area.

6.2 Summary of the Data Quality Evaluation

This data quality evaluation summarizes data validation results of definitive laboratory data associated with samples collected in support of the RI for AOU-1. The assessment of precision, accuracy, representativeness, comparability, completeness, and sensitivity parameters was not performed in detail for the HAPSITE® data, which was used for screening purposes. Sampling procedures and overall QA/QC protocols associated with the sampling and analyses are presented in the RI Work Plan (FE 2015a) and QAPP Update Revision 1 (EA 2016c). The data included in this RI Report have undergone data verification and validation, meet project DQOs, and are usable for the RI evaluations, including nature, extent, and risk.

A Tier 2B data validation was performed on 100 percent and Tier 4 data validation was performed on 10 percent of the RI laboratory analytical data. Validation was performed by a third-party subcontractor, Environmental Data Services, Newport News, Virginia, in accordance with the guidelines and QC control criteria. Analytical data generated by the EPA Region 8 laboratory, underwent internal validation prior to reporting the results.

Laboratory analytical data were reviewed to evaluate precision, accuracy, representativeness, comparability, completeness, and sensitivity. The precision and accuracy of data collected during the RI are measured in accordance with and are compared with the acceptance criteria defined in QAPP Update Revision 1 (EA 2016c) and EPA Data Validation Guidelines (EPA 2014b,c).

Data qualifiers were assigned according to the QC acceptance limits defined in QAPP Update Revision 1. The data validation qualifiers for each SDG are summarized in each individual data validation report (Attachment 1). The data qualifiers and the reason code for applying the qualifiers flag, are also maintained in the project database. Multiple qualifiers may be applied to a specific sample method/matrix/analyte; however, the final qualifier presented with the data values is based on the most conservative of the validation criteria.

The data qualifiers are defined as follows:

J = Analyte was present but the reported value is estimated.

J+ = The analyte was positively identified; the associated numerical value is its approximate concentration with a high bias in the sample.

J- = The analyte was positively identified; the associated numerical value is its approximate concentration with a low bias in the sample.

UJ = Analyte was not detected above the MDL. However, the reported detection limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R = Result has been rejected and data do not meet the project objectives.

U = Analyte was analyzed for but not detected above the MDL.

6.2.1 Groundwater Data Quality

A total of 62 shallow groundwater samples and associated field QC samples were collected for the AOU-1 RI as described in Section 5.2. A list of the 2016 groundwater samples is provided in Table 5-4. Section 5.2.3 describes groundwater sample collection protocol that was followed.

Samples were analyzed in accordance with the CLP Statement of Work (SOW) for organic and inorganic methods (EPA 2015a,b). The groundwater analytical results for PCOPCs are provided in Table 6-1 and monitoring point information is presented in Table 6-2. Groundwater data validation results are presented in the 2016 Groundwater Data Validation Report (Appendix H-1) and summarized below. The analytical data reported for this project have been reviewed for precision, accuracy, representativeness, comparability, completeness and sensitivity.

6.2.1.1 Precision and Accuracy

QC criteria exceedances for the AOU-1 project analytical data resulting in data qualification include 1) low-level detections of VOCs and metals in method, trip, field and calibration blank samples, 2) VOC and SVOC surrogate spike and internal standard recoveries outside of limits, 3) VOCs, SVOCs and metals outside of control limits for matrix spikes (MS) and MS duplicates (MSD), 4) VOC analysis instrument calibration relative response factor exceedance of criteria, 5) exceedance of the inductively coupled plasma (ICP) serial dilution criterion for metals, and 6) field duplicate sample relative percent difference for metals.

The sample data associated with the quality criteria exceedances were “J, J+, J-, UJ, U and R” -qualified as estimated, estimated detect with bias (i.e., J+ biased high, and J- biased low), estimated non-detect, non-detect, and rejected sample results. Data qualified with “J, UJ and U” qualifiers are usable to achieve project DQOs. Data qualified with “R” do not meet project objectives and are not usable for the RI. As shown in Table 6-1, the “U, J, UJ” and “R” qualifiers are identified for some of the AOU-1 groundwater results for PCOPCs; specifically, five results for 1,4-dioxane are “R” qualified (rejected data) due to exceedance of laboratory QC results.

The groundwater analytical data reports are included in Appendix J. A summary of the 2016 groundwater investigation data with the respective data qualifiers is presented in Table 6-1.

6.2.1.2 Data Representativeness

Groundwater sample collection was conducted in accordance with the sampling and analysis protocols and Standard Operating Procedure (SOP) 014 documented in the QAPP Update Revision 1 (EA 2016c). Approved procedures were used to collect, preserve, document, and ship samples to the CLP and EPA Region 8 laboratories for analysis, thus ensuring the samples were representative of the project site and conditions. Samples were analyzed using EPA CLP and EPA standard methodologies to ensure representativeness of the data results.

6.2.1.3 Data Completeness

Laboratory data packages and electronic data deliverables were reviewed for accuracy and completeness and compared to the QAPP Update Revision 1 requirements (EA 2016c). The laboratory data deliverables were verified to ensure the required elements were included the data package. The following discrepancies were noted between the project plans, the samples submitted to the CLP laboratory and the data reporting.

- The CLP laboratory ran the most current CLP SOW methods SOM02.3 and ISM02.3 for the organic and inorganic analyses rather than the SOM02.2 and ISM02.2 stated in QAPP Update Revision 1 (EA 2016c). This had no impact to data usability.

- The data validation was conducted using the 2014 National Functional Guidelines (EPA 2014b,c) rather than the 2013 guidelines as indicated in QAPP Update Revision 1 (EA 2016c). The third-party validation subcontractor used the most current version to validate the data since the more current CLP SOW methods were used for analysis. This had no impact to assessing data quality indicator criteria and documenting the data usability.

    - Thirty-five SVOC analytes in 7 samples were R-qualified signifying rejected and not usable data. A data completeness for the SVOC analysis was still greater than the 90 percent completeness goal, at 98.2 percent.

Aside from these noted discrepancies and rejected data, all data are usable to achieve project DQOs. The data completeness for the groundwater sample data is 99 percent.

6.2.1.4 Data Comparability

Comparability of data is achieved through use of industry standard analytical method protocols, approved sampling and analysis protocols, use of standard units of measure, and conformance to project-required reporting limits to achieve DQOs. Data verification indicates that project-specific methods and reporting limits were used for analysis of the AOU-1 project samples in accordance with QAPP Update Revision 1 (EA 2016c) with exception of the CLP SOWs for organic and inorganic methods. The more current versions of the CLP SOW methods SOM02.3 and ISM02.3 were used for the analysis with no impact to data usability.

6.2.1.5 Data Sensitivity

Appropriate EPA and CLP analytical methods were used for the sample analyses to achieve the required reporting limits and project-specific screening criteria per QAPP Update Revision 1 (EA 2016c) for VOCs, SVOCs, metals and general chemistry parameters with exceptions as previously noted in the QAPP – Tables 9, 10, 11 and 12 – Project Laboratory – Target Analytes and Quantitation Limits for VOCs, SVOCs, metals and general chemistry parameters in water, respectively. Contract-required reporting limits (CRQLs) for the site-specific PCOPCs were below the project screening levels with exception of VC however, the laboratory method detection limit (MDL) is below the screening level so any detection between the CRQL and MDL would have been reported and flagged "J" signifying estimated data (Table 6-1).

6.2.1.6 Data Uncertainty

The sample data associated with the quality criteria exceedances were "J, J+, J- and UJ" qualified as estimated detect or non-detect concentrations, and "U" qualified as non-detect concentrations. Estimated data are usable to achieve project DQOs. Thirty-five SVOC analytes in 7 samples (GW-14, GW-15, GW-20, GW-49, GW-50, GW-52, GW-53 over 3 sampling events) were "R" qualified signifying rejected data and not usable for the RI however, the rejected SVOC analytes were not considered PCOPCs for the AOU-1 investigation and the rejected data does not result in a data gap for the RI. Data completeness for the SVOC analysis was still greater than the 90 percent goal at 98.2 percent and 100 percent for all other groundwater data. The five rejected 1,4-dioxane values were associated with the February/March 2016 sampling event. These wells were re-sampled in July and September 2016 and valid usable data results were generated. There is no uncertainty associated with the rejected 1,4-dioxane data. The groundwater analytical data generated in support of the AOU-1 RI meet project DQOs with exception of "R" qualified data and are usable for the intended purpose.

6.2.2 Surface Water and Stormwater Data Quality

A total of 50 surface water and stormwater samples were collected between February and May 2016, in accordance with QAPP Update Revision 1 and MFM Nos. 16 and 17 as described in Section 5.3. The summary of samples collected is provided in Tables 5-5, 5-6, and 5-7. A summary of the surface water PCOPCs results is provided in Table 6-3. Surface water and stormwater data validation results are presented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2016 Surface Water and Stormwater Data Validation Report (Appendix H-2) and summarized below. The analytical data have been reviewed for precision, accuracy, representativeness, comparability, completeness, and sensitivity.

6.2.2.1 Data Precision and Accuracy

QC criteria exceedances for the AOU-1 surface water and stormwater data resulting in data qualification include: 1) low-level detections of VOCs and metals in method, trip, field, and calibration blank samples, 2) VOC and SVOC surrogate spike recoveries outside of limits, 3) SVOC analysis instrument calibration relative response factor exceedance of criteria, and 4) exceedance of the ICP serial dilution criterion for metals.

The sample data associated with the quality criteria exceedances were "J, J+, J-, UJ, U and R" qualified signifying estimated, estimated detect with bias (i.e., J+ biased high, and J- biased low), estimated non-detect, non-detect, and rejected sample results. Data qualified with "J, UJ and U" qualifiers are usable to achieve project DQOs. Data qualified with "R" do not meet project objectives and are not usable for the RI. As shown in Table 6-3, "J" and "UJ" qualifiers are identified for some of the AOU-1 surface water and stormwater results for PCOPCs, signifying estimated data but still usable to achieve project objectives. Also, on Table 6-3, 20 results for SVOC analytes are “R” qualified (rejected data) due to exceedance of QC criteria. However, the “R” qualified analytes are not PCOPCs for AOU-1.

A summary of the surface water and stormwater investigation data with the respective data qualifiers is presented in Table 6-3.

6.2.2.2 Data Representativeness

Surface water and stormwater sample collection was conducted in accordance with approved project plans. Approved procedures were used to collect, preserve, document, and ship samples to the CLP and EPA Region 8 laboratories for analysis, thus ensuring the samples were representative of the project site and conditions. Samples were analyzed using EPA CLP and EPA standard methodologies to ensure representativeness of the data results. The majority of surface water samples were collected from surface seeps and springs; however, some were collected from shallow sumps that accumulated surface water seeps and springs. One sample, SW-06, was collected from a deeper ornamental well located on a residential property and may be more representative of shallow groundwater.

6.2.2.3 Data Completeness

Project deliverables were reviewed for accuracy and completeness and compared to the QAPP Update Revision 1 requirements (EA 2016c). The laboratory data deliverables were verified to ensure the required elements were included the data package. The following discrepancies were noted between the project plans, the samples submitted to the CLP laboratory and the data reporting.

- The CLP laboratories ran the most current CLP SOW SOM02.3 and ISM02.3 for the organic analyses (VOCs and SVOCs) and metals analyses rather than the SOM02.2 and ISM02.2 stated in QAPP Update Revision 1 (EA 2016c). This had no impact to data usability.
- The data validation was conducted using the 2014 National Functional Guidelines (EPA 2014b,c) rather than the 2013 guidelines as indicated in QAPP Update Revision 1 (EA 2016c). The third-party validation subcontractor used the most current version to validate the data since the more current CLP SOW methods were used for analysis. This had no impact to assessing data quality indicator criteria and documenting the data usability.
- Five SVOC analytes (2,4-dninitrophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline and 4-nitrophenol) in four samples were R-qualified signifying rejected and not usable data. A data completeness for the SVOC analysis was still greater than the 90 percent completeness goal at 97.3 percent.

Aside from these noted discrepancies above, data are usable to achieve project DQOs. The data completeness for the surface water and stormwater sample data is 99.5 percent.

6.2.2.4 Data Comparability

Comparability of data is achieved through the use of industry standard analytical method protocols, approved sampling and analysis protocols, use of standard units of measure, and conformance to project-required reporting limits to achieve DQOs. Data verification indicates that project-specific methods and reporting limits were used for analysis of the AOU-1 project samples in accordance with QAPP Update Revision 1 (EA 2016c) with exception of the CLP SOW organic and inorganic methods. The more current versions of the CLP SOW methods SOM02.3 and ISM02.3 were used for the VOC, SVOC and metals analyses with no impact to data usability.

6.2.2.5 Data Sensitivity

Appropriate EPA and CLP analytical methods were used for the sample analyses to achieve the required reporting limits and project-specific screening criteria per QAPP Update Revision 1 (EA 2016c) for VOCs, SVOCs, metals and general chemistry parameters with exceptions as previously noted in the QAPP – Tables 9, 10, 11 and 12 – Project Laboratory – Target Analytes and Quantitation Limits for VOCs, SVOCs, metals and general chemistry parameters in water, respectively. Reporting limits for the site-specific PCOPC were below the project screening levels (Table 6-3).

6.2.2.6 Data Uncertainty

The sample data associated with the quality criteria exceedances were "J, J+, J- and UJ" qualified as estimated detect or non-detect concentrations, and "U" qualified as non-detect concentrations. Estimated data are usable to achieve project DQOs. Five SVOC analytes in four samples were R-qualified signifying rejected data and not usable for the RI, however none of these were PCOPCs. A data completeness for the SVOC analysis was still greater than the 90 percent goal at 97.3 percent and 100 percent for all other data. The surface water and stormwater analytical data generated in support of the AOU-1 RI meet project DQOs with exception of "R" qualified data and are usable for the intended purpose.

6.2.3 Soil Data Quality

Three soil samples were collected in May 2016 for the RI for AOU-1 as described in Section 5.4. A summary of soil samples collected is provided in Tables 5-8 and 5-9. A summary of soil investigation PCOPCs results is provided in Table 6-4. Details of the soil investigation are provided in Section 5.4 of this RI report. The soil analytical results for PCOPCs are provided in Table 6-4. Soil sample data validation results are presented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2016 Soil Data Validation Report (Appendix H-3) and summarized below. The analytical data have been reviewed for precision, accuracy, representativeness, comparability, completeness and sensitivity.

6.2.3.1 Data Precision and Accuracy

QC criteria exceedances for the AOU-1 soil data resulting in data qualification include: 1) low-level detections of methylene chloride in the method blank samples, 2) SVOC surrogate spike and internal standard recoveries outside of limits, 3) exceedance of MS/MSD control limits for seven SVOC analytes, and 4) exceedance of the ICP serial dilution criterion for antimony.

The sample data associated with the quality criteria exceedances were "J, J+, J-, UJ, and U" qualified signifying estimated, estimated detect with bias (i.e., J+ biased high, and J- biased low), estimated non-detect, and non-detect sample results. Data qualified with "J, UJ and U" qualifiers are usable to achieve project DQOs.

A summary of the 2016 soil investigation data with the respective data qualifiers is presented in Table 6-4.

6.2.3.2 Data Representativeness

Soil sample collection was conducted in accordance with the sampling and analysis protocols and SOP 017 documented in QAPP Update Revision 1 (EA 2016c). Approved procedures were used to collect, preserve, document, and ship samples to the CLP laboratory for analysis, thus ensuring the samples were representative of the project site and conditions. Samples were analyzed using EPA CLP methodologies to ensure representativeness of the data results.

6.2.3.3 Data Completeness

Project deliverables were reviewed for accuracy and completeness and compared to the QAPP Update Revision 1 requirements. The laboratory data deliverables were verified to ensure the required elements were included the data package. The following discrepancies were noted between the project plans, the samples submitted to the CLP laboratory and the data reporting.

- Target analyte list (TAL) metals - the complete list of TAL metals was not analyzed for the 3 soil samples. The cations – calcium, potassium, magnesium, sodium and iron were omitted from the requested ICP mass spectrometry (ICPMS) analysis due to the high concentration of these metals in soil and therefore, the laboratory did not include them in their TAL metals list. The ICPMS analysis was used to achieve the lowest reporting limits.

- VOCs – the MS/MSD analysis was not included for VOCs as the laboratory noted insufficient sample volume to perform the analysis. Analytical accuracy and precision was assessed using field duplicate and laboratory control spike sample data.

- The CLP laboratory ran the most current CLP SOW method SOM02.3 for the organic analyses (VOCs and SVOCs) rather than the SOM02.2 stated in QAPP Update Revision 1. This had no impact to data usability.

- The data validation was conducted using the 2014 National Functional Guidelines (EPA 2014b,c) rather than the 2013 guidelines as indicated in QAPP Update Revision 1. The third-party validation subcontractor used the most current version to validate the data since the more current CLP SOW methods were used for analysis. This had no impact to assessing data quality indicator criteria and documenting the data usability.

Aside from these noted discrepancies, no data were qualified as rejected or unusable to achieve project DQOs. The data completeness exceeds the 90 percent for the soil sample data.

6.2.3.4 Data Comparability

Comparability of data is achieved through the use of industry standard analytical method protocols and conformance to project-required reporting limits to achieve DQOs. Data verification indicates that project-specific methods and reporting limits were used for analysis of the AOU-1 project samples in accordance with QAPP Update Revision 1 with exception of the CLP SOW organics method. The more current version of this CLP method was used for the VOC and SVOC analysis with no impact to data usability.

6.2.3.5 Data Sensitivity

Appropriate EPA CLP analytical methods were used for the sample analyses to achieve the required reporting limits and project-specific screening criteria per QAPP Update Revision 1 (EA 2016c) for VOCs, SVOCs, and metals in soil with exceptions as previously noted in the QAPP – Tables 4, 5, and 6 – Project Laboratory – Target Analytes and Quantitation Limits for VOCs, SVOCs, metals parameters in soil, respectively. Reporting limits for the PCOPCs were below the project screening levels (Table 6-4).

6.2.3.6 Data Uncertainty

The sample data associated with the quality criteria exceedances were "J, J+, J- and UJ" qualified as estimated detect or non-detect concentrations, and "U" qualified as non-detect concentrations. Estimated data are usable to achieve project DQOs. A data completeness of 98.9 percent was achieved for the soil investigation data due to a lab oversight which omitted cations from the requested analysis of the three soil samples. The soil analytical data generated in support of the AOU-1 RI meet project DQOs and are usable for the intended purpose.

6.2.4 Indoor Air, Outdoor Air, and Soil Gas Data Quality

Samples of indoor air, outdoor air, and soil gas were collected and analyzed by EPA Method TO-15 for confirmation of HAPSITE® screening results during the AOU-1 RI. A total of 45 air samples (34 indoor air samples, 3 outdoor air samples, and 8 soil gas) were analyzed over a three-year period (2015 – 2017) in accordance with the QAPP (Appendix B of FE 2015a), QAPP Update Revision 1 (EA 2016c), and MFMs. Air sample collection is described in Section 5.5. Tables 5-10, 5-11, 5-12, and 5-13 summarize the VI field sampling activities. These samples were analyzed by ALS Environmental, Salt Lake City, Utah. The EPA Method TO-15 analytical results for VI samples are provided in Table 6-7. EPA Method TO-15 data validation results are presented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2015/2016 TO-15 Data Validation Report and Addendum (Appendices H-5 and H-6); and 2017 data validation results are presented in the 2017 VI Investigation Field Data Report Accelerated Operable Unit 1 700 South 1600 East PCE Plume (Appendix H-4). The EPA Method TO-15 analytical data have been reviewed for precision, accuracy, representativeness, comparability, completeness and sensitivity.

6.2.4.1 Data Precision and Accuracy

QC criteria exceedances for the AOU-1 VI data that resulted in data qualification include the following: 1) low-level detections of VOC analytes in blanks; 2) LCS recoveries outside of control limits for VOCs and SVOCs; 3) exceedance of calibration control limits, relative standard deviation, and exceedance of the upper range for VOCs; 4) exceedance of internal standard recoveries outside of control limits for VOCs; 5) precision for field duplicate samples outside of control limits for VOCs; and 6) surrogate spike recoveries below the control limits for SVOCs.

The sample data associated with the quality criteria exceedances were "J, J+, J-, UJ, U and R" qualified signifying estimated, estimated detect with bias (i.e., J+ biased high, and J- biased low), estimated non-detect, non-detect, and rejected sample results. Data qualified with "J, UJ and U" qualifiers are usable to achieve project DQOs. Data qualified with "R" do not meet project objectives and are not usable for the RI. As shown in Table 6-7, the "U" and "J" qualifiers are identified for some of the AOU-1 VI results for PCOPCs, signifying estimated data but usable for the RI.

A summary of the VI data with the respective data qualifiers is presented in Tables 6-7.

6.2.4.2 Data Representativeness

VI sample collection for EPA Method TO-15 analysis was conducted in accordance with the sampling and analysis protocols and SOPs 001 and 019 documented in the QAPP (Appendix B of FE 2015a) and QAPP Update Revision 1 (EA 2016c). Approved procedures were used to collect, preserve, document, and ship samples to ALS Environmental for analysis, thus ensuring the samples were representative of the project site and conditions with the exceptions noted in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2015/2016 TO-15 Data Validation Report and Addendum (Appendices H-5 and H-6). Samples were analyzed using EPA standard methodologies to ensure representativeness of the data results. Although indoor air screening using HAPSITE® was performed under several indoor pressure differentials, indoor air samples for EPA Method TO-15 analyses were collected under baseline ambient pressures to be representative of typical pressure scenarios.

6.2.4.3 Data Completeness

Project deliverables were reviewed for accuracy and completeness and compared to the QAPP requirements (FE 2015a, EA 2016c). The laboratory data deliverables were verified to ensure the required elements were included the data package. Discrepancies were noted between the field forms and logs, project plans, the samples submitted to the CLP laboratory and the data reporting for the 2015 EPA Method TO-15 data and documented in the 700 South 1600 East PCE Plume AOU-1: East Side Springs 2015/2016 TO-15 Data Validation Report and Addendum (Appendices H-5 and H-6). These discrepancies resulted in rejection of 2015 data and impacted the data completeness for that year. The 90 percent completeness objective was not achieved in 2015. As a result, the structures where screening level exceedances were noted in 2015 were re-sampled during the 2016/2017 supplemental investigations to achieve project completeness goals.

During the 2016 and 2017 VI field activities, one deviation from the SAP, Appendix A of the RI Work Plan (FE 2015a) was identified regarding the 2016 sample naming convention in the SAP Table 3. The sample naming convention was not followed, although a similar one was used. There were no discrepancies identified for 2017. No 2016 or 2017 data were qualified as rejected or unusable to achieve project DQOs. The data completeness exceeds the 90 percent objective for the 2016 and 2017 EPA Method TO-15 data.

6.2.4.4 Data Comparability

Comparability of data is achieved through the use of industry standard analytical method protocols and conformance to project-required reporting limits to achieve DQOs. Data verification indicates that project-specific methods and reporting limits were used for analysis of the AOU-1 project samples in accordance with the QAPP and QAPP Update Revision 1 for the EPA Method TO-15 analysis.

6.2.4.5 Data Sensitivity

Appropriate EPA analytical methods were used for the sample analyses to achieve the required reporting limits and project-specific screening criteria per the QAPP (Appendix B of FE 2015a) and QAPP Update Revision 1 (EA 2016c) for VOC analysis in accordance with EPA Method TO-15. Reporting limits were achieved for the PCOPCs with exception of 7 samples collected in 2015 where the reporting limits for TCE and VC exceeded the residential indoor air screening levels. EPA Method TO-15 SIM was used to analyze the PCOPCs for the 2016 and 2017 investigations to achieve the screening levels. In addition, reporting limits were elevated for samples with elevated concentrations of PCE in soil gas (0053-H) which required sample dilution and resulted in elevated reporting limits for other PCOPCs (Table 6-7). All other EPA Method TO-15 reporting limits achieved the project screening levels.

6.2.4.6 Data Uncertainty

The sample data associated with the EPA Method TO-15 QC criteria exceedances were "J, J+, J-, UJ, U and R" qualified as estimated, estimated detect with bias (i.e., J+ biased high, and J- biased low), estimated non-detect, non-detect, and rejected data, respectively. Estimated and non-detect qualified data are usable to achieve project DQOs.

The 2015 EPA Method TO-15 data does not achieve the RI data completeness goal of 90 percent due to the uncertainties with the field and laboratory documentation. In addition to the data validation conducted for the 2015 EPA Method TO-15 analytical data, a third-party QA assessment was conducted on the 2015 data by an independent contractor to determine usability of this data set due to field and laboratory documentation discrepancies resulting in a potential impact to sample integrity. In 2015, 46 samples were collected for EPA Method TO-15 analysis. The data assessment evaluation for usability determined the HAPSITE® screening data was usable for its intended purpose (as screening data to determine whether PCOPC concentrations exceeded RBSLs) for 30 of these results but not usable for the RI; while results of the remaining 16 samples were deemed usable for the risk evaluation. In addition, the data assessment rejected results for all eight samples that were collected for TO-13 analysis. The structures where the usable/unusable samples were collected are listed in Table 5-11. All 2016 and 2017 EPA Method TO-15 data are valid data to achieve the RI objectives as qualified (as shown in Tables 5-12 and 5-13). All valid EPA Method TO-15 results are provided in Table 6-7.

6.2.5 HAPSITE® Data Quality

HAPSITE® screening for PCE, TCE and 1,2-DCE was conducted on soil gas, indoor and outdoor air samples during the 2015 – 2017 VI investigations to screen samples against RBSLs and RALs for PCE and TCE. A total of 55 structures were investigated between 2015 and 2017 using a HAPSITE®, however, due to data quality problems in 2015, 29 total structures had usable HAPSITE® data. The initial VI investigation in 2015 screened 36 of these 55 structures and multiple locations within each structure using HAPSITE®. Based on independent data verification of the 2015 HAPSITE® data in accordance with the QAPP (2015), it was determined that the real-time screening data is only usable for qualitative purposes (e.g., as a line of evidence) due to discrepancies in field collection and HAPSITE® instrument documentation. The HAPSITE® screening data generated during the 2016 and 2017 VI investigations were verified and deemed usable to achieve the project objectives. This data is documented in the 2016 and 2017 VI Field Reports (EA 2018, Appendix H-4).

Field screening using the HAPSITE® in support of the 2016/2017 VI investigations achieved reporting limits for PCOPCs PCE, and cis-1,2-DCE at or below the residential soil gas screening level and the residential indoor air RBSL. The reporting limit TCE (0.5 $\mu g/m^3$) exceeded the indoor air RBSL slightly (0.48 $\mu g/m^3$); however, if there had been TCE detections in this range, they would have been reported as J-flagged values.

6.3 Screening Levels and RALs for Investigated Media

RBSLs and RALs for protection of human health were developed for the PCOPCs in each of the investigated media to facilitate the evaluation of the nature and extent of contamination and potential resident and commercial/industrial worker exposure. The screening levels and RALs were documented in the VI Screening Levels and Removal Action Levels Technical Memorandum, Appendix F of the RI Work Plan, which was reviewed and approved by the regulatory agencies (FE 2015a). During preparation of this RI Report, the screening levels and RALs were reviewed and updated as necessary to reflect the most current (November 2017) EPA Regional Screening Levels (RSLs) and input parameters defined in the EPA Regional Screening Level Tables (EPA 2017a). The updated screening levels, referred to as RBSLs, and RALs are provided in Table 3-6 for indoor air and soil gas, and Table 3-7 for soil and surface water. Details of the derivation of the RBSLs and RALs are described in Section 3.2. The technical basis for these values is summarized below, along with a description of updates to these values.

6.3.1 Human Health RBSLs and RALs for the AOU-1 RI

6.3.1.1 Indoor Air and Soil Gas

Indoor Air and Soil Gas RBSLs (Table 3-6). The residential and commercial/industrial indoor air and soil gas screening levels are risk-based concentrations that were calculated following the EPA Risk Assessment Guidance for Superfund (Part F) (EPA 2009), based on assumptions of the magnitude of exposure, chemical toxicity, and target risk threshold. The exposure assumptions are published values for reasonable maximum exposure (RME) used in the EPA RSL tables (EPA 2017a). Toxicity values were also based on the EPA RSL tables (EPA 2017a). The target risk thresholds for derivation of the RBSLs are 1 x 10^{-6} for cancer risk and a non-cancer hazard quotient (HQ) of 1, whichever results in the lower screening level.

- Residential and industrial/commercial indoor air RBSLs are from the EPA RSL tables (EPA 2017a). There were no changes to these published values for the PCOPCs, so the 2017 values presented in Table 3-6 are the same as those derived in 2015 and listed in the VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]).

- Residential and industrial/commercial soil gas RBSLs are the indoor air RSLs multiplied by a generic soil-gas-to-indoor air attenuation factor (AF) of 0.03, as identified in the EPA VI Screening Level Calculator (EPA 2017b). There were no changes to these published values for the PCOPCs, so the 2017 values presented in Table 3-6 are the same as those derived in the 2015 VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]).

Indoor Air RALs (Table 3-6). Indoor air RALs were derived to support decisions regarding the need to implement removal actions after the data from the indoor air sampling was obtained, validated and evaluated for the RI, but prior to the completion of the risk assessment, FFS, ROD, and implementation of remedial actions (FE 2015a). The residential indoor air RALs are also risk-based concentrations and were calculated following the EPA Risk Assessment Guidance for Superfund (Part F) (EPA 2009), based on assumptions of the magnitude of exposure, chemical toxicity, and target risk threshold. The same exposure factors and toxicity values were used, but the RALs were derived using higher target cancer and non-cancer risks:

- Tier 1 RALs were calculated using a target cancer risk of 1 x 10^{-5} and HQ of 1. There were no changes to the residential Tier 1 RALs for the PCOPCs from 2015 to 2017. The commercial/industrial Tier 1 RALs for 1,4-dioxane and VC were revised in 2017 based on the latest toxicity values and other input parameters.

- Tier 2 RALs were derived using a target cancer risk of 1 x 10^{-4} (Tier 2) and an HQ of 3, consistent with EPA practice of using an HQ of 3 (and a cancer risk level of 10^{-4}) for development of Removal Management Levels (EPA 2017c) in that both levels would be used to initiate a short-term action. This basis for the development of the Tier 2 RALs, including the use of an HQ of 3, was defined and approved in the VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]). There were no changes to the residential Tier 1 and Tier 2 RALs for indoor air and soil gas. The commercial/industrial Tier 1 RALs for 1,4-dioxane and VC were revised in 2017 based on the latest toxicity values and other input parameters.

The RALs presented in Tables 3-6 are the same as those identified in the VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]).

6.3.1.2 Groundwater

RBSLs for groundwater-to-indoor air are provided in Table 3-6. The residential and commercial/industrial RBSLs for groundwater are calculated by dividing the indoor air SL from the EPA RSL tables (EPA 2017a), by the generic groundwater-to-indoor AF of 0.001 (EPA 2017b) and then converting the vapor concentration to an equivalent groundwater concentration, assuming equilibrium between the aqueous and vapor phases at the water table, and assuming an average groundwater temperature of 25 degrees Celsius (EPA 2017b). The groundwater RBSLs are based on either a target cancer risk of 1×10^{-6} or a non-cancer HQ of 1, whichever results in the lower RBSL. There were no changes to these published values for the PCOPCs, so the 2017 values presented in Table 3-6 are the same as those derived in the VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a].

6.3.1.3 Soil

Residential and industrial Soil RBSLs are provided on Table 3-7. These RBSLs are from the EPA RSL tables (EPA 2017a). The soil RBSLs are based on either a target cancer risk of 1×10^{-6} or a non-cancer HQ of 1, whichever results in the lower RBSL. There were no changes to the residential soil RBSLs for published values for the PCOPCs, so the 2017 values presented in Table 3-6 are the same as those derived in the VI Screening Levels and Removal Action Levels Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]. The industrial soil RBSL for 1,4-dioxane was adjusted to account for rounding (from 23 milligrams per kilogram [mg/kg] to 24 mg/kg) per the EPA's RSL Users' Guide (EPA 2017a).

6.3.1.4 Surface Water

RBSLs for surface water are provided on Table 3-7. These RBSLs were developed taking into consideration 1) adsorption of PCOPCs to soil that may be in contact with surface water and 2) potential direct contact that resident recreators may have with surface water (i.e., through either incidental ingestion or dermal contact).

- For deriving surface water RBSLs for assessment of adsorption of PCOPC to soil, soil RBSLs were obtained from the EPA RSL tables based on either a target cancer risk of 1×10^{-6} or a non-cancer HQ of 1, whichever results in the lower RBSL, and then applying a partitioning coefficient defined in the EPA RSL tables for each of the PCOPCs (EPA 2017a). For the residential values, there were no changes to the surface water-to-soil RBSLs for the PCOPCs, so the 2017 values presented in Table 3-7 are the same as those derived in VI Screening Levels and Removal Action Level*s* Technical Memorandum (Appendix F of the RI Work Plan [FE 2015a]. For industrial values, the RBSL for 1,4-dioxane was revised from 4,400,000 µg/L to 4,600,000 µg/L based on updated industrial soil SL for 1,4-dioxane in the 2017 EPA RSL Tables (EPA 2017a).

- All of the RBSLs for direct contact with surface water by the resident recreator (SW_{DIRECT} RBSLs) were updated in 2017 using more appropriate input parameter for skin surface area based on current the RSL Users' Guide (EPA 2017a). Increases in the RBSLs result from using 15 percent of EPA's current total skin surface area values (i.e., 957 square centimeters [cm^2] for children and 3,135 cm^2 for adults in accordance with EPA's RSL Users' Guide (EPA 2017a) and from using these different values for skin surface area for adults and children in the SL calculations.

6.3.2 Ecological Screening Levels

Ecological SLs were derived and presented in the Risk Assessment Work Plan (Appendix E of the RI Work Plan) for aquatic organisms, plants, the American robin, the deer mouse, and dogs (small, medium, and large) (FE 2015a). Surface water screening levels include media benchmarks. The benchmarks were obtained from the literature and SLs were back calculated for the receptors being evaluated. As explained in the Risk Assessment Work Plan, the following conservative exposure assumptions were used:

- 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 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. PCOPCs and SLs applicable for the ecological receptors are identified in the SLERA (Appendix G).

6.4 Groundwater Contamination

Groundwater samples were collected from 42 temporary small-diameter groundwater monitoring points that were placed throughout the ESS area to assess the nature and extent of the PCOPCs in the shallow aquifer (Figure 5-1). Piezometers were constructed at ten of the temporary monitoring points to allow additional, follow-on sampling of the shallow groundwater. Section 5.2 describes the groundwater sampling activities conducted in 2016. The groundwater analytical data is presented in Table 6-1, and a spatial distribution of the PCOPCs is presented in Figure 6-1. Table 6-2 presents temporary groundwater monitoring point information and depth to groundwater.

6.4.1 Upgradient Water Quality

As explained in Section 4.3.3, the hydraulic gradient of shallow groundwater in the ESS is to the southwest (Figure 4-6). The RI for OU-2 will investigate the groundwater gradient and quality east and west of the ESS area. Currently, wells located in the area upgradient of the ESS area include the EPA monitoring wells, SCL-18, the Mount Olivet irrigation well, the Fountain of Ute Well, and the University of Utah Well #1 (Figure 1-2). Available data from these wells are provided in Table 3-2 and are summarized below. The groundwater quality information described below is from an unconfined aquifer, sampled at the EPA wells between 143 to 228 ft bgs. Groundwater in this same aquifer daylights in the ESS area, as shown in Figure 4-3. Due to the steep topography in the area, the difference in elevation between the general location of the EPA monitoring wells and the ESS area is approximately 150 to 200 ft. Therefore, the depth to groundwater, and the contaminants in this aquifer, is very shallow (less than 50 ft bgs) in the ESS area, which is the focus of the AOU-1 RI.

- EPA-MW-05R (and EPA-MW-05 prior to abandonment in 2015) is located upgradient of the VAMC Building 7. This well is screened between 182 and 221 ft bgs. While it has not been monitored for 1,4-dioxane in the past, none of the other PCOPCs have been detected above laboratory reporting limits (ranging between 0.1 and 10 µg/L) in either EPA-MW-05 or EPA-MW-05R with the exception of TCE at an estimated concentration of 0.19 µg/L in April 2016.

- EPA-MW-01S, EPA-MW-02, EPA-MW-03 (abandoned in 1999), EPA-MW-04, and EPA-GW-06 are upgradient of the ESS area. These wells are generally screened between 100 and 224 ft bgs.
    - PCE detections in these wells range from an estimated concentration of 0.46 µg/L in well EPA-MW-06 in 2014 to 320 µg/L in well EPA-MW-01S in 1998.
    - TCE concentrations have ranged from an estimated concentration of 0.15 µg/L in EPA-MW-06 in 2016 to an estimated concentration of 4 µg/L in well EPA-MW-01S in 1998.
    - cis-1,2-DCE concentrations have ranged from an estimated concentration of 0.17 µg/L in EPA-MW-04 in 2016 to an estimated concentration of 5 µg/L in 1998 at EPA-MW-01S.
    - VC analysis was not conducted as frequently as analysis for PCE, TCE, and cis-1,2-DCE, but was included in analysis of samples collected from the EPA monitoring wells in 2016 and also in some previous years (Table 3-2). All results were below the method reporting limit (MRL) of 0.5 µg/L
    - 1,4-dioxane was included in analysis of samples collected from the EPA monitoring wells in 2016. All results were below the MRL of 2 µg/L

6.4.2 Contaminant Distribution with the ESS Area

The spatial distribution of the PCOPC concentrations in the shallow groundwater (within the 50 ft bgs) in the ESS area is based on samples collected from the 42 temporary monitoring points and 10 piezometers. The nature and extent of potential PCOPC contamination in groundwater at AOU-1 is discussed in reference to the RBSLs derived to assess potential for intrusion into indoor air (Table 3-6 and 3-7.

<u>PCE</u>: The PCE residential groundwater-to-indoor air RBSL of 15 µg/L was exceeded in 11 of the 42 shallow groundwater sample locations (GW-07, GW-11, GW-13, GW-15, GW-16, GW-27, GW-28, GW-51, GW-52, GW-53, and GW-62). The sample locations above the PCE groundwater-to-indoor air RBSL are located in the center of the Pre-RI estimation of AOU-1 area and between the East Bench Fault and the East Bench Fault Spur. They are south of 700 South, north of Michigan Avenue and between 1100 East and 1300 East. The highest PCE concentration detected was in piezometer GW-52 at 57 µg/L (and the field duplicate in this location had 61 µg/L).

The extent of PCE-impacted shallow groundwater exceeding groundwater-to-indoor air RBSL in the ESS area is defined downgradient (to the southwest) and cross-gradient (northwest to southeast). PCE was detected downgradient of the estimated ESS area, including to the west of the East Bench Fault; but in concentrations that are generally an order of magnitude less than the highest reported concentrations. Locations GW-018, GW-031, GW-026, and GW-046 best represent the furthest downgradient data points, which range in concentration from non-detect (<0.5 µg/L) to 0.27J µg/L. PCE was not detected in the northern most cross-gradient groundwater monitoring points (GW-021 through GW-024), which are north of 700 South. Trace amounts of PCE (ranging up to 0.48J µg/L) were detected in the southern most cross-gradient sample locations (GW-03, GW-43, GW-46, GW-48, and GW-55). The highest concentrations of PCE were reported in the most upgradient monitoring points. The area upgradient of these locations and upgradient of the ESS area is still undefined and includes data gaps that will be addressed in the OU-2 RI.

<u>TCE</u>: The residential groundwater-to-indoor air RBSL for TCE (1.2 µg/L) was exceeded at six sampling locations (GW-08, GW-09, GW-14, GW-18, GW-50, and GW-59). In general, these six sample locations are along the leading western edge of the shallow groundwater plume east of the East Bench Fault. The highest TCE concentration was detected in piezometer GW-59 at 7.7 µg/L.

The extent of the TCE-impacted shallow groundwater exceeding groundwater-to-indoor air RBSL in the ESS area is defined downgradient (to the southwest) and cross-gradient (northwest to southeast). TCE was not detected to the west of the East Bench Fault, and only trace concentrations (up to 0.19 J µg/L) were detected immediately adjacent to the East Bench Fault (GW-010, GW-061). TCE was below detection limits in the samples collected north of 700 South and in the southern most cross-gradient sample locations (GW-03, GW-43, GW-46, GW-48, and GW-55). Upgradient, trace TCE (up to 0.4J µg/L) was detected near East High School.

Although TCE was not always co-located with PCE or other PCE degradation products (UDEQ 2012), TCE is generally present downgradient of areas with the highest PCE concentrations. Concentrations of PCE and TCE in groundwater within the larger OU-2 area are being investigated in additional detail during the OU-2 RI.

<u>cis-1,2-DCE</u>: There is no specified screening level for cis-1,2-DCE. Cis-1,2-DCE was detected at three locations in the ESS area with the highest concentration being detected in GW-59 at 3.9 µg/L. The cis-1,2-DCE detections are collocated with the three highest TCE concentrations (GW-09, GW-50, and GW059) and appear to have a similar distribution (along the leading edge of the plume, east of the East Bench Fault) in groundwater.

<u>Vinyl chloride</u>: All results for VC were < 0.50 µg/L. The residential groundwater-to-indoor air RBSL for VC in groundwater is 0.15 µg/L, which is less than the reporting limit. However, the MDL for VC was reported at 0.15 µg/L (or less), and there were no detections reported between the MDL and the RL, suggesting that VC does not occur in shallow groundwater in the ESS area.

<u>1,4-dioxane</u>: A subset of groundwater water samples were analyzed for 1,4-dioxane and the results were non-detect (less than 2.0 µg/L or 2.1 µg/L) except for the sample collected at GW-52 which had a detection of 2.7 µg/L. This detection is less than the residential groundwater-to-indoor air RBSL of 2,900 µg/L.

6.4.3 Influence of Faults on Very Shallow Groundwater Contaminant Distribution

The shallow groundwater RI data confirms neither the fault nor the spur are barriers to groundwater flow. There is a steepening of the potentiometric surface observed in ESS area between the faults (Figure 4-6) (EA 2016b). For example, the potentiometric difference between MW-01S (4,507.32 ft) and GW-52 (4,467.76) is approximately 39.5 ft vertically across 3,250 ft laterally, with a gradient of 0.012. Within the ESS area, the gradient is approximately 20 ft vertically across 200 ft laterally (0.1). 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.

Generally, shallow groundwater PCE concentrations are higher than concentrations in deeper intervals (i.e., between 150-300 ft bgs) near the VAMC. PCE concentrations in EPA-MW-01S were 210 µg/L in

September 2016 while EPA-MW-01D PCE concentration was 1.6 µg/L. The highest groundwater PCE concentration in the ESS area was 57 µg/L (61 µg/L in the duplicate sample) in March 2016, an order of magnitude lower than the upgradient EPA-MW-01S. This decrease indicates dilution either from mixing within the same geohydrologic unit, infiltration of clean recharge, or mixing between the shallow perched water and the deeper groundwater at some point either in a fault or preferential pathways such as irrigation wells completed through both water bearing units.

The steep PCE concentration gradient in Figure 6-1 corresponds to the steeper topography and hydraulic gradients (Figure 4-6) between the East Bench Fault and the East Bench Fault Spur.

6.5 Surface Water and Stormwater Contamination

Surface water samples were collected from identified and accessible seeps, springs, sumps, and Red Butte Creek to assess the lateral extent of PCOPC contamination. Several of the springs discharge to the municipal storm sewer conveyance system. Therefore, water samples were collected from selected Salt Lake City storm sewer manholes, located in and downgradient of the approximately AOU-1 area, to determine if groundwater seepage and discharge from foundation drains is impacting stormwater. These water samples collected from the storm sewer are referred to herein as stormwater samples; however, the samples were collected during periods of no rainfall (i.e., a minimum of 48 hours after a rain event). Stormwater samples are listed in Table 5-7 and the PCOPC analytical results are provided in Table 6-3. The spatial distribution of the PCOPCs for surface water is presented in Figure 6-2, and stormwater contaminant distribution is presented in Figure 6-3.

6.5.1 Upstream/Background Surface Water and Stormwater Quality

There were no surface water or stormwater samples collected specifically as background samples; however, two stormwater samples, SW-10 and SW-24, were collected the furthest up stream of the area of the approximate occurrence of springs (Figure 6-2). Stormwater samples SW-10 and SW-24 were below detection limits for all PCOPCs.

6.5.2 Contaminant Distribution in Surface Water

The nature and extent of potential PCOPC contamination in the surface water and stormwater is delineated in comparison to the residential RBSLs for surface water protection of soil and recreator surface water RBSLs for direct contact through incidental ingestion or dermal exposure. There were no surface water or stormwater sample results for PCOPCs in exceedance of these RBSLs.

PCE: PCE concentrations in surface water samples ranged from <0.5 µg/L to 82 µg/L. The surface water RBSLs for PCE are 130,000 µg/L and 1,500 µg/L for surface water protection of soil in residential areas, and the ingestion/dermal contact with surface water respectively (Table 3-7). The highest surface water sample PCE concentrations were detected in SW-35 at 82 µg/L and in SW-06 at 74 µg/L. SW-35 is located north of Sunnyside Avenue and south of 800 South in an area where PCE concentrations in very shallow groundwater are estimated to be between 10 and 20 µg/L. It is described as a seep located in a residential back yard. SW-06 is downgradient from the area of highest PCE groundwater concentrations (Figure 6-2) and is described as a subsurface well. The sample was collected from within the shallow well and was not located at the ground surface. It may be potentially more representative of shallow groundwater. All surface water samples had detections of PCE, with the exception of SW-16 (at the northern end of the ESS area, by Our Lady of Lourdes Spring), SW-47 (adjacent to Red Butte Creek), and SW-48 (at the northeastern end of the ESS area). Highest concentrations of PCE in surface water were located generally 300 to 800 ft east of the East Bench Fault, in the area of Sunnyside Avenue, Alpine Place, and Gilmer Drive.

TCE: TCE concentrations in surface water samples ranged from <0.5 to 2.3 µg/L. All results for TCE were below the RBSLs for surface water (7,700 µg/L and 110 µg/L for surface water protection of soil in residential areas, and the ingestion/dermal contact with surface water, respectively) (Table 3-7). The highest TCE concentration of 2.3 µg/L was detected in SW-36 which was a surface water sampling location in Alpine Place in the vicinity of the surface water location with the second highest PCE concentration. However, PCE at location SW-36 was low (1.2 µg/L).

Cis-1,2-DCE: cis-1,2-DCE concentration in surface water ranged from <0.5 to 0.69 µg/L. All results for cis-1,2-DCE were below the RBSLs for surface water (2,000,000 µg/L and 3,000 µg/L for surface water protection of soil in residential areas, and the ingestion/dermal contact with surface water respectively) (Table 3-7). The highest detection of 0.69 µg/L was also located at SW-36 where the highest concentration of TCE was identified.

Vinyl chloride: There were no detections of VC (at a reporting limit of <0.5 µg/L). The surface water RBSLs for VC are 1,400 µg/L and 0.61 µg/L for surface water protection of soil in residential areas, and the ingestion/dermal contact with surface water respectively (Table 3-7).

1,4-dioxane: A subset of surface water samples were analyzed for 1,4-dioxane. There were no 1,4-dioxane detections in surface water (at a reporting limit of 2.0 µg/L or less). The surface water RBSLs for 1,4-dioxane are 1,000,000 µg/L and 160 µg/L surface water protection of soil in residential areas, and the ingestion/dermal contact with surface water respectively (Table 3-7).

6.5.3 Stormwater Sewer Line Layout

The layout of the lines and manholes for the storm sewer are illustrated in Figure 6-3. Generally, the storm sewer system drains from east to west across the ESS area. It includes curbs and gutters, drains, manholes, and culverts. The storm sewer system manages stormwater runoff, but also channels run-off from activities of property owners including residential and commercial irrigation. Some of the seeps and springs in the area have been observed running off into the storm sewer system. In addition, some residents redirect seeps and spring on their property to drain into the storm sewer system. For this reason, some surface water samples were collected from the water (including drainage water) within the storm sewer system. These samples were collected during periods of no rainfall. These samples are listed in Table 5-6 and results are provided in Table 6-3 and illustrated on Figure 6-3.

6.5.4 Contaminant Distribution in Storm Sewers

Analytical results for PCOPCs in the storm sewer water samples are described below:

PCE: Concentration of PCE in storm sewer water samples ranged from <0.5 µg/L to 31 µg/L. The highest concentration of 31 µg/L was found in SW-39, adjacent to Smith Spring, in the center of the ESS area at Alpine Place (Figure 6-3). This storm sewer water sample was also adjacent to surface water sample SW-06, which had the second highest surface water PCE detection (74 µg/L). Storm sewer water samples on both sides of the East Bench Fault contained similar concentrations of PCE.

TCE: Concentrations of TCE in storm sewer water samples ranged between <0.5 µg/L and 0.66 µg/L, which are below the surface water RBSLs (Table 3-7). Highest concentrations of TCE were located in the storm sewer along Sunnyside Avenue and Alpine Place. Lesser concentrations were detected in downgradient main lines that receive water from the Alpine Place and Sunnyside Avenue and 1100 East.

Cis-1,2-DCE: Concentrations of cis1,2-DCE in storm sewer water samples ranged between <0.5 µg/L and 0.56 µg/L, which are all below the surface water RBSLs (Table 3-7).

Vinyl chloride: There were no detections of VC (at a reporting limit of <0.5 µg/L), below the surface water RBSLs.

1,4-dioxane: One storm sewer water sample was analyzed for 1,4-dioxane. The result was <2.0 µg/L, below the surface water RBSLs (Table 3-7).

6.6 Soil Contamination

Three surface soil samples were collected 3 and 4 May 2016 from the 0 to 0.5-ft interval at locations adjacent to seeps or springs where surface water samples were also collected. Two of the soil samples, A-SS-09 (adjacent to surface water sampling location SW-09) and A-SS-26 (adjacent to SW-26), were collected at locations where shallow groundwater samples exhibited the elevated PCE concentrations along Sunnyside Avenue. The third soil sample, A-SS-01 (adjacent to SW-01), was collected at a location where trace PCE (0.13 J µg/L) was detected in the shallow groundwater sample. A summary of the soil sampling PCOPCs results are presented in Table 6-4. The soils sample locations are provided in Figure 6-2.

There were no detections of PCOPCs except for PCE in A-SS-26. PCE was detected at 0.022 mg/kg, which is below the 24 mg/kg residential soil RBSL. This sample was collocated with SW-26, which had a reported PCE concentration of 23 µg/L.

6.7 Soil Gas

A total of 24 soil gas samples were collected in 2015, 2016, and 2017 in the ESS area. As described in Section 5.5.1, two sampling and analysis methods were used to evaluate soil gas. Table 5-10 identifies the structures where indoor air, outdoor air and soil gas sampling was conducted using the two methods. Table 6-5 lists the results of soil gas sampling using both methods. Figure 6-4 presents locations with detected PCOPCs. Table 6-6 is a summary of the HAPSITE® screening data that exceeded the RBSLs and/or RALs.

- A HAPSITE® was used to conduct real-time screening of soil gas for PCE, TCE, and cis-1,2-DCE at 18 locations. Usable HAPSITE® data was obtained in 2016 and 2017. A full summary of HAPSITE® data is provided in Appendix K.

- SUMMA® canister confirmatory samples for laboratory analysis using EPA Method TO-15 were collected in soil gas adjacent to 5 structures (Table 5-10). Table 6-7 presents PCOPC analytical data.

PCE: PCE was detected in at least one depth interval in 14 of the 22 soil gas sampling locations (Figure 6-4 and Table 6-5). Detections ranged from 1.4 to approximately 2,000 µg/m^3. The residential and industrial soil gas RBSLs are 370 µg/m^3 and 1,600 µg/m^3 respectively (Table 3-6). Soil gas concentrations were the highest in location 0053-H, which is located near the higher concentrations of groundwater PCE (Figure 6-4). PCE concentrations ranged from an estimated value of 510 µg/m^3 at 6.5

ft bgs to 2,000 µg/m^3 at 6 ft bgs at 0053-H. PCE in soil gas in exceedance of the RBSL is delineated on Figure 6-4. Most of the PCE soil gas detections were centrally located in the ESS area near the higher concentrations of PCE in groundwater. Highest PCE concentrations in soil gas occur north of 900 South and south of Sunnyside Avenue; and south of 900 South towards Michigan Avenue. There were no detections of PCE at the locations furthest downgradient, adjacent to and west of the East Bench Fault, with the exception of 0060-H just north of Michigan Avenue. PCE in soil gas attenuates quickly from east to west across the PCE groundwater gradient and topographic change along the fault scarp.

TCE: TCE was detected in at least one depth interval in 3 (0030-H, 0050-H, and 0053-H) of the 22 sampling locations. Detections ranged from 3.6 µg/m^3 to 21 µg/m^3. TCE concentration exceeded the residential RBSL of 16 µg/m^3 at two locations: 0030-H and 0053-H. Exceedances at both locations occurred at a depth of 6-ft bgs. The highest concentration of TCE in soil gas was collocated with the highest PCE concentrations.

Cis-1,2-DCE: cis-1,2-DCE was detected in one sample depth at 4 of the 22 soil gas sampling locations (0030-H, 0041-H, 0051-H, and 0055-H). There is no specified screening level for cis-1,2-DCE. The highest cis-1,2-DCE concentration was at 0030-H at 6 ft bgs at 2.8 µg/m^3. There are no apparent trends associated with the cis-1,2-DCE detections; however, the highest concentration was reported at the location of the second highest TCE concentration in soil gas, northeast of the ESS area.

Soil gas samples that were analyzed for 1,4-dioxane and VC were below detection levels for both analytes.

6.8 Indoor Air and Outdoor Air Contamination through Vapor Intrusion

Indoor air and outdoor air sampling, in combination with the near-slab soil gas sampling described in Section 6.7, were collected to assess VI. As described in Section 5.5.1, two sampling and analysis methods were used to evaluate indoor air and outdoor air. Table 5-10 identifies the structures where indoor air and outdoor air sampling was conducted using the two methods.

- A HAPSITE® was used to conduct real-time screening for PCE, TCE, and cis-1,2-DCE in indoor air at 29 structures and in outdoor air at 26 of those same structures (Table 5-10). Real-time screening of indoor air was typically conducted in multiple rooms within a structure, as identified in Table 6-6. Screening values obtained from the HAPSITE® indoors were compared to RBSLs and RALs and used to identify locations for collection of samples for laboratory analysis using EPA Method TO-15. Usable HAPSITE® data was obtained in 2016 and 2017, and Table 6-6 is a summary of the HAPSITE® screening data that exceeded the RBSLs and/or RALs, and whether an interior source of contaminants was identified. Locations where HAPSITE® data was collected and where that data exceeded the RBSLs are illustrated in Figure 6-5 and a full summary of HAPSITE® data is provided in Appendix K.
- SUMMA® canister confirmatory samples of indoor air for laboratory analysis using EPA Method TO-15 were collected at 23 structures. Outdoor air samples were collected at 2 of those structures (Table 5-10). Table 6-7 presents the PCOPC analytical data. The locations where indoor air and outdoor air samples were collected for laboratory analysis, as well as the EPA Method TO-15 results, are illustrated on Figure 6-6.

6.8.1 Indoor Air Results

Results of the indoor air sampling and EPA Method TO-15 analysis is presented in Table 6-7, illustrated on Figure 6-6, and summarized below:

PCE: PCE was detected in 17 locations during HAPSITE® field screening (Appendix K). Concentrations in exceedance of the RBSL were reported in six of these locations (Figure 6-5). However, interior sources were located in three of the locations (0045-S, 0054-H, and 0059-H). Screening conducted once the background source was removed did not exceed RBSLs. Therefore, no confirmatory samples were collected for EPA Method TO-15 analysis from those locations. Confirmatory samples were collected from the other three locations (0040-H, 0051-H, and 0053-H) that exhibited concentrations in exceedance of the RBSLs based on HAPSITE® data. Results of the EPA Method TO-15 analysis confirmed exceedances of the indoor air RBSL at 0040-H and 0053-H. As noted in Section 5.5, additional indoor air samples were collected for EPA Method TO-15 analysis. Based on EPA Method TO-15 results, PCE was detected in 19 of the 23 structures at concentrations ranging from 0.037 to 74 μg/m^3 (78 μg/m^3 in the duplicate sample). PCE concentrations were greater than the RBSL (11 μg/m^3) in structures 0003-H, 0011-H, 0018-H, 0040-H, and 0053-H. The majority of these structures are centrally located in the ESS area and above very shallow groundwater with elevated PCE concentrations (Figure 6-6). Low level detections of PCE in indoor air (i.e., less than 3 μg/m^3) were fairly widespread, extending east to 0008-H and north to 0030-H. Concentrations exceeding the RBSL were limited to the area south of Sunnyside Avenue (0011-H, 0053-H), southeast parallel to the fault scarp in the vicinity of Alpine Place (0018-H, 0040-H) to Gilmer Avenue (0003-H). Indoor air PCE concentrations exceeded the Tier 1 RAL (41 μg/m^3) in structure 0040-H prompting a TCRA, which has been executed in accordance with an Action Memorandum prepared in 2016 (VA 2016).

TCE: TCE was detected in four locations during HAPSITE® field screening (Appendix K). However, interior sources were located in three of the locations (0045-S, 0054-H, and 0059-H). Therefore, no confirmatory samples were collected for EPA Method TO-15 analysis from those locations. Confirmatory samples were collected from 0040-H. Results of the EPA Method TO-15 analysis confirmed exceedances of the indoor air RBSL at 0040-H. As noted in Section 5.5, additional indoor air samples were collected for EPA Method TO-15 analysis. Based on EPA Method TO-15 results, TCE was detected in 4 of the 23 structures (0002-H, 0017-H, 0018-H, and 0040-H) at concentrations ranging from 0.29 to 5.4 μg/m^3. The indoor air RBSL (0.48 μg/m^3) was exceeded in 2 of these structure (0018-H and 0040-H).

Cis-1,2-DCE: cis-1,2-DCE was detected in one structure 0040-H at concentrations ranging from 0.39 to 0.58 μg/m^3. There are no specified SLs for cis-1,2-DCE.

Vinyl chloride: VC was detected in one structure, 0001-H, at a concentration of 0.17 μg/m^3 which is also the RBSL.

1,4-dioxane: 1,4-dioxane was detected in two structures, 0025-H and 0037-H, at concentrations ranging from 0.18 to 2.3 μg/m^3. Concentrations in 0025-H exceeded the RBSL of 0.56 μg/m^3).

Based on EPA Method TO-15 results, 4 of the 23 structures had no detected PCOPC concentrations: 0004-H, 0013-H, 0027-H, and 0038-H. 0004-H, 0013-H and 0027-H are located northeast of the ESS area and 0038-H is located southwest of the ESS area, west of the East Bench Fault.

6.8.2 Outdoor Air Results

Two outdoor air samples were collected for EPA Method TO-15 analysis. These samples were collected from structures 0026-H and 0030-H (Table 6-6). They were analyzed for PCE, TCE, cis-1,2-DCE, and VC. Both outdoor air samples were less than detection limits for these four PCOPCs. Structure 0026-H is north-central in the ESS area and near the Benson Spring, and 0030-H is to the north-east between the McGillis School and Mount Olivet Cemetery.

6.8.3 Correlation Between Exterior Near-slab Soil Gas Sample Results and Indoor Air Sample Results

This section discusses the structures where samples were collected for both indoor air and near-slab soil gas and analyzed using EPA Method TO-15. Locations where both media were collected included 0003-H, 0008-H, 0026-H, 0030-H, and 0053-H.

0003-H: This structure is located within the ESS area near the intersection of 1200 East and Gilmer Avenue. PCE was detected in indoor air (1.3 to 17 µg/m^3) in concentrations that exceeded the RBSL. However, PCE was not detect in soil gas. No other PCOPC were detected at this structure in indoor air or soil gas. Depth to groundwater in this area is approximately 5 ft bgs. PCE concentrations in groundwater at this location ranged between 2.5 µg/L and 3.0 µg/L.

0008-H: This structure is located east of the ESS area, near Sunnyside Avenue east of East High School. PCE was detected in the indoor air at an estimated concentration of 2.9 µg/m^3 but no PCE was detected in the soil gas sample. No other PCOPC were detected at this structure in indoor air or soil gas. This location is outside of the area of targeted shallow groundwater sampling. PCE concentrations in groundwater in this area is currently unknown and depth to groundwater is over 50 ft bgs.

0026-H: This structure is located in the northern part of the ESS area, just south of Benson spring. PCE was detected in indoor air at 2 µg/m^3 and estimated concentration of 2.1 µg/m^3. All detections for PCE in soil gas were below detection limits. No other PCOPC were detected at this structure in indoor air or soil gas. Depth to groundwater in this area is greater than 10 ft bgs and PCE concentrations in groundwater ranged from 2.7 µg/L to 8.6 µg/L.

0030-H: This structure is located east of the ESS area. PCE was detected in indoor air at a concentration of 5.9 µg/m^3 and in soil gas at an estimated concentration of 1.5 µg/m^3. No other PCOPCs were detected in indoor air. However, there was a detection of TCE in soil gas at a concentration of 17 µg/m^3, which exceeds the soil gas RBSL. No PCOPCs other than PCE and TCE were reported in soil gas. This location is outside of the area of targeted shallow groundwater sampling. PCE concentrations in groundwater in this area is currently unknown and depth to groundwater is over 50 ft bgs.

0053-H: This structure is located in the ESS area in an area of high PCE concentrations in shallow groundwater. PCE was detected at an estimated concentration of 13 µg/m^3 which exceeds the RBSL PCE was also detected soil gas at this location at a value of 2,000 µg/m^3 which exceeds the soil gas RBSL. No other PCOPCs were detected in indoor above. However, there was a detection of TCE in the soil gas at a concentration of 18 µg/m^3, which exceeds the soil gas RBSL. Depth to groundwater in this area is approximately 5-10 ft bgs. Groundwater concentrations of PCE in the vicinity of 0053-H is interpolated to be approximately 30 to 40 µg/L.

6.9 Contaminant Sources

The potentially impacted media investigated include air (as indoor air, outdoor air, and soil gas), groundwater, surface water, stormwater, and soil. Based on data obtained from the AOU-1 RI, sources for VI are described in the following sections.

6.9.1 Groundwater as a Source

Volatilization of PCOPCs from shallow groundwater is a potential source of indoor air VOC contamination in the ESS area.

The source strength will be influenced by the vertical distribution of contaminant concentration in the shallow, unconfined groundwater and the flux of vapors from the groundwater source (EPA 2015c). As illustrated on Figure 6-1, shallow groundwater with PCE concentrations above the RBSL is present in the ESS area and is a source for VI in the vicinity of sample locations GW-07, GW-11, GW-13, GW-15, GW-16, GW-27, GW-28, GW-51, GW-52, GW-53, and GW-62. As explained in additional detail in Section 7, the depth to groundwater in this area is shallow, typically less than 10 ft bgs. The PCE in groundwater in this area can migrate by advection and dispersion, volatilize to soil gas and ultimately disperse into the atmosphere, completing the pathway for VI, or become adsorbed to aquifer soils.

TCE is also present in groundwater in the ESS area at concentrations above the RBSL and may be a source for VI, however, it does not appear to be as widespread as the PCE source and TCE was detected in slightly different locations than PCE as presented in Figure 6-7 which shows the TCE and PCE shallow concentration contours. TCE is present above the RBSLs at GW-08, GW-09, GW-14, GW-18, GW-50, and GW-59. Cis-1,2-DCE was also detected at three of the same locations. As with PCE, the TCE source (and possibly a source of cis-1,2-DCE) is also present where the depth to groundwater in this area is shallow, typically less than 10 ft bgs. As mentioned in Section 3.1.3.4, although TCE was not always co-located with PCE or other PCE degradation products (UDEQ 2012), TCE is generally present downgradient of areas with the highest PCE concentrations. Concentrations of PCE and TCE in groundwater within the larger OU-2 area are being investigated in additional detail during the OU-2 RI.

Concentrations of VC, and 1,4-dioxane did not exceed the RBSLs. In the ESS area, a distinctive groundwater source for VI of VC and 1,4-dioxane was not identified.

Upgradient (northeast) sources for PCE and TCE in the groundwater at the ESS area have not been definitively identified, but when the site was listed on the NPL in 2013, EPA identified the suspected source of the contamination as the dry-cleaning facility operated at the VAMC during the period of 1976 – 1984 (EPA 2013). The complex hydrogeology and geology make it difficult to identify the exact release area and migration pathway to the AOU-1 area. In addition, the influence from years of pumping large volumes of water from multiple aquifers at local irrigation wells (e.g., Mount Olivet irrigation well and wells utilized by the University of Utah) may be mixing the upper unconfined aquifer and lower confined aquifer, further complicating the identification of a clear source area. These data gaps are to be addressed during the OU-2 RI. Groundwater flow direction is generally from the northeast to the southwest and source area investigations conducted to date include the former UANG vehicle maintenance facility and the former USFS helicopter pad.

6.9.2 Soil and/or Soil Gas as a Source

Contaminants in groundwater may adsorb onto the soil matrix and vapors emanating from groundwater or soil may reside in the pore space in soil as soil gas. Therefore, contaminants present in both soil gas are a potential source of VI.

Within in the ESS area, RI sampling focused on collect of soil gas data as the most direct indication of a source of VI. Concentrations of PCE in the soil gas above the RBSLs are present and were detected with both HAPSITE® screening (Figure 6-4) and confirmed with laboratory data at location 0053-H, where soil concentrations for PCE were highest. The location of PCE detections in soil gas are collocated with detections of PCE in indoor air (Figure 6-6). Therefore, a PCE soil gas source for VI was confirmed to be present in the ESS area.

TCE was also detected in soil gas with the ESS area and could possibly a source for VI in the ESS area, however, the data is inconclusive because TCE soil gas detections were not collocated with indoor air TCE detections. TCE was detected in soil gas above the RBSL in 0030-H, and 0053-H and in these locations, TCE was not detected in indoor air (Figure 6-6). Therefore, at the time this AOU-1 RI data was collected, TCE in soil gas was not a confirmed source of VI, but it could act as a source in the future or under different pressure conditions or if pathways from the soil gas into nearby structures develop).

Only trace amounts of cis-1,2-DCE were detected in soil gas, and no VC or 1,4-dioxane were detected in soil gas sampling (Table 6-5, Figure 6-6). Therefore, the data do not indicate that these PCOPCs are a source in the soil gas media.

TABLE 6-1

Shallow Groundwater Data from Temporary Monitoring Points

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Location	**Sample ID**	**Sample Date**	**Analyte**				
			PCE (µg/L)	**TCE (µg/L)**	**cis-1,2-DCE (µg/L)**	**VC (µg/L)**	**1,4-dioxane (µg/L)**
Residential SLs for Groundwater to Indoor Air (µg/L) (1)			**15**	**1.2**	**NSL**	**0.15**	**2,900**
GW-01	A-GW-001	3/4/2016	0.78	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-01	A-GW-001-D	3/4/2016	0.76	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-03	A-GW-003	2/26/2016	0.48 J	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-04	A-GW-004	2/26/2016	12	0.34 J	< 0.50 U	< 0.50 U	Not Analyzed
GW-05	A-GW-005	2/26/2016	1.4	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-06	A-GW-006	2/26/2016	3.1	1.0	< 0.50 U	< 0.50 U	Not Analyzed
GW-07	A-GW-007	2/28/2016	**33**	0.59	< 0.50 U	< 0.50 U	Not Analyzed
GW-08	A-GW-008	2/27/2016	9.6	**1.8**	< 0.50 U	< 0.50 U	Not Analyzed
GW-09	A-GW-009	2/26/2016	0.70	**2.4**	0.68	< 0.50 U	Not Analyzed
GW-10	A-GW-010	2/27/2016	0.99	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-10	A-GW-010-D	2/27/2016	1.4	0.11 J	< 0.50 U	< 0.50 U	Not Analyzed
GW-10	A-GW-010	7/12/2016	1.1	< 0.50 U	< 0.50 U	< 0.50 U	< 2.0 U
GW-10	A-GW-010	9/20/2016	1.1	0.19 J	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-11	A-GW-011	2/27/2016	**45**	0.82	< 0.50 U	< 0.50 U	Not Analyzed
GW-11	A-GW-011	7/11/2016	**44**	0.56	< 0.50 U	< 0.50 U	< 2.0 U
GW-11	A-GW-011	9/19/2016	**35**	0.62	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-12	A-GW-012	3/2/2016	4.8	0.22 J	< 0.50 U	< 0.50 U	Not Analyzed
GW-13	A-GW-013	3/4/2016	**22**	0.18 J	< 0.50 U	< 0.50 U	Not Analyzed
GW-14	A-GW-014	3/2/2016	3.2	**1.9**	< 0.50 U	< 0.50 U	< 2.0 R
GW-15	A-GW-015	2/29/2016	**31**	0.62 J	< 0.50 U	< 0.50 U	< 2.0 R
GW-15	A-GW-015-D	2/29/2016	**29** J	0.63 J	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-16	A-GW-016	2/28/2016	**20** J	0.61	< 0.50 U	< 0.50 U	Not Analyzed
GW-16	A-GW-016	7/11/2016	13	0.53	< 0.50 U	< 0.50 U	< 2.0 U
GW-16	A-GW-016	9/19/2016	**18**	0.73	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-17	A-GW-017	3/2/2016	1.1	0.56	< 0.50 U	< 0.50 U	Not Analyzed
GW-18	A-GW-018	3/2/2016	10	**2.1**	< 0.50 U	< 0.50 U	Not Analyzed
GW-20	A-GW-020	3/1/2016	2.7	1.0	< 0.50 U	< 0.50 U	< 2.0 R
GW-20	A-GW-020	7/11/2016	8.3	0.40 J	< 0.50 U	< 0.50 U	< 2.0 U
GW-20	A-GW-020	9/19/2016	8.6	0.29 J	< 0.50 U	< 0.50 U	< 2.1 UJ

TABLE 6-1
Shallow Groundwater Data from Temporary Monitoring Points
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

Sample Location	Sample ID	Sample Date	Analyte									
			PCE (µg/L)		**TCE (µg/L)**		**cis-1,2-DCE (µg/L)**		**VC (µg/L)**		**1,4-dioxane (µg/L)**	
Residential SLs for Groundwater to Indoor Air (µg/L) (1)			**15**		**1.2**		**NSL**		**0.15**		**2,900**	
GW-21	A-GW-021	3/1/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-22	A-GW-022	3/1/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-23	A-GW-023	2/22/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-24	A-GW-024	2/25/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-25	A-GW-025	2/29/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-26	A-GW-026	2/28/2016	0.27	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-27	A-GW-027	3/5/2016	**22**		0.21	J	< 0.50	U	< 0.50	U	Not Analyzed	
GW-28	A-GW-028	3/5/2016	**43**		0.40	J	< 0.50	U	< 0.50	U	Not Analyzed	
GW-31	A-GW-031	2/28/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-39	A-GW-039	2/23/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-40	A-GW-040	3/3/2016	0.13	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-43	A-GW-043	3/3/2016	0.35	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-46	A-GW-046	2/24/2016	0.20	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-48	A-GW-048	3/3/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-49	A-GW-049	2/25/2016	1.2		< 0.50	U	< 0.50	U	< 0.50	U	< 2.0	R
GW-49	A-GW-049-D	2/25/2016	1.2		< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
GW-49	A-GW-049	7/12/2016	1.1		< 0.50	U	< 0.50	U	< 0.50	U	< 2.0	U
GW-49	A-GW-049	9/20/2016	1.1		< 0.50	U	< 0.50	U	< 0.50	U	< 2.1	UJ
GW-50	A-GW-050	2/29/2016	2.5		**1.7**		1.1		< 0.50	U	< 2.0	R
GW-50	A-GW-050	7/12/2016	2.8		**6.1**		1.3		< 0.50	U	< 2.0	U
GW-50	A-GW-050	9/20/2016	3.0		**6.4**		1.4		< 0.50	U	< 2.0	UJ
GW-51	A-GW-051	3/4/2016	**23**		0.19	J	< 0.50	U	< 0.50	U	Not Analyzed	
GW-52	A-GW-052	3/3/2016	**57**		0.53	J	< 0.50	U	< 0.50	U	Not Analyzed	
GW-52	A-GW-052-D	3/3/2016	**61**		0.61	J	< 0.50	U	< 0.50	U	Not Analyzed	
GW-52	A-GW-052	7/12/2016	**52**		0.56		< 0.50	U	< 0.50	U	2.7	
GW-52	A-GW-052-D	7/12/2016	**46**		0.49	J	< 0.50	U	< 0.50	U	< 2.0	U
GW-52	A-GW-052	9/20/2016	**43**		0.44	J	< 0.50	U	< 0.50	U	< 2.0	UJ
GW-52	A-GW-052-D	9/20/2016	**42**		0.40	J	< 0.50	U	< 0.50	U	< 2.0	UJ
GW-53	A-GW-053	3/3/2016	**37**		0.83		< 0.50	U	< 0.50	U	Not Analyzed	

TABLE 6-1

Shallow Groundwater Data from Temporary Monitoring Points

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Department of Veterans Affairs Salt Lake City Health Care System

Sample Location	Sample ID	Sample Date	Analyte				
			PCE (µg/L)	**TCE (µg/L)**	**cis-1,2-DCE (µg/L)**	**VC (µg/L)**	**1,4-dioxane (µg/L)**
Residential SLs for Groundwater to Indoor Air (µg/L) (1)			**15**	**1.2**	**NSL**	**0.15**	**2,900**
GW-53	A-GW-053	7/11/2016	**40**	0.84	< 0.50 U	< 0.50 U	< 2.0 U
GW-53	A-GW-053	9/19/2016	**45**	0.59	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-55	A-GW-055	3/5/2016	0.19 J	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-59	A-GW-059	3/5/2016	0.17 J	**7.7**	3.9	< 0.50 U	Not Analyzed
GW-59	A-GW-059	7/11/2016	2.0	**6.1**	2.5	< 0.50 U	< 2.0 U
GW-59	A-GW-059	9/19/2016	1.0	**7.2**	3.0	< 0.50 U	< 2.0 UJ
GW-60	A-GW-060	3/8/2016	10	1.0	< 0.50 U	< 0.50 U	Not Analyzed
GW-61	A-GW-061	3/5/2016	2.3	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
GW-61	A-GW-061	7/12/2016	2.9	< 0.50 U	< 0.50 U	< 0.50 U	< 2.0 U
GW-61	A-GW-061	9/20/2016	3.0	0.15 J	< 0.50 U	< 0.50 U	< 2.0 UJ
GW-62	A-GW-062	3/8/2016	**20**	0.23 J	< 0.50 U	< 0.50 U	Not Analyzed

NOTES

1. Screening levels are from Table 3-6

µg/L = Micrograms per liter.
D = Duplicate.
DCE = cis-1,2-dichloroethene
ID = Identification.
J = Estimated value below the contract-required quantitation limit or based on data validation.
NSL = No screening level.
PCE = Tetrachloroethene.
R = Result has been rejected and data do not meet the project objectives.
SL = Screening level.
TCE = Trichloroethene.
U = Nondetect value.
UJ = Estimated nondetect value.
VC = Vinyl chloride.

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TABLE 6-2

Depth to Shallow Groundwater At Temporary Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Elevation Top of Casing (ft amsl)**	**Water Table Elevation (ft amsl)**			**Depth to Groundwater February/ March 2016 (ft bgs)**	**Depth to Groundwater July 2016 (ft bgs)**	**Depth to Groundwater September 2016 (ft bgs)**	**Average Depth to Groundwater Measured in 2016 (ft bgs)**
		February/ March 2016	**July 2016**	**September 2016**				
GW-01	4486.95	4475.02	NA	NA	11.93	NA	NA	11.93
GW-02					NA	NA	NA	NA
GW-03	4484.03	4455.63	NA	NA	28.4	NA	NA	28.4
GW-04	4415.71	4398.45	NA	NA	17.26	NA	NA	17.26
GW-05	4465.01	4462.55	NA	NA	2.46	NA	NA	2.46
GW-06	4455.29	4450.63	NA	NA	4.66	NA	NA	4.66
GW-07	4456.07	4447.44	NA	NA	8.63	NA	NA	8.63
GW-08	4430.31	4423.35	NA	NA	6.96	NA	NA	6.96
GW-09	4416.96	4412.05	NA	NA	4.91	NA	NA	4.91
GW-10	4382.52	4370.3	4369.21	4369.17	12.22	13.31	13.35	12.96
GW-11	4437.77	4435.21	4435.02	4434.79	2.56	2.75	2.98	2.76
GW-12	4382.57	4378.22	NA	NA	4.35	NA	NA	4.35
GW-13	4489.66	4468.22	NA	NA	21.44	NA	NA	21.44
GW-14	4399.05	4389.05	NA	NA	10	NA	NA	10
GW-15	4443.22	4442.72	NA	NA	0.5	NA	NA	0.5
GW-16	4422.96	4420.96	4421.26	4421.27	2	1.7	1.69	1.80
GW-17	4395.42	4381.02	NA	NA	14.4	NA	NA	14.4
GW-18	4433.39	4425.24	NA	NA	8.15	NA	NA	8.15
GW-19					NA	NA	NA	NA
GW-20	4417.16	4405.69	4405.52	4405.72	11.47	11.64	11.44	11.52
GW-21	4462.16	4452.19	NA	NA	9.97	NA	NA	9.97
GW-22	4406.25	4400.92	NA	NA	5.33	NA	NA	5.33
GW-23	4480.78	4471.88	NA	NA	8.9	NA	NA	8.9
GW-24	4394.76	4377.86	NA	NA	16.9	NA	NA	16.9
GW-25	4368.33	4345.23	NA	NA	23.1	NA	NA	23.1

TABLE 6-2

Depth to Shallow Groundwater At Temporary Monitoring Points and Piezometers

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Department of Veterans Affairs Salt Lake City Health Care System

Location ID	**Elevation Top of Casing (ft amsl)**	**Water Table Elevation (ft amsl)**			**Depth to Groundwater February/ March 2016 (ft bgs)**	**Depth to Groundwater July 2016 (ft bgs)**	**Depth to Groundwater September 2016 (ft bgs)**	**Average Depth to Groundwater Measured in 2016 (ft bgs)**
		February/ March 2016	**July 2016**	**September 2016**				
GW-26	4376.06	4359.58	NA	NA	16.48	NA	NA	16.48
GW-27	4493.18	4472.95	NA	NA	20.23	NA	NA	20.23
GW-28	4491.28	4472.83	NA	NA	18.45	NA	NA	18.45
GW-31	4334.23	4302.36	NA	NA	31.87	NA	NA	31.87
GW-33					NA	NA	NA	NA
GW-35					NA	NA	NA	NA
GW-39	4349.59	4333.11	NA	NA	16.48	NA	NA	16.48
GW-40	4366.97	4332.44	NA	NA	34.53	NA	NA	34.53
GW-42					NA	NA	NA	NA
GW-43	4471.03	4440.53	NA	NA	30.5	NA	NA	30.5
GW-46	4418.18	4388.6	NA	NA	29.58	NA	NA	29.58
GW-48	4511.11	4474.77	NA	NA	36.34	NA	NA	36.34
GW-49	4465.84	4458.27	4458.53	4458.35	7.57	7.31	7.49	7.46
GW-50	4445.12	4442.43	4442.67	4442.67	2.69	2.45	2.45	2.53
GW-51	4480.08	4467.61	NA	NA	12.47	NA	NA	12.47
GW-52	4490.6	4467.76	4467.8	4467.45	22.84	22.8	23.15	22.93
GW-53	4459.05	4448.29	4448.07	4448.21	10.76	10.98	10.84	10.86
GW-54					NA	NA	NA	NA
GW-55	4429.71	4407.74	NA	NA	21.97	NA	NA	21.97
GW-57					NA	NA	NA	NA
GW-58					NA	NA	NA	NA
GW-59	4385.84	4377.26	4378.43	4378.6	8.58	7.41	7.24	7.74
GW-60	4394.15	4384.45	NA	NA	9.7	NA	NA	9.7
GW-61	4399.8	4388.09	4387.89	4387.6	11.71	11.91	12.2	11.94
GW-62	4455.16	4442.34	NA	NA	12.82	NA	NA	12.82

TABLE 6-2

Depth to Shallow Groundwater At Temporary Monitoring Points and Piezometers

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

NOTES:

amsl = Above mean sea level.

bgs = Below ground surface.

ft = Feet(foot).

ID = Identification.

NA = Not applicable.

RI = Remedial Investigation.

Blue shaded cells represent locations completed as a temporary groundwater monitoring point.

Totals:

Temporary monitoring points attempted with Geoprobe = 50

Refusal/no groundwater encountered = 6

Temporary monitoring point set, but no groundwater recharge = 2

One-time shallow groundwater sample collected = 42

Piezometers installed = 10

TABLE 6-3

Surface Water and Stormwater Data

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Location	**Sample ID**	**Sample Date**	**Analytes**				
			PCE (µg/L)	**TCE (µg/L)**	**cis-1,2-DCE (µg/L)**	**VC (µg/L)**	**1,4-dioxane (µg/L)**
Residential Surface Water SL for Protection of Soil (µg/L) (1)			130,000	7,700	2,000,000	1,400	1,000,000
Industrial Surface Water for Protection of Soil (µg/L) (1)			530,000	49,000	29,000,000	39,000	4,600,000
SL for Direct Contact with Surface Water (Ing/Derm) (µg/L) (1)			1,500	110	3,000	1	160
Surface Water Samples							
SW-01	A-SW-001	5/4/2016	0.13 J	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
SW-04	A-SW-004	5/2/2016	27	0.34 J	0.19 J	< 0.50 U	Not Analyzed
SW-06	A-SW-006	5/4/2016	74	0.96	0.58	< 0.50 U	Not Analyzed
SW-07	A-SW-007	5/4/2016	2.9	< 0.50 U	< 0.50 U	< 0.50 U	< 2.0 UJ
SW-08	A-SW-008	5/4/2016	7.5	0.13 J	< 0.50 U	< 0.50 U	Not Analyzed
SW-09	A-SW-009	5/3/2016	19	0.88	0.11 J	< 0.50 U	Not Analyzed
SW-11	A-SW-011	5/3/2016	20	0.61	0.60	< 0.50 U	Not Analyzed
SW-12	A-SW-012	5/3/2016	23	0.39 J	0.12 J	< 0.50 U	< 2.0 UJ
SW-12	A-SW-012	5/3/2016	17	0.36 J	< 0.50 U	< 0.50 U	Not Analyzed
SW-13	A-SW-013	5/3/2016	1.8	0.37 J	< 0.50 U	< 0.50 U	Not Analyzed
SW-14	A-SW-014	5/4/2016	18	0.53	< 0.50 U	< 0.50 U	Not Analyzed
SW-15	A-SW-015	5/4/2016	14	0.32 J	< 0.50 U	< 0.50 U	< 2.0 UJ
SW-16	A-SW-016	5/4/2016	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 2.0 UJ
SW-19	A-SW-019	5/4/2016	0.18 J	< 0.50 U	< 0.50 U	< 0.50 U	Not Analyzed
SW-21	A-SW-021	5/3/2016	6.5	0.62	0.44 J	< 0.50 U	Not Analyzed
SW-21	A-SW-021	5/3/2016	5.2	0.49 J	0.41 J	< 0.50 U	< 2.0 UJ
SW-22	A-SW-022	5/3/2016	2.9	0.47 J	0.13 J	< 0.50 U	Not Analyzed
SW-23	A-SW-023	5/3/2016	25	0.46 J	0.15 J	< 0.50 U	< 2.0 UJ
SW-23	A-SW-023	5/3/2016	22	0.47 J	< 0.50 U	< 0.50 U	< 1.9 U
SW-26	A-SW-026	5/3/2016	23	0.30 J	< 0.50 U	< 0.50 U	< 2.0 UJ
SW-27	A-SW-027	5/3/2016	19	0.61	0.57	< 0.50 U	< 2.0 UJ
SW-27	A-SW-027	5/3/2016	13	0.46 J	0.46 J	< 0.50 U	Not Analyzed
SW-29	A-SW-029	5/11/2016	26	0.28 J	< 0.50 U	< 0.50 U	Not Analyzed
SW-30	A-SW-030	5/3/2016	0.50	0.090 J	< 0.50 U	< 0.50 U	Not Analyzed
SW-31	A-SW-031	5/2/2016	20	0.48 J	0.27 J	< 0.50 U	Not Analyzed
SW-33	A-SW-033	5/2/2016	35	0.78	0.15 J	< 0.50 U	Not Analyzed

TABLE 6-3

Surface Water and Stormwater Data

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Sample Location	Sample ID	Sample Date	Analytes									
			PCE (µg/L)		TCE (µg/L)		cis-1,2-DCE (µg/L)		VC (µg/L)		1,4-dioxane (µg/L)	
SW-34	A-SW-034	5/2/2016	13		0.27	J	0.13	J	< 0.50	U	Not Analyzed	
SW-35	A-SW-035	5/4/2016	82		0.67		0.54		< 0.50	U	Not Analyzed	
SW-36	A-SW-036	5/3/2016	1.2		2.3		0.69		< 0.50	U	Not Analyzed	
SW-40	A-SW-040	5/5/2016	28		0.38	J	0.18	J	< 0.50	U	Not Analyzed	
SW-42	A-SW-042	5/2/2016	16		0.19	J	< 0.50	U	< 0.50	U	Not Analyzed	
SW-43	A-SW-043	5/2/2016	4.1		0.10	J	< 0.50	U	< 0.50	U	Not Analyzed	
SW-44	A-SW-044	5/4/2016	2.2		< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-46	A-SW-046	5/5/2016	2.4		< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-47	A-SW-047	5/4/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	< 2.0	UJ
SW-48	A-SW-048	5/4/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-50	A-SW-001	2/26/2016	6.3		0.13	J	< 0.50	UJ	< 0.50	U	Not Analyzed	
Storm Sewer Water Samples												
SW-02	A-SW-002	5/11/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-03	A-SW-003	5/11/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-05	A-SW-005	5/11/2016	0.38	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-10	A-SW-010	5/11/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-17	A-SW-017	5/11/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-18	A-SW-018	5/5/2016	17		0.43	J	0.35	J	< 0.50	U	Not Analyzed	
SW-20	A-SW-020	5/5/2016	0.23	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-24	A-SW-024	5/11/2016	< 0.50	U	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-25	A-SW-025	5/5/2016	1.4		< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-28	A-SW-028	5/3/2016	16		0.66		0.56		< 0.50	U	Not Analyzed	
SW-28	A-SW-028	5/3/2016	12		0.56		0.50		< 0.50	U	< 2.0	UJ
SW-32	A-SW-032	5/5/2016	0.46	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-37	A-SW-037	5/5/2016	15		0.39	J	0.24	J	< 0.50	U	Not Analyzed	
SW-38	A-SW-038	5/11/2016	6.0		0.22	J	< 0.50	U	< 0.50	U	Not Analyzed	
SW-39	A-SW-039	5/3/2016	31		0.50		0.31	J	< 0.50	U	Not Analyzed	
SW-41	A-SW-041	5/5/2016	0.49	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	
SW-45	A-SW-045	5/5/2016	3.1		0.11	J	0.11	J	< 0.50	U	Not Analyzed	
SW-49	A-SW-049	5/5/2016	0.21	J	< 0.50	U	< 0.50	U	< 0.50	U	Not Analyzed	

NOTES:
1. Screening levels are from Table 3-7.
µg/L = Micrograms per liter.
DCE = cis-1,2-dichloroethene
ID = Identification.
J = Estimated value below the contract-required quantitation limit or based on data validation.
PCE = Tetrachloroethene.
SL = Screening level.
TCE = Trichloroethene.
U = Non-detect value.
UJ = Estimated non-detect value.
VC = Vinyl chloride.

TABLE 6-4

Soil Data

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Sample ID	Sample Date	Analyte PCE (mg/kg)		TCE (mg/kg)		1,4-Dioxane (mg/kg)		cis-1,2-DCE (mg/kg)		VC (mg/kg)	
		Residential Soil (mg/kg) (1)	**24**		**0.94**		**5.3**		**160**		**0.059**	
		Commercial/ Industrial Soil (mg/kg) (1)	**100**		**6**		**24**		**160**		**1.7**	
SW-01	A-SS-01	5/4/2016	< 0.011	U	< 0.011	U	< 0.14	UJ	< 0.011	U	< 0.011	U
SW-01	A-SS-01-D	5/4/2016	< 0.027	U	< 0.027	U	< 0.2	UJ	< 0.027	U	< 0.027	U
SW-09	A-SS-09	5/3/2016	< 0.01	U	< 0.01	U	< 0.1	U	< 0.01	U	< 0.01	U
SW-26	A-SS-26	5/3/2016	0.022		< 0.01	U	< 0.12	UJ	< 0.01	U	< 0.01	U

NOTES:

1. Screening levels are from Table 3-7.

DAF = Dilution attenuation factor.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quatient.
ID = Identification.
mg/kg = Milligram per kilogram.
RSL = Regional Screening Level.
SSL = Soil Screening Level.
U = Non-detect value.
UJ = Estimated non-detect value.

TABLE 6-5

Soil Gas HAPSITE® and Laboratory (TO-15) Data

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Sample Location ID	Sample ID	Sample Depth (ft bgs)	Sample Date	Analytical Method (TO-15 or HAPSITE®)	Analyte				
						PCE (µg/m^3)	**TCE (µg/m^3)**	**cis-1,2-DCE (µg/m^3)**	**VC (µg/m^3)**	**1,4-dioxane (µg/m^3)**
Residential Soil Gas Screening Level (µg/m^3) (1)						**370**	**16**	**NSL**	**5.7**	**19**
Commercial/Industrial Soil Gas Screening Level (µg/m^3) (1)						**1,600**	**100**	**NSL**	**93**	**83**
0003-H	0003H-SG	A-0003H-040915-SG-001-4'	4.0	4/9/2015	TO 15	< 3.4 U	< 2.7 U	< 2 U	< 1.3 U	NA
0008-H	0008H-SG	A-0008H-041015-SG-001A-4'	4.0	4/10/2015	TO 15	< 3.4 U	< 2.7 U	< 2 U	< 1.3 U	NA
	0008H-SG	A-0008H-041015-SG-001B-4'	4.0	4/10/2015	TO 15	3 J	< 2.7 U	< 2 U	< 1.3 U	NA
0026-H	0026H-SG	A-0026H-040815-SG-002-4'	4.0	4/8/2015	TO 15	< 3.4 U	< 2.7 U	< 2 U	< 1.3 U	NA
	0026H-SG	A-0026H-040815-SG-003-4'	4.0	4/8/2015	TO 15	< 3.4 U	< 2.7 U	< 2 U	< 1.3 U	NA
0030-H	0030H-SG	A-0030H-0411150SG-001A-6	6.0	4/11/2015	TO 15	1.5 J	**17**	2.8	< 1.3 U	NA
0040-H	0040H-SG-SG1	0040H-SG-SG1-20160310-039-6'	6.0	3/10/2016	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0040H-SG-SG1	0040H-SG-SG1-20160310-040-6'	6.0	3/10/2016	HAPSITE®	1.4	< 0.5 U	< 0.4 U	NA	NA
	0040H-SG-SG2	0040H-SG-SG2-20160310-041-4'	4.0	3/10/2016	HAPSITE®	4.6	< 0.5 U	< 0.4 U	NA	NA
0041-H	0041H-SG-SG1	0041H-SG-SG1-20160308-038-7'	7.0	3/8/2016	HAPSITE®	< 0.7 U	< 0.5 U	0.59	NA	NA
0045-S	0045S-SG-SG1	0045S-SG-SG1-20160322-042-4'	4.0	3/22/2016	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0045S-SG-SG1	0045S-SG-SG1-20160322-043-4'	4.0	3/22/2016	HAPSITE®	2.55	< 0.5 U	< 0.4 U	NA	NA
0047-H	0047H-SG-SG1	0047H-SG-SG1-20160226-028-4.5'	4.5	2/26/2016	HAPSITE®	26.9	< 0.5 U	< 0.4 U	NA	NA
0050-H	0050H-SG-SG1	0050H-SG-SG1-20160323-016-5'	5.0	3/23/2016	HAPSITE®	13.1	3.6	0.4 U	NA	NA
0051-H	0051H-SG-SG1-45	0051H-SG-SG1-20160226-028-4.5'	4.5	2/26/2016	HAPSITE®	26.9	< 0.5 U	< 0.4 U	NA	NA
	0051H-SG-SG1-75	0051H-SG-SG1-20160226-029-7.5'	7.5	2/26/2016	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0051H-SG-SG1-75	0051H-SG-SG1-20160226-030-7.5'	7.5	2/26/2016	HAPSITE®	< 0.7 U	< 0.5 U	0.59	NA	NA
	0051H-SG-SG2-75	0051H-SG-SG2-20160226-032-7.5'	7.5	2/26/2016	HAPSITE®	3	< 0.5 U	< 0.4 U	NA	NA
	0051H-SG-SG2-85	0051H-SG-SG2-20160226-031-8.5'	8.5	2/26/2016	HAPSITE®	10.3	< 0.5 U	< 0.4 U	NA	NA
0052-H	0052H-SG-SG1	0052H-SG-SG1-20160311-032-4.5'	4.5	3/11/2016	HAPSITE®	10.3	< 0.5 U	< 0.4 U	NA	NA
0053-H	0053H-SG-0037	A-0053H-052316-SG-001-6'(0037)	6.0	5/23/2016	TO 15	**2000 J**	**18**	< 2 U	< 1.3 U	< 7.2 U
	0053H-SG-0050	A-0053H-052316-SG-001-6'(0050)	6.0	5/23/2016	TO 15	**1500 J**	**21**	< 2 U	< 1.3 U	< 7.2 U
	0053H-SG-SG1	0053H-SG-SG1-20160502-056-6.5'	6.5	5/2/2016	HAPSITE®	**627.7**	4.5	< 0.4 U	NA	NA
	0053H-SG-SG1	0053H-SG-SG1-20160502-058-6.5'	6.5	5/2/2016	HAPSITE®	**510**	< 0.5 U	< 0.4 U	NA	NA
0054-H	0054H-SG-SG1	0054H-SG-SG1-20160603-042-7'	7.0	6/3/2016	HAPSITE®	5.7	< 0.5 U	< 0.4 U	NA	NA
	0054H-SG-SG1	0054H-SG-SG1-20160603-043-7'	7.0	6/3/2016	HAPSITE®	61.4	< 0.5 U	< 0.4 U	NA	NA
0055-H	0055H-SG-SG1	0055H-SG-SG1-20160513--038	5.0 (2)	5/13/2016	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0055H-SG-SG1	0055H-SG-SG1-20160513--039	5.0 (2)	5/13/2016	HAPSITE®	< 0.7 U	< 0.5 U	0.48	NA	NA
0056-H	0056H-SG-SG1	0056H-SG-SG1-20160503-031-5.5'	5.5	5/3/2016	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0056H-SG-SG1	0056H-SG-SG1-20160503-032-5.5'	5.5	5/3/2016	HAPSITE®	3.2	< 0.5 U	< 0.4 U	NA	NA
0057-H	0057H-SG-2FT	A-0057H-04052017-SG-022-2'	2.0	4/5/2017	HAPSITE®	2.10	< 0.5 U	< 0.4 U	NA	NA
0058-H	0058H-SG-4FT	A-0058H-030617-SG-025-4'	4.0	3/6/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0058H-SG-4FT	A-0058H-030617-SG-026-4'	4.0	3/6/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0058H-SG-6FT	A-0058H-030617-SG-027-6'	6.0	3/6/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
0059-H	0059H-SG-1.8FT	A-0059H-031717-SG-039-1.8'	1.8	3/17/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0059H-SG-5FT	A-0059H-031717-SG-040-5'	5.0	3/17/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
0060-H	0060H-SG-4.8FT	A-0060H-030717-SG-037-4.8'	4.8	3/7/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0060H-SG-4.8FT	A-0060H-030717-SG-038-4.8'	4.8	3/7/2017	HAPSITE®	4.81	< 0.5 U	< 0.4 U	NA	NA

TABLE 6-5

Soil Gas HAPSITE® and Laboratory (TO-15) Data

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Location ID	Sample Location ID	Sample ID	Sample Depth (ft bgs)	Sample Date	Analytical Method (TO-15 or HAPSITE®)	Analyte				
						PCE (µg/m^3)	TCE (µg/m^3)	cis-1,2-DCE (µg/m^3)	VC (µg/m^3)	1,4-dioxane (µg/m^3)
0061-H	0061H-SG-4.7FT	A-0061H-030817-SG-029-4.7'	4.7	3/8/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0061H-SG-4.7FT	A-0061H-030817-SG-030-4.7'	4.7	3/8/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
	0061H-SG-6.1FT	A-0061H-030817-SG-031-6.1'	6.1	3/8/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
0062-H	0062H-SG-6.5FT	A-0062H-032917-SG-025-6.5'	6.5	3/29/2017	HAPSITE®	< 0.7 U	< 0.5 U	< 0.4 U	NA	NA
0063-H	0063H-SG-SG1	A-0063H-032117-6'-SG-041-SG1	6.0	3/21/2017	HAPSITE®	108.5 E	< 0.5 U	< 0.4 U	NA	NA

NOTES:

1. Screening levels are from Table 3-6.
2. Depth is documented in Table 14 of the 2016 Vapor intrusion Investigation Field Data Report (EA 2018b).

µg/m^3 = Micrograms per cubic meter.
DCE = cis-1,2-dichloroethene
E = HAPSITE® estimated value (undiluted)
ft bgs = Feet below ground surface.
ID = Identification.
J = Estimated value.
NA = Not analyzed.
NSL = No screening level.
PCE = Tetrachloroethene.
TCE = Trichloroethene.
U = Nondetect value.
VC = Vinyl chloride.

Bold values exceed the residential soil gas sceening level

TABLE 6-6

Indoor Air, Outdoor Air, and Soil Gas, HAPSITE® Data - Exceedances of RBSLs and RALs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure	**Location ID**	**Sample Name**	**Sample Date**	**Analyte**			**Background Source Present in Breathing Zone? (Yes/No)**
				PCE (µg/m^3)	**TCE (µg/m^3)**	**cis-1,2-DCE (µg/m^3)**	
Residential Indoor Air RBSL (1)				**11**	**0.48**	**NSL**	
Residential Indoor Air Tier 1 RAL (2)				**41**	**2.1**	**NSL**	
Residential Indoor Air Tier 2 RAL (3)				**120**	**6.3**	**NSL**	
Residential Soil Gas RBSL (4)				**370**	**16**	**NSL**	
Commercial/Industrial Indoor Air RBSL (1)				**47**	**3**	**NSL**	
0040-H	0040H-IA-BBBED	0040H-IA-BBED-20160310-BL-014	3/10/2016	**27.6**	**1.7**	< 0.4 U	No (5)
	0040H-IA-BBED	0040H-IA-BBED-20160310-BL-005	3/10/2016	**32.2**	**2.1**	0.52	
	0040H-IA-BBED	0040H-IA-BBED-20160310-BL-012	3/10/2016	**51.7**	**3**	0.55	
	0040H-IA-BBED	0040H-IA-BBED-20160310-N10-024	3/10/2016	**24.8**	**1.4**	< 0.4 U	
	0040H-IA-BBED	0040H-IA-BBED-20160310-N10-027	3/10/2016	**25.5**	**1.5**	< 0.4 U	
	0040H-IA-BBED	0040H-IA-BBED-20160310-N5-015	3/10/2016	**30.4**	**1.5**	< 0.4 U	
	0040H-IA-BBED	0040H-IA-BBED-20160310-N5-018	3/10/2016	**40.7**	**2.2**	< 0.4 U	
	0040H-IA-BBED	0040H-IA-BBED-20160310-N5-021	3/10/2016	**32.4**	**1.7**	< 0.4 U	
	0040H-IA-HAL	0040H-IA-HAL-20160310-N5-016	3/10/2016	**27.6**	**0.9**	< 0.4 U	
	0040H-IA-HALL	0040H-IA-HALL-20160310-N10-025	3/10/2016	**20.7**	**0.9**	< 0.4 U	
	0040H-IA-HALL	0040H-IA-HALL-20160310-N10-028	3/10/2016	**11.7**	< 0.5 U	< 0.4 U	
	0040H-IA-HALL	0040H-IA-HALL-20160310-N5-019	3/10/2016	**15.2**	**0.6**	< 0.4 U	
	0040H-IA-HALL	0040H-IA-HALL-20160310-N5-022	3/10/2016	**15.9**	**0.7**	< 0.4 U	
	0040H-IA-MEC	0040H-IA-MEC-20160310-BL-009	3/10/2016	**22.8**	**1.5**	0.39	
	0040H-IA-MR1	0040H-IA-MR1-20160310-BL-006	3/10/2016	**42.8**	**2.8**	0.75	
	0040H-IA-MR1	0040H-IA-MR1-20160310-BL-013	3/10/2016	**34.5**	**2**	0.48	
	0040H-IA-MR2	0040H-IA-MR2-20160310-BL-008	3/10/2016	**20**	**1.3**	0.55	
	0040H-IA-STA	0040H-IA-STA-20160310-N5-017	3/10/2016	**18.6**	**0.8**	< 0.4 U	
	0040H-IA-STA	0040H-IA-STA-20160310-N5-020	3/10/2016	**11**	< 0.5 U	< 0.4 U	
	0040H-IA-SUM	0040H-IA-SUM-20160310-BL-029	3/10/2016	**153.1**	**12.6**	0.52	
	0040H-IA-UBED	0040H-IA-UBED-20160310-BL-007	3/10/2016	**39.3**	**2.6**	0.67	
0045-S	0045S-IA-CHEM-A	0045S-IA-CHEM-A-20160304-BL-014	3/4/2016	40	< 0.5 U	< 0.4 U	Yes (6)
0051-H	0051H-IA-FLC	0051H-IA-FLC-20160226-N10-018	2/26/2016	**402.2**	< 0.5 U	< 0.4 U	No (7)
	0051H-IA-MEC	0051H-IA-MEC-20160226-N10-016	2/26/2016	**24.1**	< 0.5 U	< 0.4 U	
	0051H-IA-MEC	0051H-IA-MEC-20160226-N10-019	2/26/2016	**13.1**	< 0.5 U	< 0.4 U	
	0051H-IA-MEC	0051H-IA-MEC-20160226-N5-014	2/26/2016	**13.8**	< 0.5 U	< 0.4 U	

TABLE 6-6

Indoor Air, Outdoor Air, and Soil Gas, HAPSITE® Data - Exceedances of RBSLs and RALs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure	Location ID	Sample Name	Sample Date	Analyte			Background Source Present in Breathing Zone? (Yes/No)
				PCE (µg/m^3)	TCE (µg/m^3)	cis-1,2-DCE (µg/m^3)	
0053-H	0053H-IA-BLO	0053H-IA-BLO-20160502-N10-037	5/2/2016	**11.7**	< 0.5 U	< 0.4 U	No (8)
	0053H-IA-CRWL	0053H-IA-CRWL-20160502-BL-023	5/2/2016	**13.1**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-BL-020	5/2/2016	**11**	< 0.5 U	0.52	
	0053H-IA-LIV	0053H-IA-LIV-20160502-BL-022	5/2/2016	**11**	< 0.5 U	0.55	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N10-036	5/2/2016	**22.1**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N10-039	5/2/2016	**21.4**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N10-042	5/2/2016	**24.1**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N5-027	5/2/2016	**13.1**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N5-030	5/2/2016	**13.1**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-N5-035	5/2/2016	**19.3**	< 0.5 U	< 0.4 U	
	0053H-IA-LIV	0053H-IA-LIV-20160502-P5-044	5/2/2016	**21.4**	< 0.5 U	< 0.4 U	
	0053H-SG-SG1	0053H-SG-SG1-20160502-056-6.5'	5/2/2016	**627.7**	4.5	< 0.4 U	
	0053H-SG-SG1	0053H-SG-SG1-20160502-058-6.5'	5/2/2016	**510**	< 0.5 U	< 0.4 U	
0054-H	0054H-IA-BAT	0054H-IA-BAT-20160509-BL-015	5/9/2016	6.7	**5.2**	< 0.4 U	Yes (9)
	0054H-IA-BLO	0054H-IA-BLO-20160509-N5-023	5/9/2016	4.1	**3.7**	< 0.4 U	
	0054H-IA-BLO	0054H-IA-BLO-20160509-N5-027	5/9/2016	2.6	**1.4**	< 0.4 U	
	0054H-IA-BLO	0054H-IA-BLO-20160603-N5-014	6/3/2016	< 0.7 U	**1.1**	< 0.4 U	
	0054H-IA-BLO	0054H-IA-BLO-20160603-N5-018	6/3/2016	< 0.7 U	**0.7**	< 0.4 U	
	0054H-IA-CONT	0054H-IA-CONT-20160603-BL-044	6/3/2016	3	**4**	< 0.4 U	
	0054H-IA-GAR	0054H-IA-GAR-20160509-BL-012	5/9/2016	< 0.7 U	**0.7**	< 0.4 U	
	0054H-IA-LAU	0054H-IA-LAU-20160509-BL-010	5/9/2016	5	**4.5**	< 0.4 U	
	0054H-IA-LAU	0054H-IA-LAU-20160509-BL-017	5/9/2016	5.8	**4.8**	< 0.4 U	
	0054H-IA-LAU	0054H-IA-LAU-20160603-BL-003	6/3/2016	< 0.7 U	**0.7**	< 0.4 U	
	0054H-IA-LAU	0054H-IA-LAU-20160603-BL-008	6/3/2016	1.3	**1.7**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160509-BL-009	5/9/2016	6	**5.4**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160509-BL-018	5/9/2016	5.7	**5.2**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160509-N5-024	5/9/2016	3.1	**3.2**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160603-BL-002	6/3/2016	< 0.7 U	**1**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160603-BL-011	6/3/2016	0.8	**1.9**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160603-N5-015	6/3/2016	0.6	**1.3**	< 0.4 U	
	0054H-IA-LIV	0054H-IA-LIV-20160603-N5-019	6/3/2016	< 0.7 U	**0.7**	< 0.4 U	
	0054H-IA-SBED	0054H-IA-SBED-20160509-BL-020	5/9/2016	6.9	**5.4**	< 0.4 U	

TABLE 6-6

Indoor Air, Outdoor Air, and Soil Gas, HAPSITE® Data - Exceedances of RBSLs and RALs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure	Location ID	Sample Name	Sample Date	Analyte			Background Source Present in Breathing Zone? (Yes/No)
				PCE (μg/m^3)	TCE (μg/m^3)	cis-1,2-DCE (μg/m^3)	
0054-H (cont'd.)	0054H-IA-SHOP	0054H-IA-SHOP-20160509-BL-014	5/9/2016	**14.2**	**8.7**	< 0.4 U	Yes [9]
	0054H-IA-SHOP	0054H-IA-SHOP-20160509-BL-019	5/9/2016	10.3	**9.3**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160509-N5-021	5/9/2016	**21.4**	**8.7**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160509-N5-025	5/9/2016	6.3	**6**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-BL-004	6/3/2016	1	**1.6**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-BL-005	6/3/2016	< 0.7 U	**1.4**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-BL-006	6/3/2016	1.7	**2.9**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-N10-022	6/3/2016	2.8	**0.8**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-N5-012	6/3/2016	1.7	**2.8**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-N5-016	6/3/2016	1.7	**1.2**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-N5-020	6/3/2016	2.3	**0.8**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-P5-033	6/3/2016	2.7	**0.7**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-P5-037	6/3/2016	0.9	**0.7**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-P5-039	6/3/2016	0.7	**0.8**	< 0.4 U	
	0054H-IA-SHOP	0054H-IA-SHOP-20160603-P5-041	6/3/2016	< 0.7 U	**0.8**	< 0.4 U	
	0054H-IA-SUM	0054H-IA-SUM-20160603-BL-007	6/3/2016	1.7	**3.5**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160509-BL-016	5/9/2016	5.2	**5.1**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160509-N5-022	5/9/2016	5.4	**5.5**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160509-N5-026	5/9/2016	5	**4.3**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-BL-010	6/3/2016	1.1	**1.6**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N10-023	6/3/2016	1.9	**0.9**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N10-028	6/3/2016	2.1	**0.7**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N10-032	6/3/2016	2.1	**0.5**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N5-013	6/3/2016	1.2	**1.8**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N5-017	6/3/2016	1.6	**1.5**	< 0.4 U	
	0054H-IA-TVR	0054H-IA-TVR-20160603-N5-021	6/3/2016	1.7	**1**	< 0.4 U	
0059-H	0059H-IA-BLO1	A-0059H-031717-IA-022-BLO1	3/17/2017	**12.35**	< 0.5 U	< 0.4 U	NA [10]
	0059H-IA-LAU2	A-0059H-031717-IA-029-LAU2	3/17/2017	**1071.2 E**	**12.35**	2.18	
	0059H-IA-LAU2	A-0059H-031717-IA-033-LAU2	3/17/2017	**220.30**	0.39	< 0.4 U	

TABLE 6-6

Indoor Air, Outdoor Air, and Soil Gas, HAPSITE® Data - Exceedances of RBSLs and RALs

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

NOTES:

1. The Indoor Air RBSLs are the indoor air RSLs (EPA 2017a).
2. The Indoor Air Tier 1 RALs are based on the indoor air RSLs (EPA 2017a) using either a target cancer risk of 1×10^{-5} and a non-cancer hazard
3. The Indoor Air Tier 2 RALs are based on the RSLs (EPA 2017a) using either a target cancer risk of 1×10^{-4} and a non-cancer hazard quotient of 3,
4. The Soil Gas SLs are the indoor air RSLs multiplied by a generic soil-gas-to-indoor air attenuation factor of 0.03 (EPA 2017b). The Indoor Air SL
5. A Time-Critical Removal Action was initiated at 0040-H in 2016.
6. At 0045-S, the commercial/industrial RBSLs apply rather than the Residential RBSLs and there were no exceedances of commercial/industrial
7. At 0051-H, a SUMMA® canister sample was collected in the basement. TO-15 results are listed on Table 6-6 and are included in the HHRA
8. At 0053-H, a SUMMA canister sample was collected in basement. TO-15 results are listed on Table 6-6 and are included in the HHRA
9. At 0054-H, data suggested that indoor air TCE concentrations resulted from an interior background source(s) or residual TCE from historical
10. At 0059-H, these HAPSITE® detections occurred when monitoring vapors entering the laundry room floor drain, 1-inch above the floor during

µg/m^3 = Microgram(s) per cubic meter.
DCE = cis-1,2-dichloroethene.
E = Exceeded calibration range.
EPA = U.S. Environmental Protection Agency.
HHRA = Human health risk assessment.
ID = Identification.
NA = Not applicable
NSL = No screening level.

PCE = Tetrachloroethene.
RAL = Removal action level.
RBSL = Risk-based screening level.
RSL = Regional Screening Level.
SL = Screening level.
TCE = Trichloroethene.
U = Not detected above the reporting limit.
VI = Vapor intrusion.

Bold Values = Exceed the Indoor Air Residential RBSL
Bold Values = Exceed the Residential Indoor Air Tier 1 RAL
Bold Values = Exceed the Residential Indoor Air Tier 2 RAL
Bold Values = Exceed the Soil Gas Residential RBSL

There are no RBSLs or RALs for Outdoor Air

TABLE 6-7

Indoor Air, Outdoor Air, and Soil Gas Laboratory Data (Method TO-15)

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure	Location ID	Sample ID	Sample Date	Sample Type	Analyte									
					PCE ($\mu g/m^3$)		TCE ($\mu g/m^3$)		cis-1,2-DCE ($\mu g/m^3$)		VC ($\mu g/m^3$)		1,4-dioxane ($\mu g/m^3$)	
				Residential Indoor Air SL (1)	**11**		**0.48**		**NSL**		**0.17**		**0.56**	
				Residential Indoor Air Tier 1 RAL (2)	**41**		**2.1**		**NSL**		**1.7**		**5.6**	
				Residential Indoor Air Tier 2 RAL (3)	**120**		**6.3**		**NSL**		**17**		**56**	
				Residential Soil Gas SL (4)	**370**		**16**		**NSL**		**5.7**		**19**	
Indoor Air Samples														
0001-H	0001H-TO-BAS	A-0001H-032317-TO-001-BAS	3/23/2017	N	1.1		< 0.27	U	< 0.2	U	**0.17**		< 0.18	U
	0001H-TO-BAS	A-0001H-032317-TO-002-BAS	3/23/2017	FD	1.1		< 0.27	U	< 0.2	U	**0.19**		< 0.18	U
0002-H	0002H-TO-BAS	A-0002H-032317-TO-001-BAS	3/23/2017	N	1.4		0.29		< 0.2	U	< 0.13	U	< 0.18	U
0003-H	0003H-IA-BAS	A-0003H-030316-IA-BAS	3/3/2016	N	1.3		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0003H-TO-BAS	A-0003H-040915-TO-002-BAS	4/9/2015	N	1.5	J	< 2.7	U	< 2	U	< 1.3	U	NA	
	0003H-TO-BBB	A-0003H-040915-TO-003-BBB	4/9/2015	N	1.7	J	< 2.7	U	< 2	U	< 1.3	U	NA	
	0003H-TO-LIV	A-0003H-040915-TO-001-LIV	4/9/2015	N	**17**		< 2.7	U	< 2	U	< 1.3	U	NA	
0004-H	0004H-TO-BAS	A-0004H-031417-TO-001-BAS	3/14/2017	N	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0008-H	0008H-TO-BAS	A-0008H-041015-TO-001-BAS	4/10/2015	N	2.9	J	< 2.7	U	< 2	U	< 1.3	U	NA	
0011-H	0011H-IA-LLL	A-0011H-030116-IA-012A-LLL	3/1/2016	N	**12**	J	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0012-H	0012H-TO-BAS	A-0012H-031417-TO-001-BAS	3/14/2017	N	2.3		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0013-H	0013H-TO-BAS	A-0013H-031017-TO-001-BAS	3/10/2017	N	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0017-H	0017H-IA-BAS	A-0017H-031616-IA-BAS	3/16/2016	N	10	J	0.39		< 0.2	U	< 0.13	U	< 0.18	U
0018-H	0018H-IA-BAS	A-0018H-031616-IA-BAS	3/16/2016	N	**12**	J	**0.83**		< 0.2	U	< 0.13	U	< 0.18	U
0023-H	0023-IA-BA1	A-0023-031616-IA-BA1	3/16/2016	N	1.4		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0025-H	0025H-TO-BAS	A-0025H-031417-TO-001-BAS	3/14/2017	N	0.37		< 0.27	U	< 0.2	U	< 0.13	U	**2.3**	
0026-H	0026H-TO-LIV	A-0026H-031617-TO-001-LIV	3/16/2017	N	2		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0026H-TO-PAN	A-0026H-040815-TO-001-PAN	4/8/2015	N	2.1	J	< 2.7	U	< 2	U	< 1.3	U	NA	
0027-H	0027H-TO-BAS	A-0027H-031017-TO-001-BAS	3/10/2017	N	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0027H-TO-BAS	A-0027H-031017-TO-002-BAS	3/10/2017	FD	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0029-H	0029H-TO-BAS	A-0029H-033117-TO-001-BAS	3/31/2017	N	2		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U

TABLE 6-7

Indoor Air, Outdoor Air, and Soil Gas Laboratory Data (Method TO-15)

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Structure	**Location ID**	**Sample ID**	**Sample Date**	**Sample Type**	**Analyte**									
					PCE ($\mu g/m^3$)		**TCE ($\mu g/m^3$)**		**cis-1,2-DCE ($\mu g/m^3$)**		**VC ($\mu g/m^3$)**		**1,4-dioxane ($\mu g/m^3$)**	
0030-H	0030H-TO-BAS	A-0030H-041115-TO-001-BAS	4/11/2015	N	5.9		< 2.7	U	< 2	U	< 1.3	U	NA	
0036-H	0036H-TO-BAS	A-0036H-040415-TO-001-BAS	4/2/2015	N	3.6		< 2.7	U	< 2	U	< 1.3	U	NA	
0037-H	0037H-IA-LAU	A-0037H-030816-IA-LAU	3/8/2016	N	4		< 0.27	U	< 0.2	U	< 0.13	U	0.18	
0038-H	0038H-TO-BAS	A-0038H-041117-TO-001-BAS	4/11/2017	N	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0038H-TO-BAS	A-0038H-041117-TO-002-BAS	4/11/2017	FD	< 0.34	U	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0040-H	0040H-IA-BAS	A-0040H-031216-IA-BAS	3/12/2016	N	**74**	J	**5.2**		0.55		< 0.13	U	< 0.18	U
	0040H-IA-BAS	A-0040H-031216-IA-BAS-D	3/12/2016	FD	**78**	J	**5.4**	J	0.58		< 0.13	U	< 0.18	U
	0040H-IA-KIT	A-0040H-031216-IA-KIT	3/12/2016	N	**59**	J	**4.3**		0.39		< 0.13	U	< 0.18	U
0051-H	0051-IA-BAS	A-0051-031616-IA-BAS	3/16/2016	N	1.8		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0051-IA-BAS	A-0051-031616-IA-BAS-D	3/16/2016	FD	2		< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0053-H	0053H-IA-BAS	A-0053H-052416-IA-BAS	5/24/2016	N	**13**	J	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
	0053H-IA-BAS	A-0053H-052416-IA-BAS-D	5/24/2016	FD	**13**	J	< 0.27	U	< 0.2	U	< 0.13	U	< 0.18	U
0064-H	0064H-TO-LIV	A-0064H-041417-TO-001-LIV	4/14/2017	N	1.9	J	< 0.27	UJ	< 0.2	UJ	< 0.13	UJ	< 0.18	UJ
Outdoor Air Samples														
0026-H	0026H-TO-OUT	A-0026H-040815-TO-003-OUT	4/8/2015	N	< 3.4	U	< 2.7	U	< 2	U	< 1.3	U	NA	
0030-H	0030H-TO-OUT	A-0030H-041115-TO-002-OUT	4/11/2015	N	< 3.4	U	< 2.7	U	< 2	U	< 1.3	U	NA	
	0030H-TO-OUT	A-0030H-041115-TO-003-OUT	4/11/2015	FD	< 3.4	U	< 2.7	U	< 2	U	< 1.3	U	NA	
Soil Gas Samples (From Table 6-5 and repeated here for context in evaluating VI)														
0003-H	0003H-SG	A-0003H-040915-SG-001-4'	4/9/2015	N	< 3.4	U	< 2.7	U	< 1.3	U	< 2	U	NA	
0008-H	0008H-SG	A-0008H-041015-SG-001A-4'	4/10/2015	N	< 3.4	U	< 2.7	U	< 1.3	U	< 2	U	NA	
	0008H-SG	A-0008H-041015-SG-001B-4'	4/10/2015	FD	3	J	< 2.7	U	< 1.3	U	< 2	U	NA	
0026-H	0026H-SG	A-0026H-040815-SG-002-4'	4/8/2015	N	< 3.4	U	< 2.7	U	< 1.3	U	< 2	U	NA	
	0026H-SG	A-0026H-040815-SG-003-4'	4/8/2015	FD	< 3.4	U	< 2.7	U	< 1.3	U	< 2	U	NA	
0030-H	0030H-SG	A-0030H-0411150SG-001A-6	4/11/2015	N	1.5	J	**17**		< 1.3	U	2.8		NA	
0053-H	0053H-SG-0037	A-0053H-052316-SG-001-6'(0037)	5/23/2016	N	**2000**	J	**18**		< 1.3	U	< 2	U	< 7.2	U
	0053H-SG-0050	A-0053H-052316-SG-001-6'(0050)	5/23/2016	FD	**1500**	J	**21**		< 1.3	U	< 2	U	< 7.2	U

TABLE 6-7
Indoor Air, Outdoor Air, and Soil Gas Laboratory Data (Method TO-15)
700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report
Department of Veterans Affairs Salt Lake City Health Care System

NOTES:

1. The Indoor Air RBSLs are the indoor air RSLs (EPA 2017a).
2. The Indoor Air Tier 1 RALs are based on the indoor air RSLs(EPA 2017a) using either a target cancer risk of 1 x 10^{-5} and an noncancer hazard quotient of 1, whichever results in the lower RAL.
3. The Indoor Air Tier 2 RALs are based on the RSLs (EPA 2017a) using either a target cancer risk of 1 x 10^{-4} and an noncancer hazard quotient of 3, whichever results in the lower RAL.
4. The Soil Gas SLs are the indoor air RSLs multiplied by a generic soil-gas-to-indoor air attenuation factor of 0.03 (EPA 2017b). The Indoor Air SL and the Soil Gas SL based on either a target cancer risk of 1 x 10^{-6} and an non-cancer hazard quotient of 1, whichever results in the lower SL.

μg/m^3 = Micrograms per cubic meter.
DCE = Dichloroethene.
EPA = U.S. Environmental Protection Agency.
FD = Field duplicate.
ID = Identification.
J = Estimated value below the contract-required quantitation limit or based on data validation.
N = Normal field sample.
NA = Not analyzed.
SL = Screening level.
PCE = Tetrachloroethene.
NSL = No screening criteria.
RAL = Removal action level.
TCE = Trichloroethene.
U = Nondetect value.
UJ = Estimated nondetect value.
VC = Vinyl chloride.

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File: Albuquerque EA \\lovetongis\gisdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-1 Shallow Groundwater Sampling Locations.mxd   mdhruv   9/11/2018   9:35:32 AM

Legend

- ⊕ Monitoring Wells
- ⊕ Production/Irrigation Wells
- ⊕ Abandoned Monitoring Wells
- ◆ Temporary Groundwater Monitoring Point
- ◆ Temporary Groundwater Monitoring Point/Piezometer
- ◆ Drilled to Refusal/No Groundwater
- 💧 Spring Location
- → Direction of Groundwater Flow
- – – Wasatch Fault Line
- – – Inferred PCE Contour Near Surface Groundwater
- ∼ PCE Contour Near Surface Groundwater
- – · · – Jordan River Canal (subterranean)
- ∼ Streams
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)

Note(s) :

1.Shallow groundwater samples were collected between 22 Feb 2016 and 8 March 2016.

2.Summary of Temporary Monitoring Point Installation and Sampling:

Action	Number of Locations
Temporary monitoring points attempted with Geoprobe®	50 locations
Refusal: no groundwater encountered, no point set. (GW-2, GW-33, GW-35, GW-42, GW-57, GW-58)	6 out of the 50 locations
Temporary monitoring point set, but no groundwater recharge at (GW-19 and GW-54)	2 out of the 44 locations
Shallow groundwater sample collected	42 locations
Piezometers installed	10 of the 44 locations

3.Table 6-1 lists the shallow groundwater analytical results for the PCOPCs.

4.If multiple samples were collected from one monitoring point, then the sample result with the highest concentration is shown.

5.Concentrations are in µg/L

6.Contours representing PCE concentrations in shallow groundwater are in µg/L

7.Vinyl chloride results were all <0.5 µg/L.

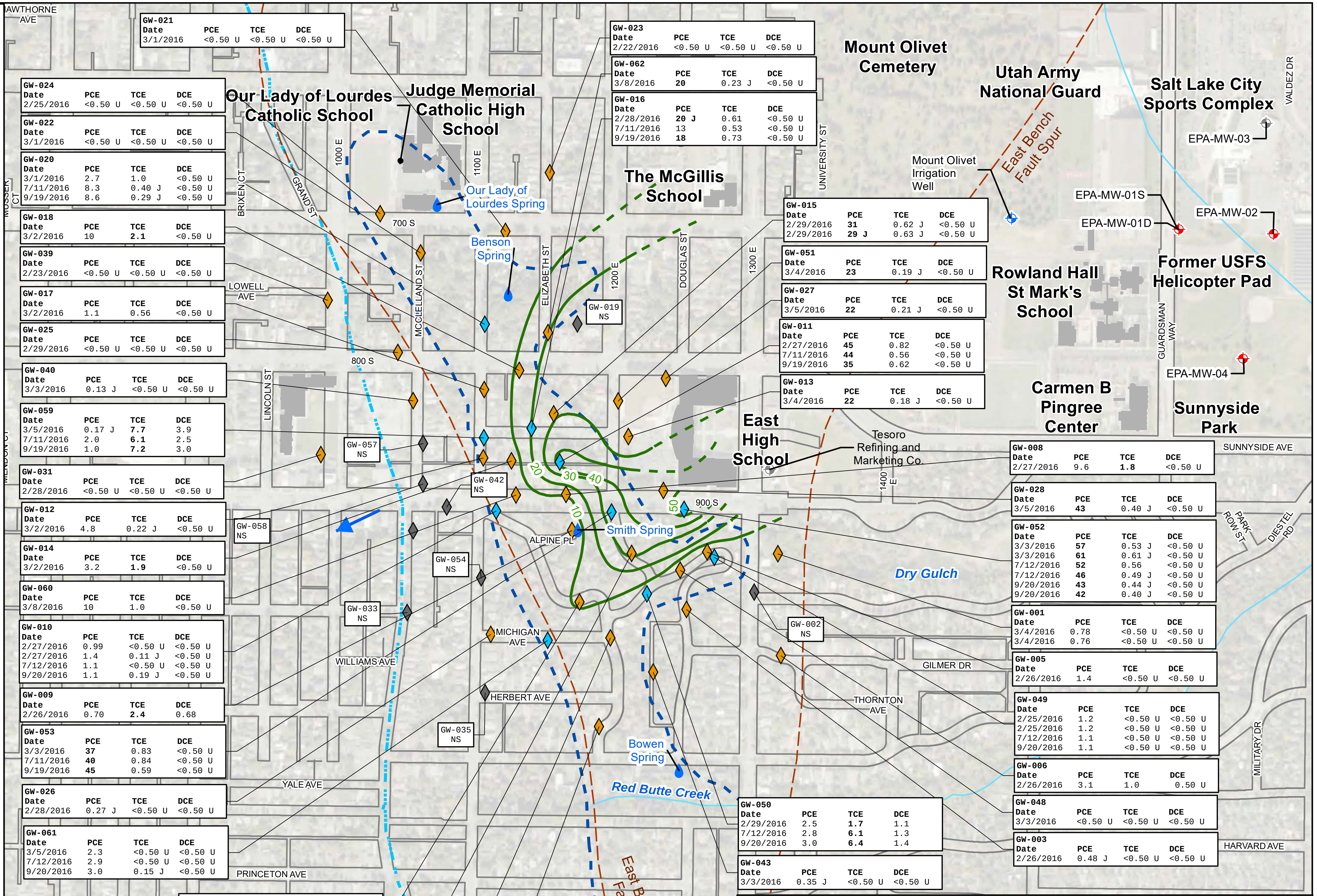
8.1,4-dioxane results were <2.0 µg/L, except at GW-52 where the result was 2.7 µg/L.

9.Bold text indicates PCOPC results greater than the residential screening levels for groundwater to indoor air, that are identified in Table 3-6:

Chemical	Residential SLs for Groundwater to Indoor Air (µg/L)
cis-1,2-Dichloroethene	No screening level
1,4-Dioxane	2,900
Tetrachloroethene	15
Trichloroethene	1.2
Vinyl chloride (chloroethene)	0.15

Source(s) :
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
EPA = U.S. Environmental Protection Agency
GW = Groundwater
J = estimated value
MW = Monitoring Well
NS = No Sample
PCE = tetrachloroethene
PCOPC = Preliminary Contaminant of Potential Concern
RI = Remedial Investigation
SL = Screening Level
TCE = trichloroethene
U = non detect value



GW-021

Date	PCE	TCE	DCE
3/1/2016	<0.50 U	<0.50 U	<0.50 U

GW-024

Date	PCE	TCE	DCE
2/25/2016	<0.50 U	<0.50 U	<0.50 U

GW-022

Date	PCE	TCE	DCE
3/1/2016	<0.50 U	<0.50 U	<0.50 U

GW-020

Date	PCE	TCE	DCE
3/1/2016	2.7	1.0	<0.50 U
7/11/2016	8.3	0.40 J	<0.50 U
9/19/2016	8.6	0.29 J	<0.50 U

GW-018

Date	PCE	TCE	DCE
3/2/2016	10	**2.1**	<0.50 U

GW-039

Date	PCE	TCE	DCE
2/23/2016	<0.50 U	<0.50 U	<0.50 U

GW-017

Date	PCE	TCE	DCE
3/2/2016	1.1	0.56	<0.50 U

GW-025

Date	PCE	TCE	DCE
2/29/2016	<0.50 U	<0.50 U	<0.50 U

GW-040

Date	PCE	TCE	DCE
3/3/2016	0.13 J	<0.50 U	<0.50 U

GW-059

Date	PCE	TCE	DCE
3/5/2016	0.17 J	**7.7**	3.9
7/11/2016	2.0	**6.1**	2.5
9/19/2016	1.0	**7.2**	3.0

GW-031

Date	PCE	TCE	DCE
2/28/2016	<0.50 U	<0.50 U	<0.50 U

GW-012

Date	PCE	TCE	DCE
3/2/2016	4.8	0.22 J	<0.50 U

GW-014

Date	PCE	TCE	DCE
3/2/2016	3.2	**1.9**	<0.50 U

GW-060

Date	PCE	TCE	DCE
3/8/2016	10	1.0	<0.50 U

GW-010

Date	PCE	TCE	DCE
2/27/2016	0.99	<0.50 U	<0.50 U
2/27/2016	1.4	0.11 J	<0.50 U
7/12/2016	1.1	<0.50 U	<0.50 U
9/20/2016	1.1	0.19 J	<0.50 U

GW-009

Date	PCE	TCE	DCE
2/26/2016	0.70	**2.4**	0.68

GW-053

Date	PCE	TCE	DCE
3/3/2016	**37**	0.83	<0.50 U
7/11/2016	**40**	0.84	<0.50 U
9/19/2016	**45**	0.59	<0.50 U

GW-026

Date	PCE	TCE	DCE
2/28/2016	0.27 J	<0.50 U	<0.50 U

GW-061

Date	PCE	TCE	DCE
3/5/2016	2.3	<0.50 U	<0.50 U
7/12/2016	2.9	<0.50 U	<0.50 U
9/20/2016	3.0	0.15 J	<0.50 U

GW-004

Date	PCE	TCE	DCE
2/26/2016	12	0.34 J	<0.50 U

GW-007

Date	PCE	TCE	DCE
2/28/2016	**33**	0.59	<0.50 U

GW-055

Date	PCE	TCE	DCE
3/5/2016	0.19 J	<0.50 U	<0.50 U

GW-046

Date	PCE	TCE	DCE
2/24/2016	0.20 J	<0.50 U	<0.50 U

GW-023

Date	PCE	TCE	DCE
2/22/2016	<0.50 U	<0.50 U	<0.50 U

GW-062

Date	PCE	TCE	DCE
3/8/2016	**20**	0.23 J	<0.50 U

GW-016

Date	PCE	TCE	DCE
2/28/2016	**20 J**	0.61	<0.50 U
7/11/2016	13	0.53	<0.50 U
9/19/2016	**18**	0.73	<0.50 U

GW-015

Date	PCE	TCE	DCE
2/29/2016	**31**	0.62 J	<0.50 U
2/29/2016	**29 J**	0.63 J	<0.50 U

GW-051

Date	PCE	TCE	DCE
3/4/2016	**23**	0.19 J	<0.50 U

GW-027

Date	PCE	TCE	DCE
3/5/2016	**22**	0.21 J	<0.50 U

GW-011

Date	PCE	TCE	DCE
2/27/2016	**45**	0.82	<0.50 U
7/11/2016	**44**	0.56	<0.50 U
9/19/2016	**35**	0.62	<0.50 U

GW-013

Date	PCE	TCE	DCE
3/4/2016	**22**	0.18 J	<0.50 U

GW-008

Date	PCE	TCE	DCE
2/27/2016	9.6	**1.8**	<0.50 U

GW-028

Date	PCE	TCE	DCE
3/5/2016	**43**	0.40 J	<0.50 U

GW-052

Date	PCE	TCE	DCE
3/3/2016	**57**	0.53 J	<0.50 U
3/3/2016	**61**	0.61 J	<0.50 U
7/12/2016	**52**	0.56	<0.50 U
7/12/2016	**46**	0.49 J	<0.50 U
9/20/2016	**43**	0.44 J	<0.50 U
9/20/2016	**42**	0.40 J	<0.50 U

GW-001

Date	PCE	TCE	DCE
3/4/2016	0.78	<0.50 U	<0.50 U
3/4/2016	0.76	<0.50 U	<0.50 U

GW-005

Date	PCE	TCE	DCE
2/26/2016	1.4	<0.50 U	<0.50 U

GW-049

Date	PCE	TCE	DCE
2/25/2016	1.2	<0.50 U	<0.50 U
2/25/2016	1.2	<0.50 U	<0.50 U
7/12/2016	1.1	<0.50 U	<0.50 U
9/20/2016	1.1	<0.50 U	<0.50 U

GW-006

Date	PCE	TCE	DCE
2/26/2016	3.1	1.0	0.50 U

GW-048

Date	PCE	TCE	DCE
3/3/2016	<0.50 U	<0.50 U	<0.50 U

GW-003

Date	PCE	TCE	DCE
2/26/2016	0.48 J	<0.50 U	<0.50 U

GW-050

Date	PCE	TCE	DCE
2/29/2016	2.5	**1.7**	1.1
7/12/2016	2.8	**6.1**	1.3
9/20/2016	3.0	**6.4**	1.4

GW-043

Date	PCE	TCE	DCE
3/3/2016	0.35 J	<0.50 U	<0.50 U

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0 150 300 600
Feet

FIGURE 6-1 SHALLOW GROUNDWATER INVESTIGATION SAMPLING RESULTS (2016)

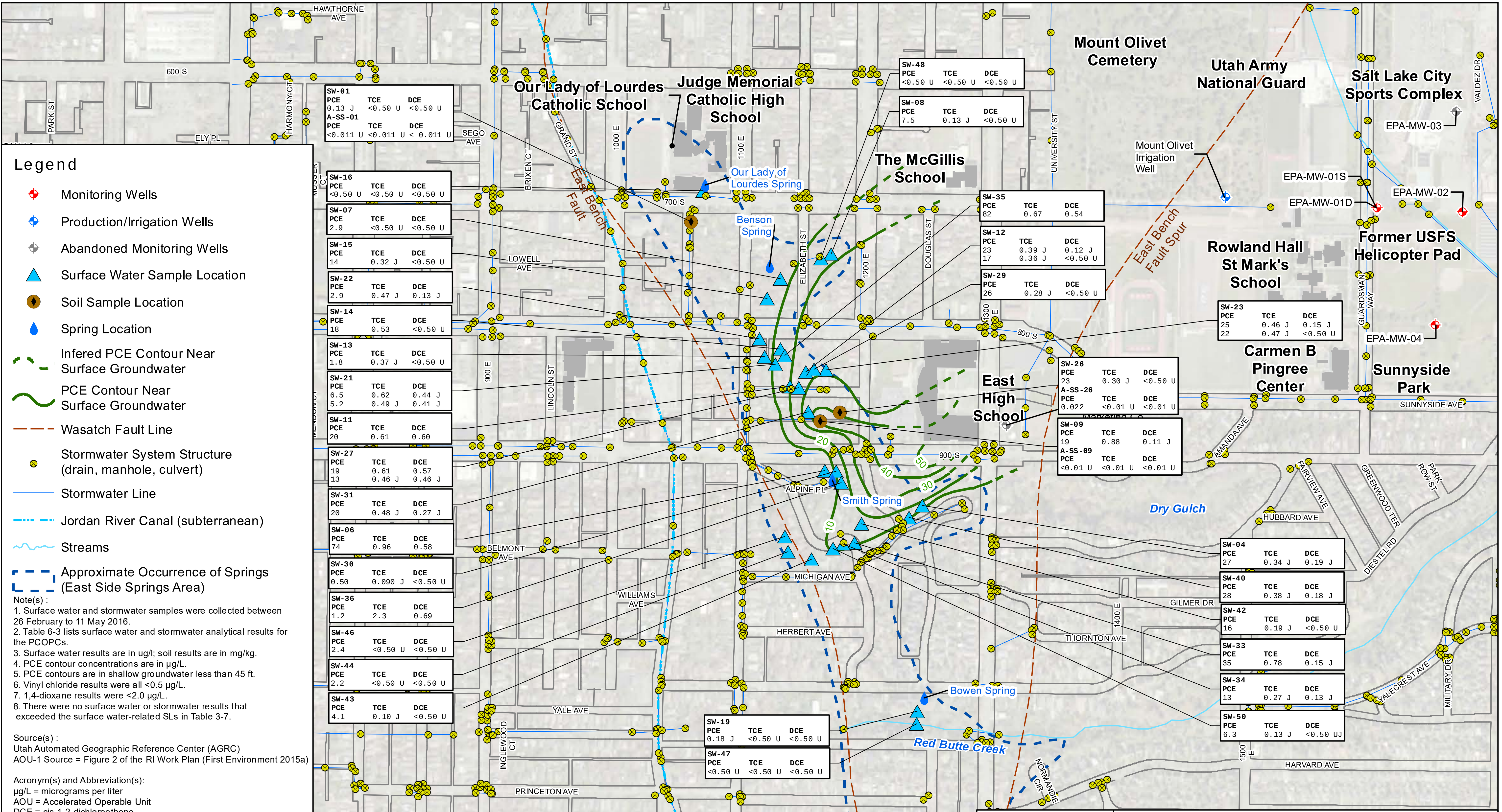
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 600'
APPRVD.

SHEET 1 of 1



Sample	PCE	TCE	DCE
SW-01	0.13 J	<0.50 U	<0.50 U
A-SS-01	<0.011 U	<0.011 U	< 0.011 U
SW-16	<0.50 U	<0.50 U	<0.50 U
SW-07	2.9	<0.50 U	<0.50 U
SW-15	14	0.32 J	<0.50 U
SW-22	2.9	0.47 J	0.13 J
SW-14	18	0.53	<0.50 U
SW-13	1.8	0.37 J	<0.50 U
SW-21	6.5 5.2	0.62 0.49 J	0.44 J 0.41 J
SW-11	20	0.61	0.60
SW-27	19 13	0.61 0.46 J	0.57 0.46 J
SW-31	20	0.48 J	0.27 J
SW-06	74	0.96	0.58
SW-30	0.50	0.090 J	<0.50 U
SW-36	1.2	2.3	0.69
SW-46	2.4	<0.50 U	<0.50 U
SW-44	2.2	<0.50 U	<0.50 U
SW-43	4.1	0.10 J	<0.50 U
SW-19	0.18 J	<0.50 U	<0.50 U
SW-47	<0.50 U	<0.50 U	<0.50 U
SW-48	<0.50 U	<0.50 U	<0.50 U
SW-08	7.5	0.13 J	<0.50 U
SW-35	82	0.67	0.54
SW-12	23 17	0.39 J 0.36 J	0.12 J <0.50 U
SW-29	26	0.28 J	<0.50 U
SW-26	23	0.30 J	<0.50 U
A-SS-26	0.022	<0.01 U	<0.01 U
SW-09	19	0.88	0.11 J
A-SS-09	<0.01 U	<0.01 U	<0.01 U
SW-23	25 22	0.46 J 0.47 J	0.15 J <0.50 U
SW-04	27	0.34 J	0.19 J
SW-40	28	0.38 J	0.18 J
SW-42	16	0.19 J	<0.50 U
SW-33	35	0.78	0.15 J
SW-34	13	0.27 J	0.13 J
SW-50	6.3	0.13 J	<0.50 UJ

Note(s) :
1. Surface water and stormwater samples were collected between 26 February to 11 May 2016.
2. Table 6-3 lists surface water and stormwater analytical results for the PCOPCs.
3. Surface water results are in ug/l; soil results are in mg/kg.
4. PCE contour concentrations are in µg/L.
5. PCE contours are in shallow groundwater less than 45 ft.
6. Vinyl chloride results were all <0.5 µg/L.
7. 1,4-dioxane results were <2.0 µg/L.
8. There were no surface water or stormwater results that exceeded the surface water-related SLs in Table 3-7.

Source(s) :
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s):
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
EPA = U.S. Environmental Protection Agency
ft = feet
J = estimated value
mg/kg = milligrams per kilogram
MW = Monitoring Well
PCE = tetrachloroethene
PCOPC = Preliminary Contaminant of Potential Concern
RI = Remedial Investigation
SL = Screening Level
TCE = trichloroethene
U = non detect value
UJ = estimated non detect value

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-2 SW Sampling Results.mxd bpawling 6/8/2018 9:44:37 AM

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0 150 300 600
Feet

FIGURE 6-2 SURFACE WATER SAMPLING
AND SOIL SAMPLING RESULTS (2016)
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 6-15-18
DWN. BP
SCALE 1" = 600'
APPRVD.
SHEET 1 of 1

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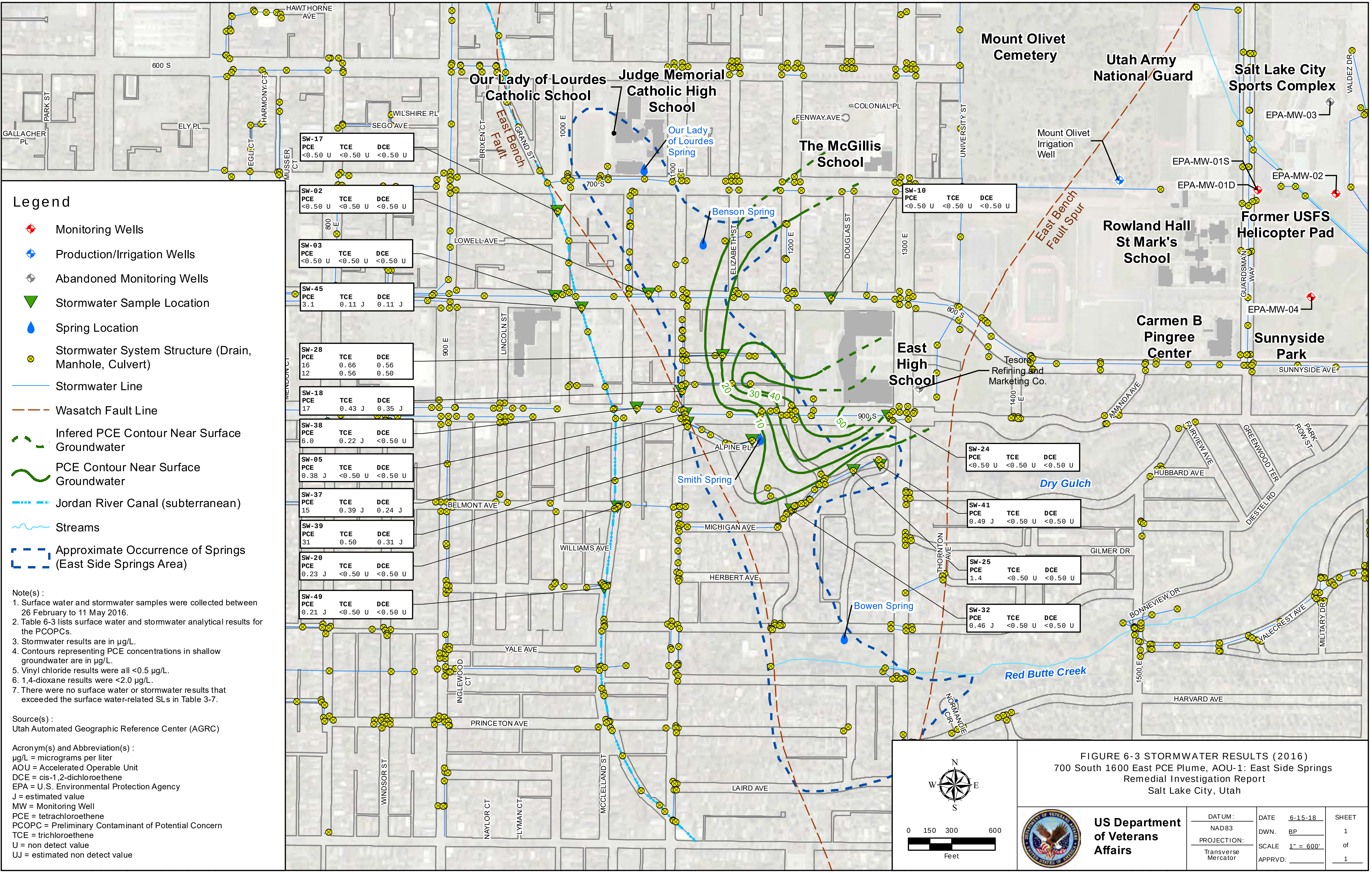

SW-17

PCE	TCE	DCE
<0.50 U	<0.50 U	<0.50 U

SW-02

PCE	TCE	DCE
<0.50 U	<0.50 U	<0.50 U

SW-03

PCE	TCE	DCE
<0.50 U	<0.50 U	<0.50 U

SW-45

PCE	TCE	DCE
3.1	0.11 J	0.11 J

SW-28

PCE	TCE	DCE
16	0.66	0.56
12	0.56	0.50

SW-18

PCE	TCE	DCE
17	0.43 J	0.35 J

SW-38

PCE	TCE	DCE
6.0	0.22 J	<0.50 U

SW-05

PCE	TCE	DCE
0.38 J	<0.50 U	<0.50 U

SW-37

PCE	TCE	DCE
15	0.39 J	0.24 J

SW-39

PCE	TCE	DCE
31	0.50	0.31 J

SW-20

PCE	TCE	DCE
0.23 J	<0.50 U	<0.50 U

SW-49

PCE	TCE	DCE
0.21 J	<0.50 U	<0.50 U

SW-10

PCE	TCE	DCE
<0.50 U	<0.50 U	<0.50 U

SW-24

PCE	TCE	DCE
<0.50 U	<0.50 U	<0.50 U

SW-41

PCE	TCE	DCE
0.49 J	<0.50 U	<0.50 U

SW-25

PCE	TCE	DCE
1.4	<0.50 U	<0.50 U

SW-32

PCE	TCE	DCE
0.46 J	<0.50 U	<0.50 U

Legend

⌖	Monitoring Wells
⌖	Production/Irrigation Wells
⌖	Abandoned Monitoring Wells
▼	Stormwater Sample Location
💧	Spring Location
⊗	Stormwater System Structure (Drain, Manhole, Culvert)
—	Stormwater Line
– –	Wasatch Fault Line
- -	Infered PCE Contour Near Surface Groundwater
⁀	PCE Contour Near Surface Groundwater
-··-	Jordan River Canal (subterranean)
～	Streams
⌜ ⌟	Approximate Occurrence of Springs (East Side Springs Area)

Note(s) :
1. Surface water and stormwater samples were collected between 26 February to 11 May 2016.
2. Table 6-3 lists surface water and stormwater analytical results for the PCOPCs.
3. Stormwater results are in µg/L.
4. Contours representing PCE concentrations in shallow groundwater are in µg/L.
5. Vinyl chloride results were all <0.5 µg/L.
6. 1,4-dioxane results were <2.0 µg/L.
7. There were no surface water or stormwater results that exceeded the surface water-related SLs in Table 3-7.

Source(s) :
Utah Automated Geographic Reference Center (AGRC)

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
EPA = U.S. Environmental Protection Agency
J = estimated value
MW = Monitoring Well
PCE = tetrachloroethene
PCOPC = Preliminary Contaminant of Potential Concern
TCE = trichloroethene
U = non detect value
UJ = estimated non detect value

FIGURE 6-3 STORMWATER RESULTS (2016)
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 600'
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Legend

- ⊕ Monitoring Wells
- ⊕ Production/Irrigation Wells
- ⊕ Abandoned Monitoring Wells

Soil Gas Analysis Location and Method

- 🟪 HAPSITE®
- 🟦 TO-15
- 🟧 TO-15/HAPSITE®
- ▨ No Soil Gas Sampling
- 💧 Spring Location
- – – Wasatch Fault Line
- -·· Jordan River Canal (subterranean)
- ~ Streams
- – · Inferred PCE Contour Near Surface Groundwater
- — PCE Contour Near Surface Groundwater
- – – Approximate Occurrence of Springs (East Side Springs Area)

Note:

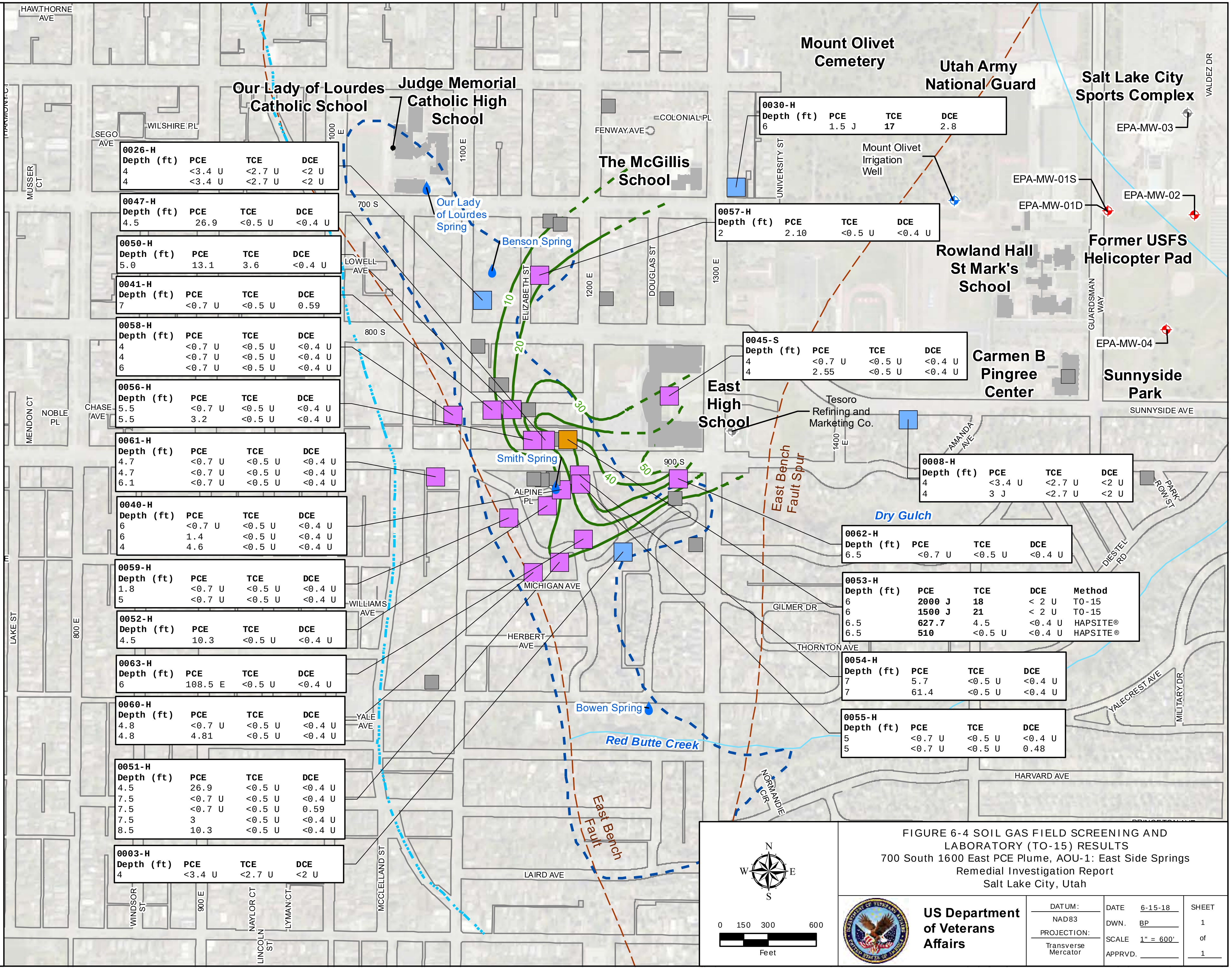
1. Soil gas samples were collected between April 8th, 2015 and April 5th, 2017, using both a HAPSITE® for field screening and SUMMA® Canister for TO-15 laboratory analysis.
2. Table 6-5 lists soil gas HAPSITE® and SUMMA® Canister/ TO-15 analytical results for the PCOPCs.
3. Soil gas results are in µg/m³.
4. PCE contour concentrations are in µg/L.
5. PCE contours are in shallow groundwater less than 45 ft bgs.
6. **Bold** text indicates concentration detected above the residential soil gas RSL
7. Vinyl chloride and 1,4-dioxane are not included in HAPSITE® screening. TO-15 results for vinyl chloride and 1,4-dioxane were below MRLs.

Chemical	Residential Soil Gas Screening Level (µg/m3)
cis-1,2-Dichloroethene	No screening level
1,4-Dioxane	19
Tetrachloroethene	370
Trichloroethene	16
Vinyl chloride (chloroethene)	5.7

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
µg/m³ = micrograms per cubic meter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
E = Estimated HAPSITE® result
EPA = Environmental Protection Agency
ft bgs = feet below ground surface
J = estimated value
MW = Monitoring Well
MRL = Method Reporting Limit
PCE = tetrachloroethene
PCOPC = Preliminary Contaminant of Potential Concern
RI = Remedial Investigation
RSL = Regional Screening Level
TCE = trichloroethene
U = non detect value

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-4 Soil Gas Sampling Results.mxd bpawling 6/8/2018



0026-H

Depth (ft)	PCE	TCE	DCE
4	<3.4 U	<2.7 U	<2 U
4	<3.4 U	<2.7 U	<2 U

0047-H

Depth (ft)	PCE	TCE	DCE
4.5	26.9	<0.5 U	<0.4 U

0050-H

Depth (ft)	PCE	TCE	DCE
5.0	13.1	3.6	<0.4 U

0041-H

Depth (ft)	PCE	TCE	DCE
7	<0.7 U	<0.5 U	0.59

0058-H

Depth (ft)	PCE	TCE	DCE
4	<0.7 U	<0.5 U	<0.4 U
4	<0.7 U	<0.5 U	<0.4 U
6	<0.7 U	<0.5 U	<0.4 U

0056-H

Depth (ft)	PCE	TCE	DCE
5.5	<0.7 U	<0.5 U	<0.4 U
5.5	3.2	<0.5 U	<0.4 U

0061-H

Depth (ft)	PCE	TCE	DCE
4.7	<0.7 U	<0.5 U	<0.4 U
4.7	<0.7 U	<0.5 U	<0.4 U
6.1	<0.7 U	<0.5 U	<0.4 U

0040-H

Depth (ft)	PCE	TCE	DCE
6	<0.7 U	<0.5 U	<0.4 U
6	1.4	<0.5 U	<0.4 U
4	4.6	<0.5 U	<0.4 U

0059-H

Depth (ft)	PCE	TCE	DCE
1.8	<0.7 U	<0.5 U	<0.4 U
5	<0.7 U	<0.5 U	<0.4 U

0052-H

Depth (ft)	PCE	TCE	DCE
4.5	10.3	<0.5 U	<0.4 U

0063-H

Depth (ft)	PCE	TCE	DCE
6	108.5 E	<0.5 U	<0.4 U

0060-H

Depth (ft)	PCE	TCE	DCE
4.8	<0.7 U	<0.5 U	<0.4 U
4.8	4.81	<0.5 U	<0.4 U

0051-H

Depth (ft)	PCE	TCE	DCE
4.5	26.9	<0.5 U	<0.4 U
7.5	<0.7 U	<0.5 U	<0.4 U
7.5	<0.7 U	<0.5 U	0.59
7.5	3	<0.5 U	<0.4 U
8.5	10.3	<0.5 U	<0.4 U

0003-H

Depth (ft)	PCE	TCE	DCE
4	<3.4 U	<2.7 U	<2 U

0030-H

Depth (ft)	PCE	TCE	DCE
6	1.5 J	**17**	2.8

0057-H

Depth (ft)	PCE	TCE	DCE
2	2.10	<0.5 U	<0.4 U

0045-S

Depth (ft)	PCE	TCE	DCE
4	<0.7 U	<0.5 U	<0.4 U
4	2.55	<0.5 U	<0.4 U

0008-H

Depth (ft)	PCE	TCE	DCE
4	<3.4 U	<2.7 U	<2 U
4	3 J	<2.7 U	<2 U

0062-H

Depth (ft)	PCE	TCE	DCE
6.5	<0.7 U	<0.5 U	<0.4 U

0053-H

Depth (ft)	PCE	TCE	DCE	Method
6	**2000 J**	**18**	< 2 U	TO-15
6	**1500 J**	**21**	< 2 U	TO-15
6.5	**627.7**	4.5	<0.4 U	HAPSITE®
6.5	**510**	<0.5 U	<0.4 U	HAPSITE®

0054-H

Depth (ft)	PCE	TCE	DCE
7	5.7	<0.5 U	<0.4 U
7	61.4	<0.5 U	<0.4 U

0055-H

Depth (ft)	PCE	TCE	DCE
5	<0.7 U	<0.5 U	<0.4 U
5	<0.7 U	<0.5 U	0.48

N
W E
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0 150 300 600
Feet

FIGURE 6-4 SOIL GAS FIELD SCREENING AND LABORATORY (TO-15) RESULTS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 600'
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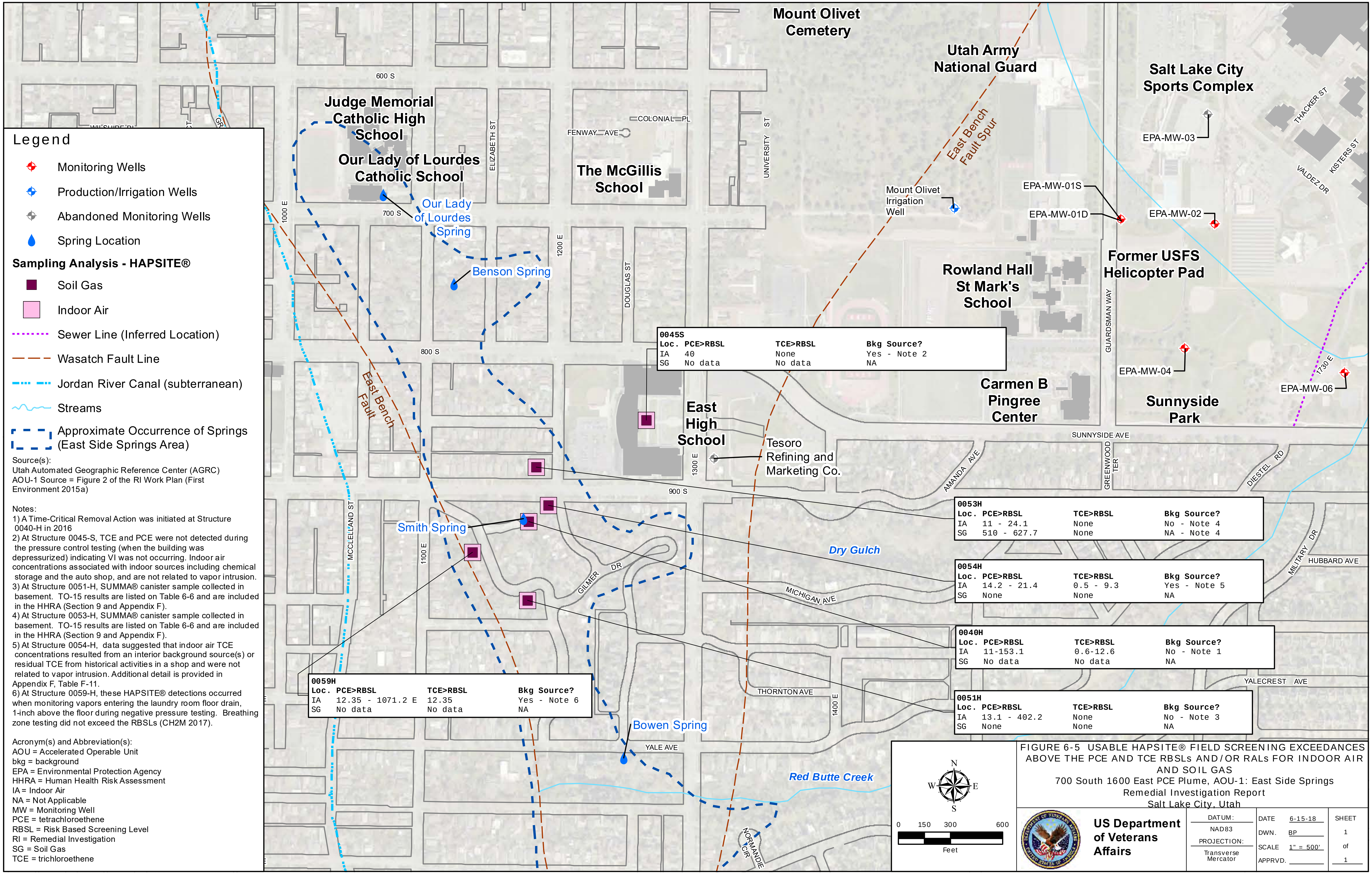

Legend

- ✚ Monitoring Wells
- ✚ Production/Irrigation Wells
- ✚ Abandoned Monitoring Wells
- 💧 Spring Location

Sampling Analysis - HAPSITE®

- ■ Soil Gas
- □ Indoor Air
- ······ Sewer Line (Inferred Location)
- — — Wasatch Fault Line
- -·-·- Jordan River Canal (subterranean)
- ∼∼ Streams
- - - - Approximate Occurrence of Springs (East Side Springs Area)

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Notes:
1) A Time-Critical Removal Action was initiated at Structure 0040-H in 2016
2) At Structure 0045-S, TCE and PCE were not detected during the pressure control testing (when the building was depressurized) indicating VI was not occurring. Indoor air concentrations associated with indoor sources including chemical storage and the auto shop, and are not related to vapor intrusion.
3) At Structure 0051-H, SUMMA® canister sample collected in basement. TO-15 results are listed on Table 6-6 and are included in the HHRA (Section 9 and Appendix F).
4) At Structure 0053-H, SUMMA® canister sample collected in basement. TO-15 results are listed on Table 6-6 and are included in the HHRA (Section 9 and Appendix F).
5) At Structure 0054-H, data suggested that indoor air TCE concentrations resulted from an interior background source(s) or residual TCE from historical activities in a shop and were not related to vapor intrusion. Additional detail is provided in Appendix F, Table F-11.
6) At Structure 0059-H, these HAPSITE® detections occurred when monitoring vapors entering the laundry room floor drain, 1-inch above the floor during negative pressure testing. Breathing zone testing did not exceed the RBSLs (CH2M 2017).

Acronym(s) and Abbreviation(s):
AOU = Accelerated Operable Unit
bkg = background
EPA = Environmental Protection Agency
HHRA = Human Health Risk Assessment
IA = Indoor Air
NA = Not Applicable
MW = Monitoring Well
PCE = tetrachloroethene
RBSL = Risk Based Screening Level
RI = Remedial Investigation
SG = Soil Gas
TCE = trichloroethene

0045S

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	40	None	Yes - Note 2
SG	No data	No data	NA

0053H

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	11 - 24.1	None	No - Note 4
SG	510 - 627.7	None	NA - Note 4

0054H

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	14.2 - 21.4	0.5 - 9.3	Yes - Note 5
SG	None	None	NA

0040H

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	11-153.1	0.6-12.6	No - Note 1
SG	No data	No data	NA

0059H

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	12.35 - 1071.2 E	12.35	Yes - Note 6
SG	No data	No data	NA

0051H

Loc.	PCE>RBSL	TCE>RBSL	Bkg Source?
IA	13.1 - 402.2	None	No - Note 3
SG	None	None	NA

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FIGURE 6-5 USABLE HAPSITE® FIELD SCREENING EXCEEDANCES ABOVE THE PCE AND TCE RBSLs AND/OR RALs FOR INDOOR AIR AND SOIL GAS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 500'
APPRVD.

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File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-5 Vapor Intrusion Sampling Results.mxd bpawling 6/8/2018

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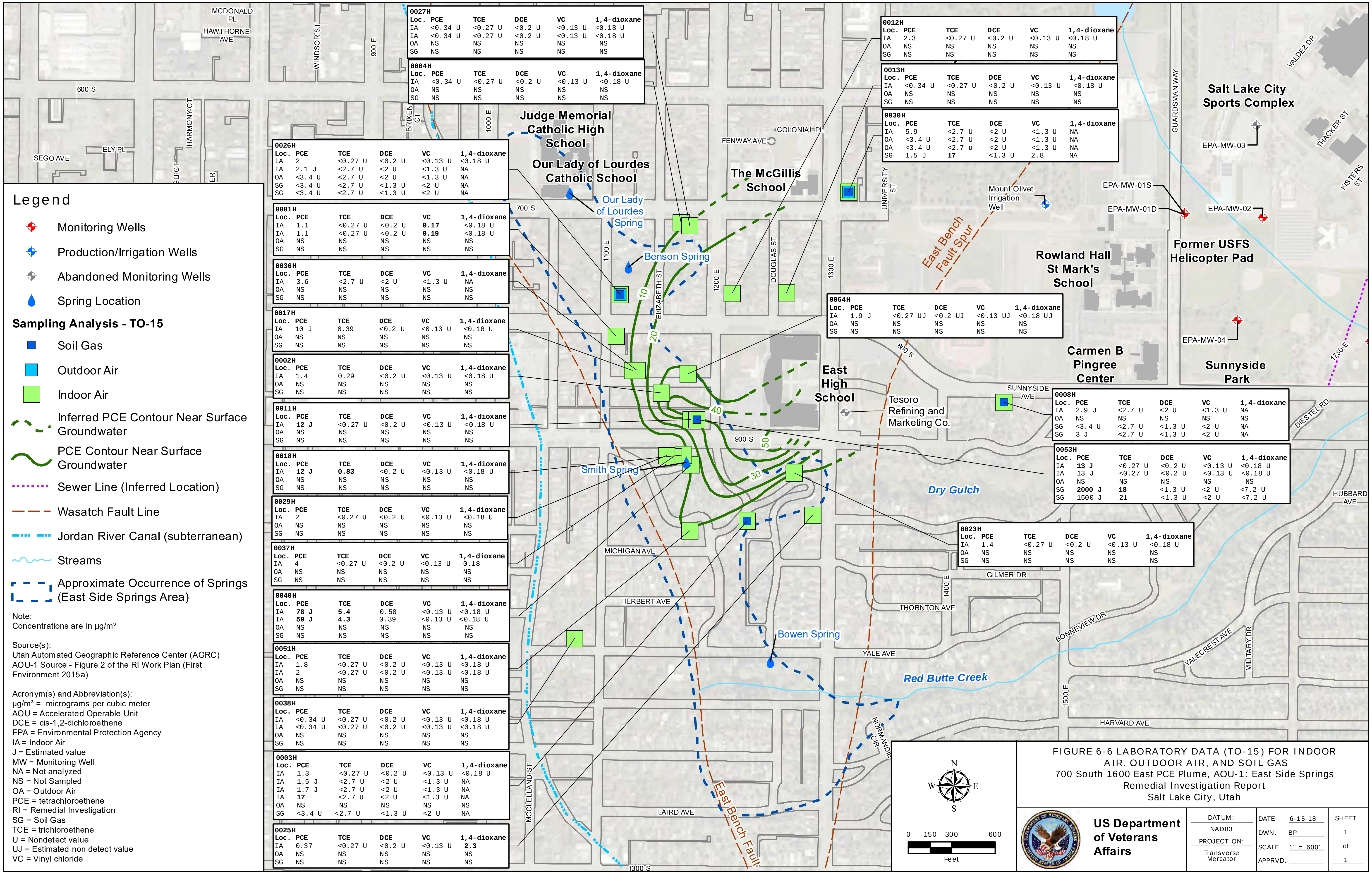
File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-6 Laboratory Data (TO-15) for Indoor and Outdoor Air.mxd bpawling 6/8/2018



Legend

- ⊕ Monitoring Wells
- ⊕ Production/Irrigation Wells
- ⊕ Abandoned Monitoring Wells
- 💧 Spring Location

Sampling Analysis - TO-15

- 🟦 Soil Gas
- 🟦 Outdoor Air
- 🟩 Indoor Air
- Inferred PCE Contour Near Surface Groundwater
- PCE Contour Near Surface Groundwater
- Sewer Line (Inferred Location)
- Wasatch Fault Line
- Jordan River Canal (subterranean)
- Streams
- Approximate Occurrence of Springs (East Side Springs Area)

Note:
Concentrations are in µg/m³

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source - Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s):
µg/m³ = micrograms per cubic meter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
EPA = Environmental Protection Agency
IA = Indoor Air
J = Estimated value
MW = Monitoring Well
NA = Not analyzed
NS = Not Sampled
OA = Outdoor Air
PCE = tetrachloroethene
RI = Remedial Investigation
SG = Soil Gas
TCE = trichloroethene
U = Nondetect value
UJ = Estimated non detect value
VC = Vinyl chloride

0027H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0004H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0026H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	2	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	2.1 J	<2.7 U	<2 U	<1.3 U	NA
OA	<3.4 U	<2.7 U	<2 U	<1.3 U	NA
SG	<3.4 U	<2.7 U	<1.3 U	<2 U	NA
SG	<3.4 U	<2.7 U	<1.3 U	<2 U	NA

0001H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.1	<0.27 U	<0.2 U	**0.17**	<0.18 U
IA	1.1	<0.27 U	<0.2 U	**0.19**	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0036H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	3.6	<2.7 U	<2 U	<1.3 U	NA
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0017H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	10 J	0.39	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0002H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.4	0.29	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0011H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	**12 J**	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0018H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	**12 J**	**0.83**	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0029H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	2	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0037H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	4	<0.27 U	<0.2 U	<0.13 U	0.18
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0040H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	**78 J**	**5.4**	0.58	<0.13 U	<0.18 U
IA	**59 J**	**4.3**	0.39	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0051H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.8	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	2	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0038H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0003H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.3	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	1.5 J	<2.7 U	<2 U	<1.3 U	NA
IA	1.7 J	<2.7 U	<2 U	<1.3 U	NA
IA	**17**	<2.7 U	<2 U	<1.3 U	NA
OA	NS	NS	NS	NS	NS
SG	<3.4 U	<2.7 U	<1.3 U	<2 U	NA

0025H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	0.37	<0.27 U	<0.2 U	<0.13 U	**2.3**
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0012H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	2.3	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0013H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	<0.34 U	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0030H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	5.9	<2.7 U	<2 U	<1.3 U	NA
OA	<3.4 U	<2.7 U	<2 U	<1.3 U	NA
OA	<3.4 U	<2.7 u	<2 U	<1.3 U	NA
SG	1.5 J	**17**	<1.3 U	2.8	NA

0064H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.9 J	<0.27 UJ	<0.2 UJ	<0.13 UJ	<0.18 UJ
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

0008H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	2.9 J	<2.7 U	<2 U	<1.3 U	NA
OA	NS	NS	NS	NS	NS
SG	<3.4 U	<2.7 U	<1.3 U	<2 U	NA
SG	3 J	<2.7 U	<1.3 U	<2 U	NA

0053H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	**13 J**	<0.27 U	<0.2 U	<0.13 U	<0.18 U
IA	13 J	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	**2000 J**	**18**	<1.3 U	<2 U	<7.2 U
SG	1500 J	21	<1.3 U	<2 U	<7.2 U

0023H

Loc.	PCE	TCE	DCE	VC	1,4-dioxane
IA	1.4	<0.27 U	<0.2 U	<0.13 U	<0.18 U
OA	NS	NS	NS	NS	NS
SG	NS	NS	NS	NS	NS

FIGURE 6-6 LABORATORY DATA (TO-15) FOR INDOOR AIR, OUTDOOR AIR, AND SOIL GAS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM:
NAD83
PROJECTION:
Transverse Mercator

DATE 6-15-18
DWN. BP
SCALE 1" = 600'
APPRVD.

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File: Albuquerque EA \\lovetonGIS\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 6-7 Shallow Groundwater Investigation TCE and PCE Concentration Contours.mxd cohara 10/26/2018 2:57:49 PM

Legend

- Monitoring Wells
- Production/Irrigation Wells
- Abandoned Monitoring Wells
- Temporary Groundwater Monitoring Point
- Temporary Groundwater Monitoring Point/Piezometer
- Drilled to Refusal/No Groundwater
- Spring Location
- Direction of Groundwater Flow
- Wasatch Fault Line
- Inferred PCE Contour Near Surface Groundwater
- PCE Contour Near Surface Groundwater
- Inferred TCE Contour Near Surface Groundwater
- TCE Contour Near Surface Groundwater
- Jordan River Canal (subterranean)
- Streams
- Approximate Occurrence of Springs (East Side Springs Area)

Note(s) :

1.Shallow groundwater samples were collected between 22 Feb 2016 and 8 March 2016.

2.Summary of Temporary Monitoring Point Installation and Sampling:

Action	Number of Locations
Temporary monitoring points attempted with Geoprobe®	50 locations
Refusal: no groundwater encountered, no point set.(GW-2, GW-33, GW-35, GW-42, GW-57, GW-58)	6 out of the 50 locations
Temporary monitoring point set, but no groundwater recharge at (GW-19 and GW-54)	2 out of the 44 locations
Shallow groundwater sample collected	42 locations
Piezometers installed	10 of the 44 locations

3.Table 6-1 lists the shallow groundwater analytical results for the PCOPCs.

4.If multiple samples were collected from one monitoring point, then the sample result with the highest concentration is shown.

5.Concentrations are in µg/L

6.Contours representing PCE and TCE concentrations in shallow groundwater are in µg/l

7.Vinyl chloride results were all <0.5 µg/L.

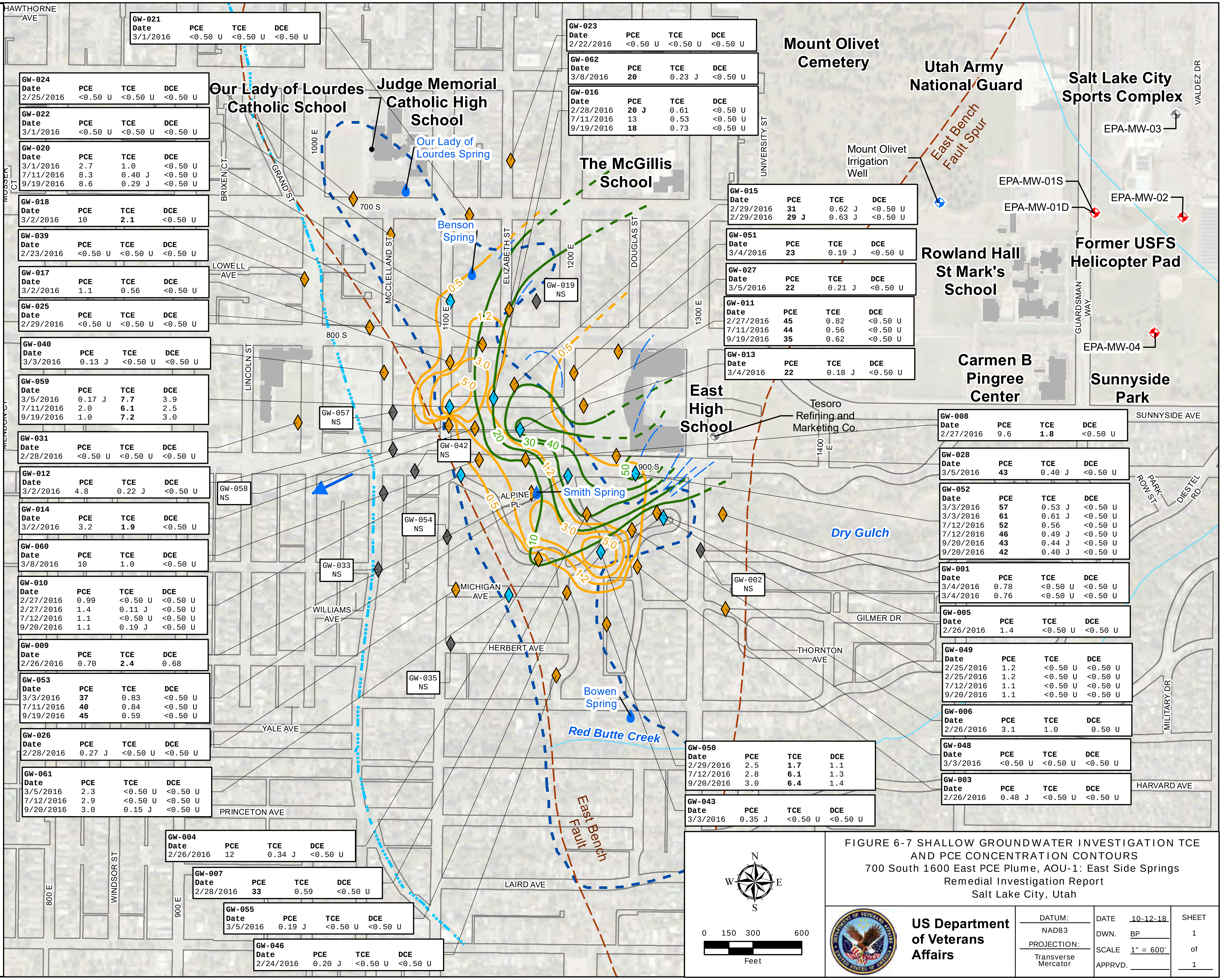
8.1,4-dioxane results were <2.0 µg/L, except at GW-52 where the result was 2.7 µg/L.

9.Bold text indicates PCOPC results greater than the residential screening levels for groundwater to indoor air, that are identified in Table 3-6:

Chemical	Residential SLs for Groundwater to Indoor Air (µg/L)
cis-1,2-Dichloroethene	No screening level
1,4-Dioxane	2,900
Tetrachloroethene	15
Trichloroethene	1.2
Vinyl chloride(chloroethene)	0.15

Source(s) :
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
DCE = cis-1,2-dichloroethene
EPA = U.S. Environmental Protection Agency
GW = Groundwater
J = estimated value
MW = Monitoring Well
NS = No Sample
PCE = tetrachloroethene
PCOPC = Preliminary Contaminant of Potential Concern
RI = Remedial Investigation
SL = Screening Level
TCE = trichloroethene
U = non detect value



GW-021

Date	PCE	TCE	DCE
3/1/2016	<0.50 U	<0.50 U	<0.50 U

GW-024

Date	PCE	TCE	DCE
2/25/2016	<0.50 U	<0.50 U	<0.50 U

GW-022

Date	PCE	TCE	DCE
3/1/2016	<0.50 U	<0.50 U	<0.50 U

GW-020

Date	PCE	TCE	DCE
3/1/2016	2.7	1.0	<0.50 U
7/11/2016	8.3	0.40 J	<0.50 U
9/19/2016	8.6	0.29 J	<0.50 U

GW-018

Date	PCE	TCE	DCE
3/2/2016	10	**2.1**	<0.50 U

GW-039

Date	PCE	TCE	DCE
2/23/2016	<0.50 U	<0.50 U	<0.50 U

GW-017

Date	PCE	TCE	DCE
3/2/2016	1.1	0.56	<0.50 U

GW-025

Date	PCE	TCE	DCE
2/29/2016	<0.50 U	<0.50 U	<0.50 U

GW-040

Date	PCE	TCE	DCE
3/3/2016	0.13 J	<0.50 U	<0.50 U

GW-059

Date	PCE	TCE	DCE
3/5/2016	0.17 J	**7.7**	3.9
7/11/2016	2.0	**6.1**	2.5
9/19/2016	1.0	**7.2**	3.0

GW-031

Date	PCE	TCE	DCE
2/28/2016	<0.50 U	<0.50 U	<0.50 U

GW-012

Date	PCE	TCE	DCE
3/2/2016	4.8	0.22 J	<0.50 U

GW-014

Date	PCE	TCE	DCE
3/2/2016	3.2	**1.9**	<0.50 U

GW-060

Date	PCE	TCE	DCE
3/8/2016	10	1.0	<0.50 U

GW-010

Date	PCE	TCE	DCE
2/27/2016	0.99	<0.50 U	<0.50 U
2/27/2016	1.4	0.11 J	<0.50 U
7/12/2016	1.1	<0.50 U	<0.50 U
9/20/2016	1.1	0.19 J	<0.50 U

GW-009

Date	PCE	TCE	DCE
2/26/2016	0.70	**2.4**	0.68

GW-053

Date	PCE	TCE	DCE
3/3/2016	**37**	0.83	<0.50 U
7/11/2016	**40**	0.84	<0.50 U
9/19/2016	**45**	0.59	<0.50 U

GW-026

Date	PCE	TCE	DCE
2/28/2016	0.27 J	<0.50 U	<0.50 U

GW-061

Date	PCE	TCE	DCE
3/5/2016	2.3	<0.50 U	<0.50 U
7/12/2016	2.9	<0.50 U	<0.50 U
9/20/2016	3.0	0.15 J	<0.50 U

GW-004

Date	PCE	TCE	DCE
2/26/2016	12	0.34 J	<0.50 U

GW-007

Date	PCE	TCE	DCE
2/28/2016	**33**	0.59	<0.50 U

GW-055

Date	PCE	TCE	DCE
3/5/2016	0.19 J	<0.50 U	<0.50 U

GW-046

Date	PCE	TCE	DCE
2/24/2016	0.20 J	<0.50 U	<0.50 U

GW-023

Date	PCE	TCE	DCE
2/22/2016	<0.50 U	<0.50 U	<0.50 U

GW-062

Date	PCE	TCE	DCE
3/8/2016	**20**	0.23 J	<0.50 U

GW-016

Date	PCE	TCE	DCE
2/28/2016	**20 J**	0.61	<0.50 U
7/11/2016	13	0.53	<0.50 U
9/19/2016	**18**	0.73	<0.50 U

GW-015

Date	PCE	TCE	DCE
2/29/2016	**31**	0.62 J	<0.50 U
2/29/2016	**29 J**	0.63 J	<0.50 U

GW-051

Date	PCE	TCE	DCE
3/4/2016	**23**	0.19 J	<0.50 U

GW-027

Date	PCE	TCE	DCE
3/5/2016	**22**	0.21 J	<0.50 U

GW-011

Date	PCE	TCE	DCE
2/27/2016	**45**	0.82	<0.50 U
7/11/2016	**44**	0.56	<0.50 U
9/19/2016	**35**	0.62	<0.50 U

GW-013

Date	PCE	TCE	DCE
3/4/2016	**22**	0.18 J	<0.50 U

GW-008

Date	PCE	TCE	DCE
2/27/2016	9.6	**1.8**	<0.50 U

GW-028

Date	PCE	TCE	DCE
3/5/2016	**43**	0.40 J	<0.50 U

GW-052

Date	PCE	TCE	DCE
3/3/2016	**57**	0.53 J	<0.50 U
3/3/2016	**61**	0.61 J	<0.50 U
7/12/2016	**52**	0.56	<0.50 U
7/12/2016	**46**	0.49 J	<0.50 U
9/20/2016	**43**	0.44 J	<0.50 U
9/20/2016	**42**	0.40 J	<0.50 U

GW-001

Date	PCE	TCE	DCE
3/4/2016	0.78	<0.50 U	<0.50 U
3/4/2016	0.76	<0.50 U	<0.50 U

GW-005

Date	PCE	TCE	DCE
2/26/2016	1.4	<0.50 U	<0.50 U

GW-049

Date	PCE	TCE	DCE
2/25/2016	1.2	<0.50 U	<0.50 U
2/25/2016	1.2	<0.50 U	<0.50 U
7/12/2016	1.1	<0.50 U	<0.50 U
9/20/2016	1.1	<0.50 U	<0.50 U

GW-006

Date	PCE	TCE	DCE
2/26/2016	3.1	1.0	0.50 U

GW-048

Date	PCE	TCE	DCE
3/3/2016	<0.50 U	<0.50 U	<0.50 U

GW-003

Date	PCE	TCE	DCE
2/26/2016	0.48 J	<0.50 U	<0.50 U

GW-050

Date	PCE	TCE	DCE
2/29/2016	2.5	**1.7**	1.1
7/12/2016	2.8	**6.1**	1.3
9/20/2016	3.0	**6.4**	1.4

GW-043

Date	PCE	TCE	DCE
3/3/2016	0.35 J	<0.50 U	<0.50 U

FIGURE 6-7 SHALLOW GROUNDWATER INVESTIGATION TCE AND PCE CONCENTRATION CONTOURS
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator

DATE 10-12-18
DWN. BP
SCALE 1" = 600'
APPRVD.

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7.0 Contaminant Fate and Transport

Chemical and physical attributes of the ESS area PCOPCs, routes of contaminant migration in soil, soil gas, surface water, stormwater, and groundwater, and degradation mechanisms are discussed in the following subsections for the PCOPCs at AOU-1: PCE, TCE, cis-DCE, VC, and 1,4-dioxane.

7.1 Contaminant Characteristics

7.1.1 Tetrachloroethene

PCE is a halogenated alkene with low solubility (200 mg/L), high vapor pressure (18.4 millimeters of mercury [mmHg]), and a moderately high Henry's Constant (0.765 cubic centimeters of water per cubic centimeters of air [cm^3-H_20/cm^3-air]). The Log organic carbon water partition coefficient (K_{oc}) and Log octanol-water partition coefficient (K_{ow}) for PCE are 2.19 and 2.97, respectively. Because of its high vapor pressure in conjunction with a low K_{oc}, PCE tends to migrate quickly through sandy soils. Under anaerobic conditions, PCE degrades via reductive dechlorination to TCE (Agency for Toxic Substances and Disease Registry [ATSDR] 2015a).

7.1.2 Trichloroethene

TCE is a halogenated alkene with a moderate solubility (1,100 mg/L), high vapor pressure (72 mmHg) and a high Henry's Constant (0.428 m^3-H_20/cm^3-air). The Log K_{oc} and Log K_{ow} for TCE are 1.97 and 2.47, respectively. Like PCE, TCE tends to migrate quickly through sandy soils. Under anaerobic conditions, TCE degrades via reductive dechlorination to cis-1,2-DCE (ATSDR 2015b).

7.1.3 cis-1,2-Dichloroethene

Cis-1,2-DCE is a halogenated alkene with a high solubility (4,930 mg/L), high vapor pressure (175 mmHg), and a high Henry's constant (0.187 m^3-H_20/cm^3-air). The Log K_{oc} and Log K_{ow} for cis-1,2-DCE are 1.46 and 1.86, respectively. This compound is very volatile and will migrate quickly through soils with low organic contents. It is very mobile in groundwater (ATSDR 2015c).

7.1.4 Vinyl Chloride

VC, also known as chloroethene, is an organochloride with a moderate solubility of 2,763 mg/L), with a very high vapor pressure of 2,530 mmHg, and a high Henry's Constant of 0.0278 m^3-H_20/cm^3-air). The Log K_{oc} and Log K_{ow} for VC are 1.36 and 1.99 respectively. This compound is very volatile and will exist entirely as a gas when at atmospheric pressure. The primary transport process for VC in a natural water system is volatilization into the atmosphere. VC is mobile in soil and susceptible to leaching (ATSDR 2015d).

7.1.5 1,4–Dioxane

1,4-Dioxane is a heterocyclic organic compound which is completely miscible is water, with a high vapor pressure of 38.1 mm Hg, and a Henry's Constant of 4.80×10^{-6} m^3-H_20/cm^3-air. The Log K_{ow} and Log K_{oc} are -027 and 1.23, respectively. 1,4-Dioxane is moderately volatile from water and soil surfaces. It is readily mobile in groundwater and binds weakly to soil surfaces. It is relatively resistant to biodegradation (ATSDR 2015e)

7.2 Transport Processes and Potential Routes of Migration

In the ESS area, shallow VOC-impacted groundwater is the primary contaminated media from which other media are impacted. The source of the PCE-impacted groundwater and surface water in the ESS area is upgradient and northeast of the ESS area. PCOPCs migrate by advection and dispersion, from the upgradient source into the ESS area. The Wasatch Fault appears to have some influence on the hydraulic properties and flow for the ESS area. Generally, groundwater flow is perpendicular to the fault; however, neither the fault nor the spur is a barrier to groundwater flow, which would cause smoothing or flattening of the potentiometric surface map. In addition, the presence of PCE in springs and seeps downgradient of the fault, although in much lower concentrations than along the fault scarp, further suggests that the East Bench Fault Spur is not a flow barrier. The complex geology and hydrogeology between the suspected release site(s) east of the ESS area, and the influence of high volume pumping from public irrigation wells that may be mixing the upper unconfined aquifer and lower confined aquifer will be investigated further during the OU-2 RI.

Vapor intrusion is a pathway of concern for human health risk within the ESS area. The contributing factors to the VI pathway include a subsurface source of vapor-forming chemicals, a route along which the vapors can migrate, moderate to highly volatile PCOPCs in shallow groundwater, the presence of buildings that are susceptible to soil gas entry, and receptors in the buildings when vapor-forming chemicals are present indoors (EPA 2015c). Contaminants in groundwater can be a primary source for VI if they volatilize under normal temperatures and pressure conditions and if they are in the upper reaches of an unconfined aquifer as they are within the ESS area (EPA 2015c). Because of their high vapor pressures, PCE; TCE; cis-1,2-DCE; and VC readily volatilize from the liquid phase when present in groundwater, surface water/stormwater, or within the soil, becoming a vapor in the surrounding environment or in soil gas.

As contaminants partition into the vapor phase, migration occurs primarily via diffusion and advection. Advection processes in the vadose zone may result from barometric pumping, which induces subsurface pressure gradients in soil. Barometric pumping can be caused by the natural variations in ambient temperature and pressure that may occur with seasonal and weather changes. VI rates into structures can also be influenced by barometric pumping; however, instead of being driven directly by the seasons or weather, it can fluctuate with in-home climate control such as heaters and air-conditioners/swamp coolers (EPA 2015c). In deep vadose zones, density-driven flow can occur: volatilized contaminants can be denser than air or lighter than air (EPA 2015c). PCE, TCE, and cis-1,2-DCE will form a soil gas denser than air, which will in turn migrate to depth via negative buoyancy. This flux can be enhanced with barometric pumping, with negative buoyancy, and advection working in tandem (VA 2016).

The secondary sources of chlorinated solvent contamination are soil and vapor as soil gas. Not only can soil gas contaminants migrate in the vapor phase, but they can partition into pore water and into the sorbed phase on the soil matrix. VOCs in pore water and soil gas can adsorb onto the soil matrix and continue to volatilize once groundwater has retreated (Vogel and McCarty 1985, EPA 1991a, EPA 1992). The contaminated pore water in turn can leach to the water table where it contaminates groundwater. Pore water can leach back into groundwater, depending on recharge rates and water level fluctuations. While water level fluctuations have been observed at the VAMC, they have not been explored in detail as transport mechanisms from soil to groundwater at AOU-1. The amount of sorbed-phase contamination on soil matrix is a function of the fraction of organic carbon (f_{oc}). While f_{oc} analysis was not analyzed in soil in the AOU-1 area, it is expected that the f_{oc} is relatively low based on soil mapping conducted by the

Natural Resource Conservation Service (NRCS). The NRCS online soil report shows the Bingham loam is present in the AOU-1 area with f_{oc} values ranging from 0.02 to 0.008 (NRCS 2018). A conservative f_{oc} value of 0.002 – compared to the f_{oc} for the Bingham loam – was used in the derivation of the risk-based screening levels used in the human health risk assessment (HHRA) (Table F1-2).

7.3 Contaminant Migration in Groundwater

As stated above, the primary source for contaminants beneath the ESS area is via the groundwater pathway where contamination within the vadose zone and shallow groundwater volatilizes to the vapor phase. The shallower the groundwater, the more readily the VOCs can volatilize at atmospheric pressure and the shorter the pathway to enter the atmosphere or overlying structure. Therefore, the thickness of the soils above groundwater, measured as depth to water, is a contributing factor in the VI distribution at the site. Figure 7-1 shows depth to shallow groundwater in the ESS area as measured within the temporary well points, which varies between 0 ft (where groundwater is exposed to the surface as seeps and springs) to 20 ft bgs when measured in 2016.

When groundwater VOC concentrations are high, and groundwater is close to the surface, there is an elevated risk for VI. There is less soil storage, shorter travel time, and higher vapor concentration in these areas. Figure 7-2 illustrates the general the groundwater concentrations of PCE in relation to depth to groundwater and topography.

Generally, groundwater PCE concentrations are higher to the east and decrease to the west of the ESS area, as discussed in Section 6.4. Surficial soils are thinnest (and depth to groundwater is shallowest) near the center and south-center of the ESS area. Shallow depths to groundwater (i.e., less than 10 ft) where PCE and TCE is reported, such as GW-07, GW-08, GW-09, GW-11, GW-15, GW-16, and GW-53, indicate a higher probability of VI into susceptible structures. This concept is discussed further in the soil gas and VI migration sections (Section 7.5) below.

In evaluating the AOU-1 RI data, the extent of AOU-1 was refined from the estimated extent in the RI Work Plan. AOU-1 was defined in the RI Work Plan as: area where groundwater and springs were known to have PCE contamination, area where groundwater is within 50 ft of the surface, and a 100-ft buffer around the areas defined by the previous two criteria. Using AOU-1 RI data, specifically: 1) distribution of locations where PCE exceeded indoor air RBSLs, 2) depth to groundwater 3) occurrence of PCE in groundwater and soil gas, 4) distribution of PCE in exceedance of groundwater and soil gas impact-to-indoor air RBSLs, and 5) review of other PCOPC occurrence and distribution, the AOU-1 Boundary was refined and is shown on the Section 7 figures (i.e., the Post-RI AOU-1 Boundary). The new AOU-1 Boundary is the area likely to provide the conditions for VI of PCE and its degradation products if preferential pathways exist in a given structure.

Data collected during the RI shows that all locations with an indoor air exceedance of the PCE RBSL (not attributed to background interior source) were within the area where groundwater was within 10 ft of the surface (Figure 7-5). Similarly, the only exceedance of the soil gas RBSL for impact to indoor air in the study area (as defined by depth to groundwater within 50 ft) occurred in samples collected where some of the highest concentrations of PCOPCs in groundwater were within 10 ft of the ground surface.

Therefore, the 10-ft depth to groundwater interval was used as the initial basis of the revised AOU-1 boundary (Figure 7-1). To further develop the revised AOU-1 boundary, the 10-ft depth to groundwater contour was refined by smoothing and adding a buffer. Adding a buffer is a recognized approach when addressing the potential for soil VI from groundwater contaminant plumes (EPA 2015c). While a buffer of 100-ft is suggested in the guidance, the buffer may be larger or smaller based on site-specific information. The smoothing and application of a buffer conservatively increased the area. For example, professional judgement was used in smoothing the contour between GW-018, GW-017, and GW-059 to the west side, and in the vicinity of GW-004 to the south. The buffer applied to the smoothed 10-ft depth to water interval was minimal along the west side of the site, as depth to groundwater increased dramatically across the fault scarp. Several locations were drilled to refusal during the 2016 investigation without encountering groundwater in this area (Table 5-3).

Concentrations of PCE (and other PCOPCs) in groundwater and soil gas were further evaluated against the refined 10-ft depth to groundwater contour in developing the revised AOU-1 boundary. To the east/northeast, a buffer was extended well beyond the 10-ft depth to groundwater interval to capture GW-013, GW-027, GW-028, GW-52, and GW-62, and to extend to just west of East High School. Soil gas concentrations in this area did not exceed RBSLs (depth to groundwater is near 20 ft bgs in this area); however, the groundwater RBSL for PCE impact to indoor air ratio was exceeded in these locations. Such a large buffer from the 10-ft depth to groundwater contour is conservative given the lack of exceedances in soil gas but was applied in this area given the higher concentrations of PCE in groundwater in the eastern portion of the ESS area. Although East High School is not included in the post-RI AOU-1 boundary, VA will conduct future monitoring and/or sampling at East High School due to its use and sensitivity, to ensure no future impact from VI.

Once the revised AOU-1 boundary was established (Figure 7-1), concentrations of all COPCs in groundwater, surface water, soil gas, and indoor air were reviewed against the boundary as a qualitative check of the conservatism of the revised boundary. All locations sampled during the AOU-1 RI where PCOPCs in groundwater were in exceedance of the RBSLs are within the revised boundary. It is possible that concentrations of PCOPCs in groundwater in exceedance of the RBSL extend beyond the boundary to the northeast, but depth to groundwater is expected to be an attenuating factor.

There are occurrences of PCOPCs in surface water outside of the revised boundary; however, the higher concentrations of PCOPCs in surface water (i.e., greater than the groundwater RBSLs of 15, 1.2 and 0.15 µg/L of PCE, TCE, and vinyl chloride, respectively) occur within the revised AOU-1 boundary. The boundary was extended to include the surface water swale between 1100 East and 1200 East (north of 800 South) as several springs in this area had reported concentrations of PCE, with one ranging up to 14 µg/L.

All occurrences of PCOPCs in soil gas in exceedance of the RBSL occur within the revised AOU-1 boundary, with the exception of TCE in soil gas at 0030-H. However, depth to groundwater in the area of 0030-H is greater than 50 ft bgs and is likely closer to 60 ft bgs. This is based on data from a newly-installed well in support of the OU-2 RI (MW-18), which is located approximately 500 ft southeast of 0030-H and near the same elevation. The depth to groundwater in MW-18 was measured at 81.73 ft bgs. Given the depth to groundwater at location 0030-H, this area is outside of the original boundary of AOU-1 because it is unlikely that the volatilization from groundwater to indoor air would occur from such a depth. In addition, there are multiple non-chlorinated VOCs (i.e., benzene, toluene, etc.) reported in soil gas at this and other locations suggesting there may be some other source contributing to shallow soil gas. It’s worth noting that there were no exceedances of the indoor air RBSL at 0030-H. Further, most soil gas results did not exceed indoor air RBSLs (a very conservative check), but where they did, the locations were located within the revised boundary. All locations where there was an exceedance of the indoor air RBSL also fall within the revised AOU-1 boundary.

7.4 Contaminant Migration in Surface Water and Stormwater

Generally, the surface water and stormwater gradient is from east to west across the site, following the steep drop in topography in this area. The general range of PCE concentrations in surface water in comparison to topography and depth to groundwater are illustrated in Figure 7-3. Surface water and stormwater sample results are illustrated on Figures 6-2 and 6-3, respectively.

7.4.1 Surface Water

Based on a review of groundwater elevations in upgradient shallow wells (e.g., MW-01S), topography, and groundwater gradient, daylighting of groundwater along the fault scarp has been confirmed. The seeps and springs in the ESS area are due to unconfined water table groundwater aquifer intercepting ground surface within the steeply declining topography in the fault scarp between the East Bench Fault Spur and the East Bench Fault. The groundwater gradient also steepens dramatically in the fault scarp; however, a significant amount of shallow groundwater surfaces in this area due to the topographic change. Review of available lithologic data (Figure 4-2), groundwater elevations in upgradient wells (Table 3-2), and potentiometric surface and groundwater gradient between the ESS area and the VAMC suggest hydrologic connectivity. As illustrated in Figure 7-3, the higher concentrations of contaminants in surface water are also centrally located and occur at similar elevations along the fault scarp (approximately 4,430 ft amsl). Flow pathways for springs, and therefore contaminant migration in shallow groundwater and spring water, may be affected by development including compaction from construction of buildings and roads and other anthropogenic appurtenances such as utilities. The seeps and springs contain PCE and TCE concentrations similar to the subsurface groundwater concentrations. The presence of PCE, TCE, and cis-1,2-DCE concentrations in surface water, similar to the groundwater in the same area, are an additional line of evidence confirming the groundwater-to-surface water migration pathway is complete.

7.4.2 Stormwater

Samples collected from the storm sewer system (stormwater samples) indicate that the PCE, TCE, and cis-1,2-DCE in surface water and groundwater are being transported to the storm sewer system as water from seeps and springs runs off or is diverted by property owners into the system. PCE, TCE, and cis-1,2-DCE were detected in stormwater samples downstream from seeps and springs (Figure 6-3). Generally, the concentrations detected in stormwater were similar to those detected in the upgradient springs; however, these concentrations are diluted with precipitation and residential irrigation water that enters the storm sewer system. The presence of PCE, TCE, and cis-1,2-DCE concentrations in stormwater, also indicates that the migration pathway to stormwater is complete, similar to the upgradient surface water samples and subsequently the upgradient groundwater concentration in the same area.

7.5 Contaminant Migration in Soil

Three soil samples were collected during the AOU-1 RI (Figure 6-2): two samples near springs where shallow groundwater samples exhibited elevated PCE concentrations, and one in an area where PCE was not detected in the associated shallow groundwater sample. As shown in Table 6-4, the PCOPCs were either not detected or very low (i.e., only PCE was detected in SS-26 at 0.022 mg/kg). As discussed in Section 7.2, the degree of VOC sorption from water to the soils is primarily related to the $f_{oc,}$ which is expected to be low, and percent fines of the soils. Generally, shallow soil in the vadose zone of the ESS area is sandy, with small fractions of silt and clay (Figure 4-3). Consequently, based on the data available from the two soil samples and general characteristics of the soil in the AOU-1 area, it is expected that the PCOPCs do not tend to significantly sorb onto the soils, and, instead, remain mobile in the aqueous phase, or volatilize to the vapor phase, especially where the vadose zone is shallow and soil pore pressure will be near atmospheric pressure.

7.6 Contaminant Migration through Vapor Intrusion

7.6.1 Soil Gas

All three of the VOC compounds (PCE, TCE, and cis-1,2-DCE) detected in groundwater at AOU-1 are highly volatile, with moderate to high solubility's and densities greater than air. The vapor phase plume is driven by barometric pressure and density of the gas, while concentration gradients and diffusion processes promote lateral migration. If the vapor phase is denser than air, it will move down the soil profile until the pore space is filled by another media like groundwater or increased soil pressures. However, when groundwater is near the surface this dense vapor is also present near the surface. The gas may migrate up through the profile depending on barometric pressure changes (i.e., lower barometric pressure will allow the gas to move upward in the soil profile into the surrounding environment or structure).

As summarized in Section 6.7, soil gas samples collected contained PCE, TCE, and trace levels of 1,2-cis-DCE. In general, the soil gas samples with higher concentrations of PCE and TCE were located in areas where there are also higher concentrations in groundwater. This is visible in Figure 7-4 where PCE detections in soil gas are shown along with the depth to groundwater. In these locations, there is increased potential for the indoor air VI pathway being completed. The presence of PCE, TCE, and cis-1,2-DCE in the soil gas samples indicate the groundwater-to-soil gas pathways are complete.

7.6.2 Indoor and Outdoor Air

PCE concentrations in indoor air, based on laboratory analysis, are shown with depth to groundwater on Figure 7-5. There were no PCE detections in outdoor air samples that were analyzed in the laboratory. The indoor air results do not show as significant a correlation between soil gas concentrations and depth to groundwater, most likely because structure construction and ventilation play a significant role in the completion of the pathway. For example, if a structure within the revised AOU-1 boundary has poor circulation and cracks in the foundation, it has the potential of having a VI pathway. The potential for infiltration can be increased if there is a negative pressure induced in the interior as is often seen during furnace exhaust operation during the heating season. Alternatively, adequate ventilation of structures and/or spaces may reduce the potential of having a complete VI pathway. For example, ventilation of crawl spaces and basements often results in significant reduction in the potential for intrusion into the living space above. However, Figure 7-5 shows that nearly all the structures with indoor air samples exceeding the PCE RBSL, including structure 0040-H, are near locations of shallow groundwater in the center of the ESS area.

7.7 Degradation Pathways

Under anaerobic conditions (i.e., oxygen limited, reducing environments) PCE and TCE can breakdown into their daughter products cis-1,2-DCE, and VC. TCE is also a daughter product of PCE, but it is also used independently and can enter the environment as a parent contaminant. The primary degradation pathway for these compounds is reductive dechlorination where PCE can degrade to TCE and TCE may further degrade into cis-1,2-DCE and VC. It eventually degrades to ethene, which can be converted to carbon dioxide or ethane when oxidized. Cis-1,2-DCE and VC can also be oxidized to carbon dioxide (Vogel and McCarty 1985).

Within the ESS area, the groundwater is very near the surface and aerobic breakdown of TCE may be occurring. The development of anaerobic conditions needed for dechlorination may not be present except perhaps in localized areas. However, the limited presence of cis-1,2-DCE and absence of VC indicate that dechlorination is not wide spread and not taking place at an appreciable rate.

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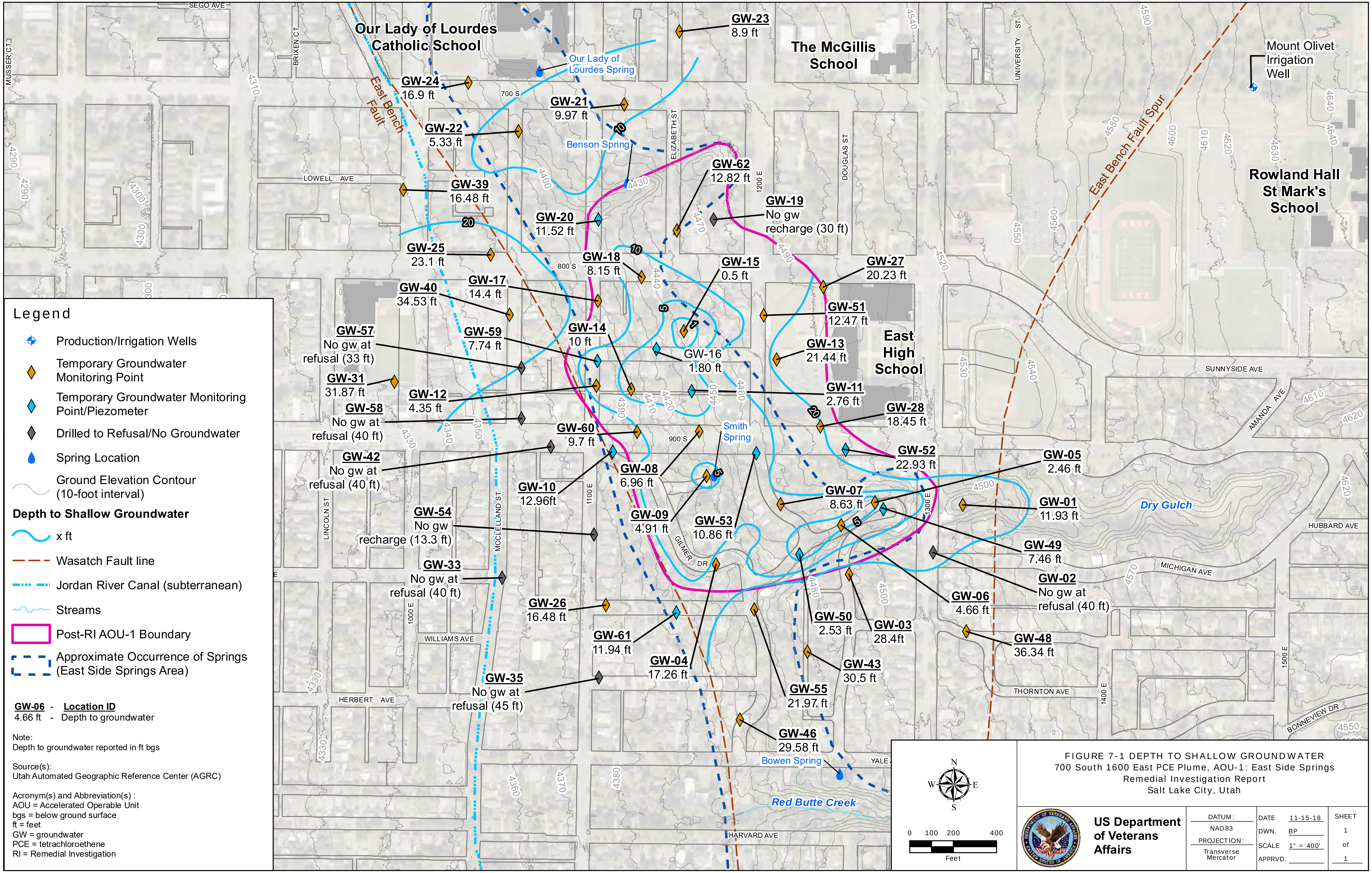


Legend

- ⌖ Production/Irrigation Wells
- ◆ Temporary Groundwater Monitoring Point
- ◆ Temporary Groundwater Monitoring Point/Piezometer
- ◆ Drilled to Refusal/No Groundwater
- 💧 Spring Location
- Ground Elevation Contour (10-foot interval)

Depth to Shallow Groundwater

- x ft
- Wasatch Fault line
- Jordan River Canal (subterranean)
- Streams
- Post-RI AOU-1 Boundary
- Approximate Occurrence of Springs (East Side Springs Area)

GW-06 - **Location ID**
4.66 ft - Depth to groundwater

Note:
Depth to groundwater reported in ft bgs

Source(s):
Utah Automated Geographic Reference Center (AGRC)

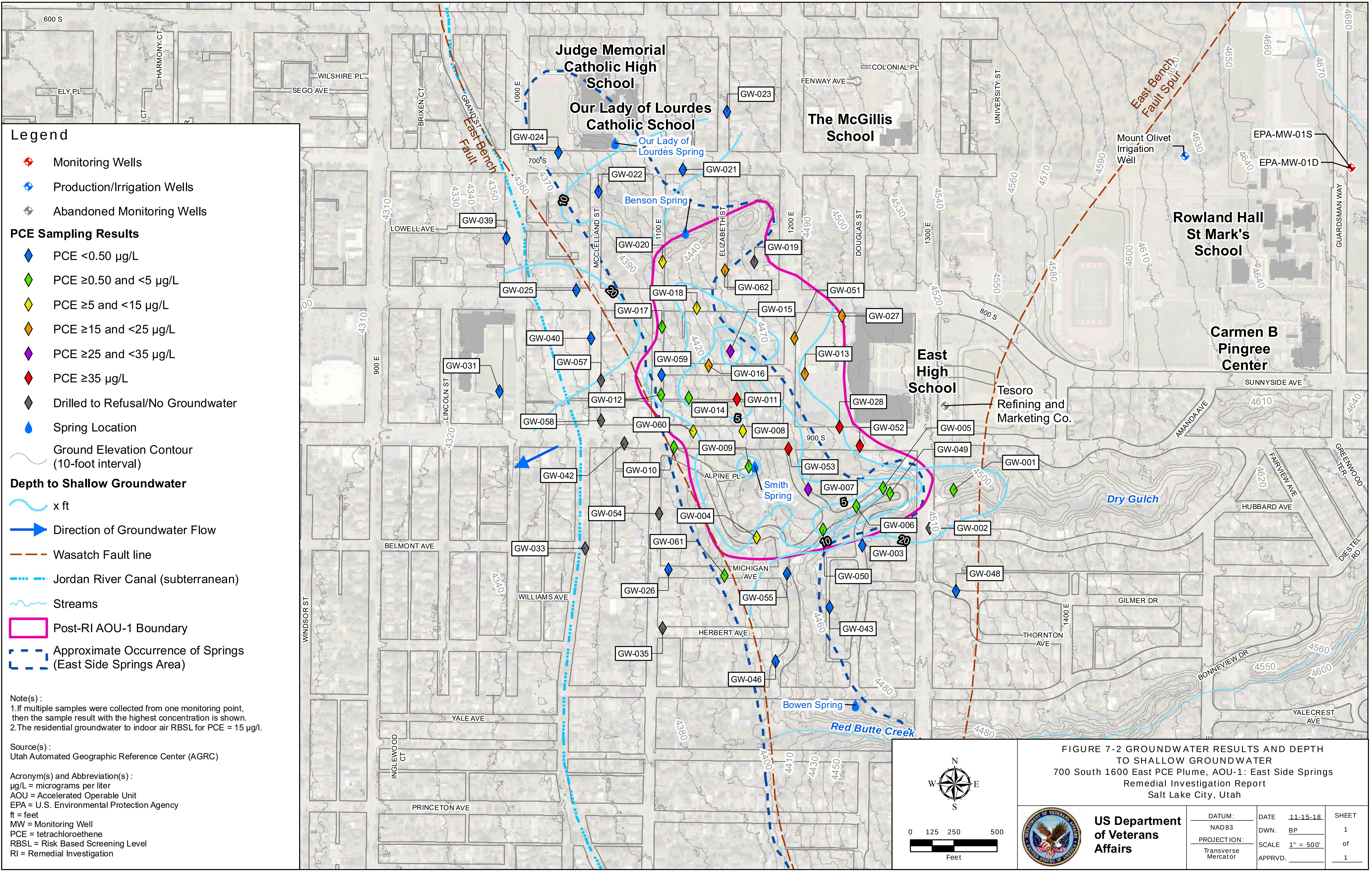
Acronym(s) and Abbreviation(s) :
AOU = Accelerated Operable Unit
bgs = below ground surface
ft = feet
GW = groundwater
PCE = tetrachloroethene
RI = Remedial Investigation

FIGURE 7-1 DEPTH TO SHALLOW GROUNDWATER
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE	11-15-18	SHEET 1
PROJECTION: Transverse Mercator	DWN.	BP	of
	SCALE	1" = 400'	1
	APPRVD.		

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 7-1 Surficial Soil Thickness Contours.mxd bpawling 11/15/2018



Legend

- Monitoring Wells
- Production/Irrigation Wells
- Abandoned Monitoring Wells

PCE Sampling Results

- PCE <0.50 µg/L
- PCE ≥0.50 and <5 µg/L
- PCE ≥5 and <15 µg/L
- PCE ≥15 and <25 µg/L
- PCE ≥25 and <35 µg/L
- PCE ≥35 µg/L
- Drilled to Refusal/No Groundwater
- Spring Location
- Ground Elevation Contour (10-foot interval)

Depth to Shallow Groundwater

- x ft
- Direction of Groundwater Flow
- Wasatch Fault line
- Jordan River Canal (subterranean)
- Streams
- Post-RI AOU-1 Boundary
- Approximate Occurrence of Springs (East Side Springs Area)

Note(s) :
1.If multiple samples were collected from one monitoring point, then the sample result with the highest concentration is shown.
2.The residential groundwater to indoor air RBSL for PCE = 15 µg/l.

Source(s) :
Utah Automated Geographic Reference Center (AGRC)

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
ft = feet
MW = Monitoring Well
PCE = tetrachloroethene
RBSL = Risk Based Screening Level
RI = Remedial Investigation

FIGURE 7-2 GROUNDWATER RESULTS AND DEPTH TO SHALLOW GROUNDWATER

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

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 11-15-18
DWN. BP
SCALE 1" = 500'
APPRVD.
SHEET 1 of 1

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 7-2 Groundwater Results and Depth to Shallow GW.mxd bpawling 11/15/2018 2:16:32 PM

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Legend

- ⌖ Monitoring Wells
- ⌖ Production/Irrigation Wells
- ⌖ Abandoned Monitoring Wells

Surface Water PCE Sampling Results

- ▲ PCE <0.50 µg/L
- ▲ PCE ≥0.5 and <5 µg/L
- ▲ PCE ≥5 and <15 µg/L
- ▲ PCE ≥15 and <25 µg/L
- ▲ PCE ≥25 and <35 µg/L
- ▲ PCE ≥35 µg/L

Stromwater PCE Sampling Results

- ▼ PCE <0.50 µg/L
- ▼ PCE ≥0.5 and <5 µg/L
- ▼ PCE ≥5 and <15 µg/L
- ▼ PCE ≥15 and <25 µg/L
- ▼ PCE ≥25 and <35 µg/L
- ▼ PCE ≥35 µg/L
- 💧 Spring Location
- — Stormwater line
- ∼ Ground Elevation Contour (10-foot interval)

Depth to Shallow Groundwater

- ∼ x ft
- – – Wasatch Fault line
- -··- Jordan River Canal (subterranean)
- ∼ local streams
- ☐ Post-RI AOU-1 Boundary
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)

Notes:
1. There were no surface water or stormwater results that exceeded the surface water-related SLs in Table 3-7.
2. The resident recreator surface water RBSL for PCE = 1,500 µg/L.

Source(s):
Utah Automated Geographic Reference Center (AGRC)
The ESS-SW identification nomenclature is for springs identified and sampled by the UDEQ (2012).

Acronym(s) and Abbreviation(s) :
µg/L = micrograms per liter
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
ft = feet
MW = Monitoring Well
PCE = tetrachloroethene
RBSL = Risk Based Screening Level
RI = Remedial Investigation
SL = Screening Level
UDEQ = Utah Department of Environmental Quality

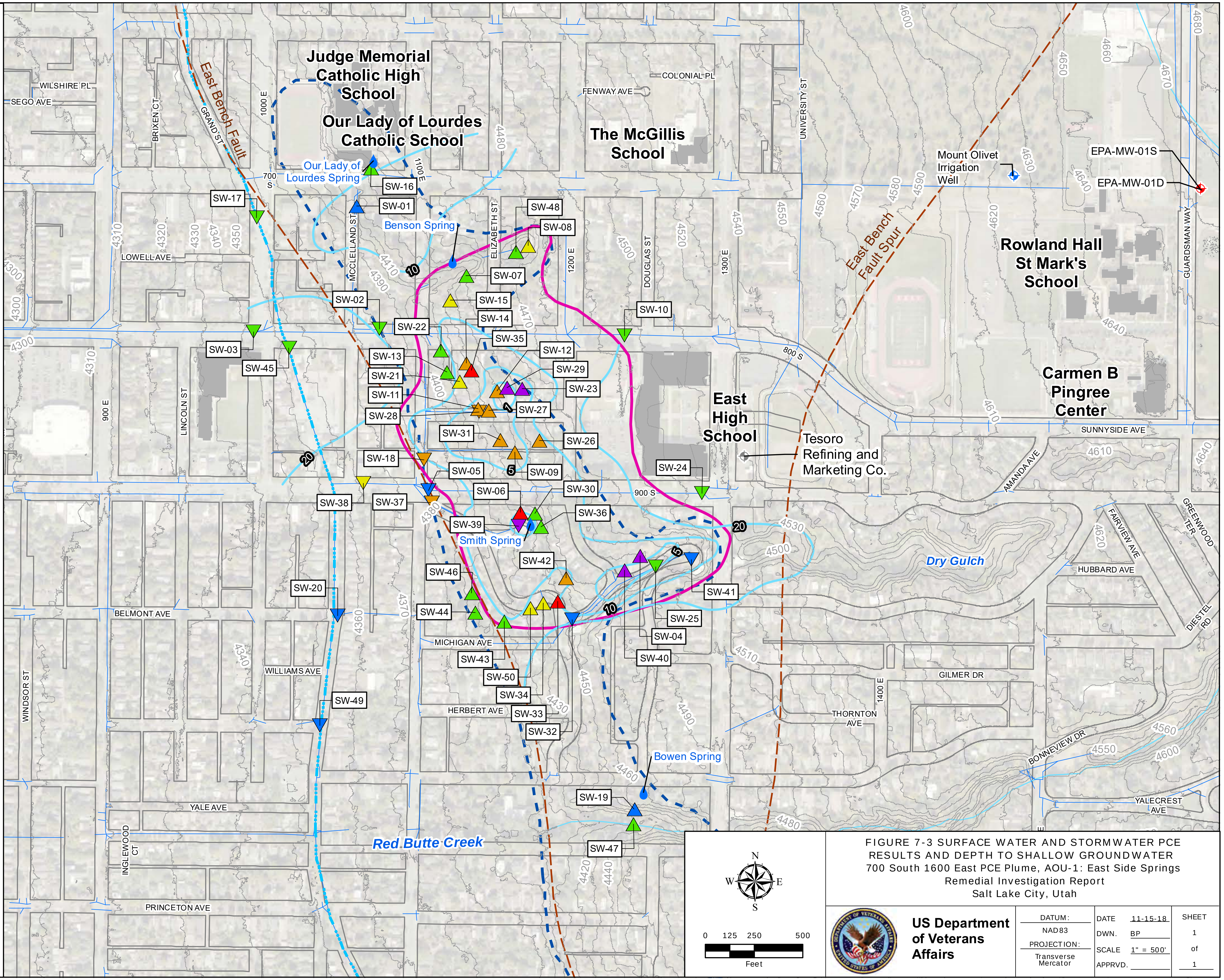

FIGURE 7-3 SURFACE WATER AND STORMWATER PCE
RESULTS AND DEPTH TO SHALLOW GROUNDWATER
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83	DATE	11-15-18	SHEET
PROJECTION: Transverse Mercator	DWN.	BP	1
	SCALE	1" = 500'	of
	APPRVD.		1

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 7-3 Surface Water and Storm Water Results with Depth to Groundwater Contours.mxd bpawling 11/15/2018 2:54:36 PM

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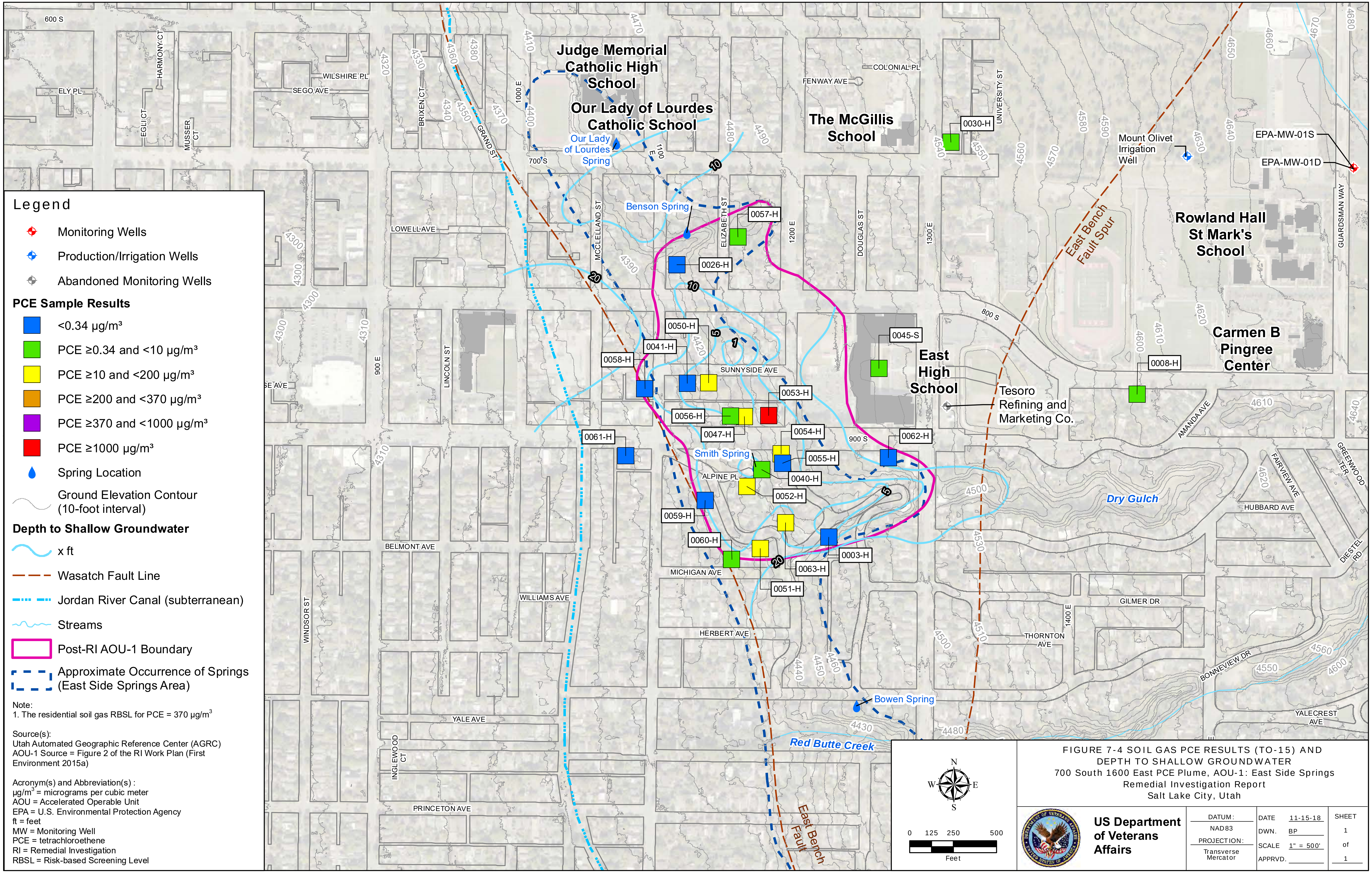

Legend

- Monitoring Wells
- Production/Irrigation Wells
- Abandoned Monitoring Wells

PCE Sample Results

- 🟦 <0.34 μg/m³
- 🟩 PCE ≥0.34 and <10 μg/m³
- 🟨 PCE ≥10 and <200 μg/m³
- 🟧 PCE ≥200 and <370 μg/m³
- 🟪 PCE ≥370 and <1000 μg/m³
- 🟥 PCE ≥1000 μg/m³
- Spring Location
- Ground Elevation Contour (10-foot interval)

Depth to Shallow Groundwater

- x ft
- Wasatch Fault Line
- Jordan River Canal (subterranean)
- Streams
- Post-RI AOU-1 Boundary
- Approximate Occurrence of Springs (East Side Springs Area)

Note:
1. The residential soil gas RBSL for PCE = 370 μg/m^3

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source = Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s) :
μg/m^3 = micrograms per cubic meter
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
ft = feet
MW = Monitoring Well
PCE = tetrachloroethene
RI = Remedial Investigation
RBSL = Risk-based Screening Level

FIGURE 7-4 SOIL GAS PCE RESULTS (TO-15) AND DEPTH TO SHALLOW GROUNDWATER

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

US Department of Veterans Affairs

DATUM: NAD83	DATE	11-15-18	SHEET
PROJECTION: Transverse Mercator	DWN.	BP	1
	SCALE	1" = 500'	of
	APPRVD.		1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 7-4 Soil Gas PCE Results (TO-15) and Depth to Shallow Groundwater.mxd bpawling 11/15/2018

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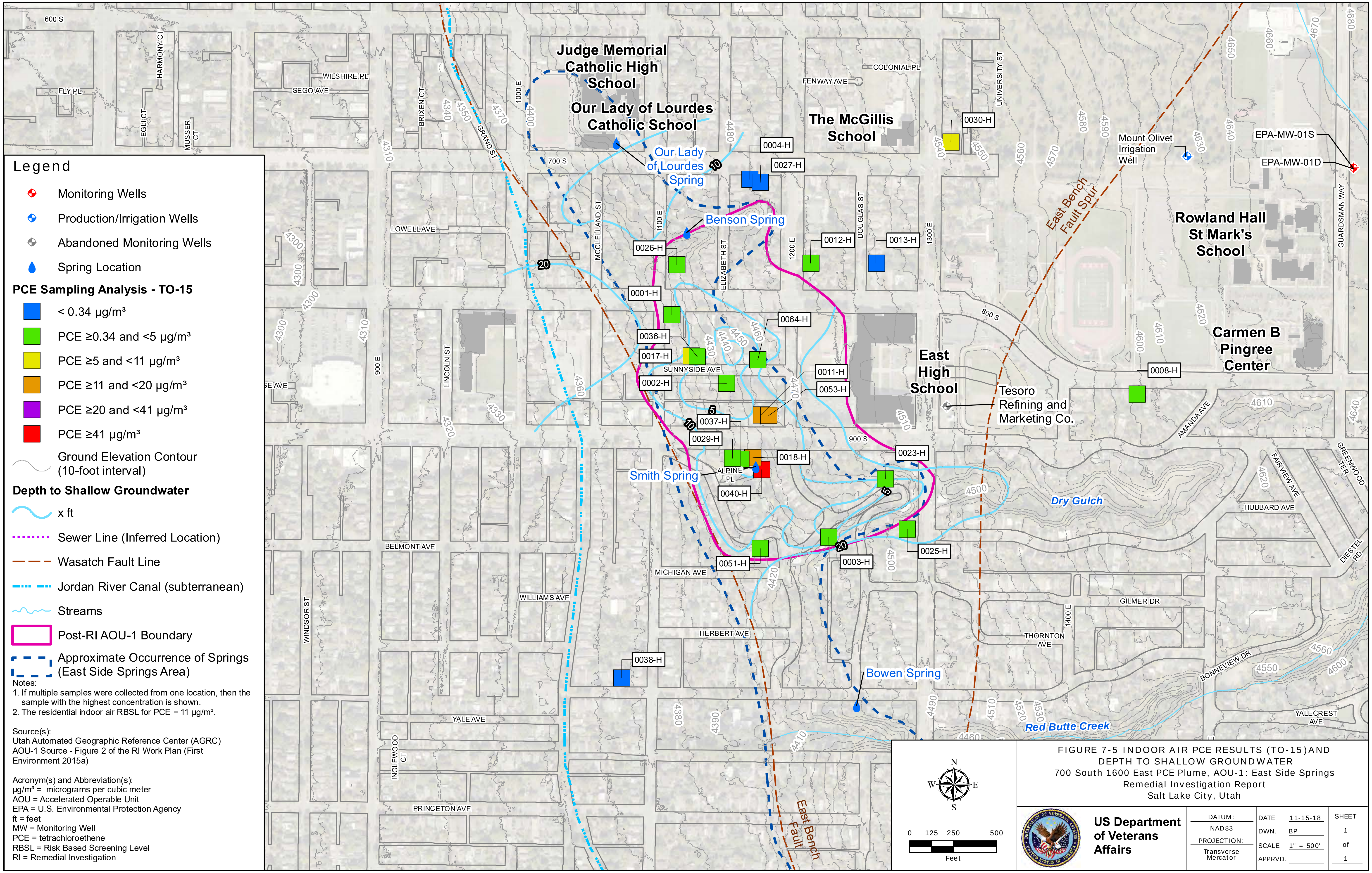

Legend

- ⯐ Monitoring Wells
- ⯐ Production/Irrigation Wells
- ⯐ Abandoned Monitoring Wells
- 💧 Spring Location

PCE Sampling Analysis - TO-15

- 🟦 < 0.34 µg/m³
- 🟩 PCE ≥0.34 and <5 µg/m³
- 🟨 PCE ≥5 and <11 µg/m³
- 🟧 PCE ≥11 and <20 µg/m³
- 🟪 PCE ≥20 and <41 µg/m³
- 🟥 PCE ≥41 µg/m³
- ∼ Ground Elevation Contour (10-foot interval)

Depth to Shallow Groundwater

- ∼ x ft
- ⋯ Sewer Line (Inferred Location)
- – – Wasatch Fault Line
- –·– Jordan River Canal (subterranean)
- ∼ Streams
- ▭ Post-RI AOU-1 Boundary
- ⬚ Approximate Occurrence of Springs (East Side Springs Area)

Notes:
1. If multiple samples were collected from one location, then the sample with the highest concentration is shown.
2. The residential indoor air RBSL for PCE = 11 µg/m³.

Source(s):
Utah Automated Geographic Reference Center (AGRC)
AOU-1 Source - Figure 2 of the RI Work Plan (First Environment 2015a)

Acronym(s) and Abbreviation(s):
µg/m³ = micrograms per cubic meter
AOU = Accelerated Operable Unit
EPA = U.S. Environmental Protection Agency
ft = feet
MW = Monitoring Well
PCE = tetrachloroethene
RBSL = Risk Based Screening Level
RI = Remedial Investigation

FIGURE 7-5 INDOOR AIR PCE RESULTS (TO-15) AND DEPTH TO SHALLOW GROUNDWATER
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NAD83
PROJECTION: Transverse Mercator
DATE 11-15-18
DWN. BP
SCALE 1" = 500'
APPRVD.
SHEET 1 of 1

File: Denver EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Fig 7-5 Indoor Air PCE Results (TO-15) and Depth to Shallow Groundwater.mxd bpawling 11/15/2018

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8.0 Updated Conceptual Site Model for Risk

Using the RI data obtained between 2015 and 2017, a more detailed CSM for the ESS area is described below. While the broader, regional conceptual site model that was presented in Section 4 has not changed, this section provides a synopsis of the hydrogeology and migration of PCOPCs in the groundwater, soil gas, and indoor air specifically within the ESS area.

8.1 Sources of Contamination

The possible source of groundwater containing PCE, TCE, and lower levels of cis-1,2-DCE is the same as described previously in this report: a former dry-cleaning facility and the associated sewer line from Building 7 of the VAMC (UDEQ 2000, UDEQ 2012), with other possible sources being former UANG vehicle maintenance facility, and/or the Former USFS helicopter pad, or other maintenance shops in the area. The OU-2 RI will investigate the source of contamination in detail.

As mentioned in Section 6.4.2, although TCE was not always co-located with PCE or other PCE degradation products (UDEQ 2012), TCE is generally present downgradient of areas with the highest PCE concentrations. Concentrations of PCE and TCE in groundwater within the larger OU-2 area are being investigated in additional detail during the OU-2 RI.

Within the ESS area, the AOU-1 RI data confirmed that this groundwater contamination is present near the surface (i.e., within 20 ft of the ground surface) and is a possible source of VI.

8.2 Local Geology, Hydrogeology, and Groundwater Quality

As described in the CSM in Section 4, the surficial geology is comprised of the unconsolidated Quaternary-era deposits that formed as alluvial fans by streams as deltas and other lacustrine features associated with the paleo-lake, Lake Bonneville. Borings that were logged during installation of temporary monitoring points and piezometers in the ESS area primarily encountered fine-grained sediments including clay, gravelly clay, and sandy clay with localized gravel and cobble (i.e., where direct push borings hit refusal before reaching groundwater). In locations where the highest concentrations of PCE were identified in groundwater (GW-07, GW-11, GW-28, GW-52, and GW-53), the soil consisted of fine sand underlain by clayey sand.

The gradient in the ESS area was identified as being southwest and the depth to shallow groundwater is 50 ft bgs or less, with groundwater daylighting in several springs in the area. The ESS area occurs where the topography is steep, with a slope of approximately 10 percent, as shown in Figure 4-3 and Figure 7-1.

The Wasatch Fault influences the hydraulic properties and flow of groundwater in the ESS area. Groundwater flow is generally perpendicular to the fault and the fault does not appear to act as a barrier to groundwater flow. The presence of PCE in springs and seeps downgradient of the fault suggests that the East Bench Fault Spur is not a flow barrier. Shallow groundwater PCE concentrations are highest to the east of the East Bench Fault. West of the East Bench Fault, groundwater was not encountered in several borings, and where it was encountered, PCE concentrations are much lower (less than 5 µg/L). On the east side of the East Bench Fault, PCE concentrations ranged up to 61 µg/L in GW-052. In addition, shallow groundwater PCE concentrations in the ESS area are higher than concentrations in deeper intervals (i.e., between 150-300 ft bgs) near the VAMC.

8.3 Soil Gas and Indoor Air Quality

The secondary sources of chlorinated solvent contamination are soil and vapor as soil gas. PCE was detected in soil gas above the RBSLs and typically correlates with locations where detections of PCE were also found in groundwater and indoor air. The presence of PCE and TCE in soil gas confirms that vapors are forming from the shallow contaminants in the groundwater and are migrating into some of the structures in the ESS area. The structures with indoor air samples exceeding the RBSLs, including structure 0040-H, are near locations of shallow groundwater in the center of the ESS area.

8.4 Surface Water Quality

While PCE was detected in several surface water and stormwater samples, concentrations were lower that the surface water RBSLs for the resident recreator (via ingestion or dermal contact).

8.5 Human Receptors and Potential Exposure Pathways

AOU-1 is located in a predominantly residential area along the Wasatch Fault Scarp where PCE has been 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 VI into homes and businesses. VOC-impacted groundwater is 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 VI pathways. Detections of PCE at or near the water table at concentrations greater than the RBSLs for residential VI screening level suggest that a potentially complete exposure pathway is present.

The ESS area is currently a developed urban area, with well-established residential neighborhoods (East Central and Yalecrest), a public high school, several small retail shops, churches, and daycare centers. East High School and its grounds form a significant portion of AOU-1, along with portions of the McGillis School and portions of Our Lady of Lourdes/Judge Memorial Catholic School. The few commercial operations in AOU-1 include an auto repair shop, convenience store/gasoline station, and coffee shop located near the intersections of 800 South and 900 South with 1300 East.

The public land area is accessible to residents and visitors due to the location in an urban setting with multiple publicly-owned parcels and roads. The residential areas where the ESS area discharge PCE- and TCE- containing water are also readily accessible to residents and visitors. The seeps and springs in the ESS area are located on residential, public, and private properties containing numerous homes, several public and private schools, a long-term residential care facility, a convenience store, a large public park, and several churches.

Salt Lake City's Master Plan (Salt Lake City 2005) shows that future land use at AOU-1 is consistent with current land use. Future land use in an urban, mostly developed area is difficult to project, but AOU-1 is likely to remain under similar use conditions for some decades due to the well-established, stable neighborhoods, public and private schools, and the abundant public parklands. A review of Salt Lake City Property Tax maps indicates current land use within AOU-1 is approximately 75 percent residential, 5 percent commercial, 10 percent public or private schools, and the reminder public-owned rights of way or parkland. Consistent with the concept of an accelerated operable unit, the CSM focuses on potential current, plausible exposure pathways between known contaminated media and actual receptors.

Groundwater is used to supplement surface water, which is the main drinking water source in Salt Lake City. There are 27 wells and one groundwater spring operated by eight water systems located within a four-mile radius of AOU-1. These sources serve a total population of 108,525 persons in the Salt Lake Valley, but the wells only operate intermittently during dry summer and early fall peak water usage periods. The nearest active well is the University of Utah irrigation well located approximately 0.6 miles to the northwest of the suspected source area at the VAMC. Based on the likely hydraulic gradient to the west-southwest, the Plume would be migrating toward two downgradient artesian wells; the SLC-Eighth South Well and the Liberty Park drinking water fountain, both located approximately 0.9 miles from the currently known boundary of the Site within AOU-1.

Mount Olivet Cemetery operates irrigation well during dry seasons to fill a storage pond with water for lawn irrigation. This well is located northeast of the ESS are, west of the VAMC. The potential also exists for residents in the neighborhoods included within AOU-1 to utilize shallow dug wells for irrigation.

No surface drinking water sources exist within the 15-mile downstream target distance limit of the Site (UDEQ 2011). The nearest surface water body to the Site is the Red Butte Creek, which flows across the VAMC almost at the expected plume boundary. The creek then flows southwesterly and continues to approximately 1,500 ft south of the AOU-1 area at the downgradient end of the plume. Red Butte Creek is believed to flow in a stream bed well above the aquifer containing the Site and may act as a recharge source to the aquifer rather than a receptor at the VAMC; however, the lower reaches of Red Butte Creek, west of AOU-1, may be hydraulically connected to the shallow unconfined aquifer and could potentially be a receptor. Red Butte Creek flows towards Liberty Park Pond where it is joined by Parley's Creek, before continuing to the Jordan River with the confluence located approximately 3.5 miles west of the Site (USGS 1975). Red Butte Creek is not considered a fishery stream, although some trout have been observed, and the stream is readily accessible at several public parks for wading.

The Jordan River below the Red Butte confluence is protected for secondary contact recreational use (i.e., boating and wading), warm water species of game fish, including organisms necessary for their food chain, and agricultural usage. Closer to the Great Salt Lake, the Jordan River is additionally protected for waterfowl, shore birds, and other water-oriented wildlife (UDEQ 2011).

In addition to streams, Salt Lake City sampled and monitored 25 springs/seeps along the Wasatch Fault line in the ESS area (UDEQ 2011). Some of these springs/seeps appear to have been artificially contained by small basins and are believed to be used for irrigation. The spring water is not believed to be used as a drinking water source, and no visual evidence exists that the seeps/springs support any population of ecological receptors or sensitive environments. Several property owners have reportedly constructed channels and dams to create small spring-fed ponds and water fountains on their property.

8.6 Ecological Receptors and Potential Exposure Pathways

The AOU-1 project area contains low quality habitat for native plants and wildlife, primarily due to the extent of urban and suburban development. The habitat is generally non-contiguous 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. 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). Representative endpoint species that may be found in the available habitats of AOU-1 were selected for evaluation in the ecological risk assessment (Appendix G). Ecological risk assessments do not typically evaluate potential risks to domesticated species. However, given that the site is predominantly urban/residential, domesticated dogs were included in this SLERA in response to stakeholder concerns. Representative species include the following:

- Aquatic organisms – aquatic plants, invertebrates, fish, amphibians
- Plants – wetland and upland plans
- Birds – American robin (*Turdus migratorius)*
- Small mammals – Deer mouse (*Peromyscus maniculatus*)
- Domestic pets – dogs (*Canus lupus familiaris*)
    - Small breed (pomeranian)
    - Medium breed (labrador retriever)
    - Large breed (great dane)

8.7 Uncertainties

Source(s) of the release of PCE and TCE into the groundwater northeast of the East Side Springs area have not been definitively identified and will be addressed under the OU-2 investigation. There is not a complete understanding of the hydrogeology upgradient and within AOU-1 and the influence of pumping stresses that may be mixing the upper unconfined aquifer and lower confined aquifer. While concentrations of PCOPCs decrease moving from east to west across the East Bench Fault, groundwater could not be assessed immediately west of the East Bench Fault downgradient of SW-06 (e.g., in the area of GW-054). SW-06 is actually a subsurface feature (shallow well) more representative of shallow groundwater than a surface spring.

Construction of structures, i.e., whether a structure is competent with no cracks, French drains, or other preferential pathways for migration of soil gas or shallow groundwater/surface water has a significant influence on indoor air concentrations. While the RI can indicate areas where VI is not likely based on multiple lines of evidence (i.e., groundwater concentrations, depth to groundwater, soil gas concentrations), in those areas where VI is possible, it is unknown whether indoor air concentrations of PCOPCs exceed the RBSLs unless the indoor air at that residence is sampled.

It is unknown whether the plume within the ESS is increasing in PCOPC concentrations, stable, or decreasing. Increasing concentration trends would result in a potentially larger area of possible VI and/or higher indoor air concentrations than observed during the RI.

9.0 Summary of Risk Assessments

9.1 Human Health Risk Assessment

A HHRA has been prepared to assess potential long-term exposure to chemicals in indoor air, soil gas, groundwater, soil, and surface water under current and reasonably anticipated future land use conditions at AOU-1. The HHRA will be used to support the RI and site management decisions regarding PCE-contaminated groundwater and surface water/seeps located in the southwestern, downgradient portion of the PCE plume. Based on data and evaluations conducted during the recent RI, the extent of PCE-contaminated shallow groundwater, seeps, and springs extends southwest beyond 1100 East. The HHRA was designed to provide VA, EPA, and UDEQ risk managers and other stakeholders with useful information on which to base site management decisions.

Although the scope of this HHRA is primarily to assess the VI pathway within AOU-1 to address chronic (i.e., long-term) exposure to potential receptors, other exposure pathways were also assessed, including incidental exposure to surface water located in residential backyards and exposure to soil and homegrown produce impacted by contaminated surface water. In addition, the potential need for time-critical removal actions (e.g., interim mitigation) to mitigate VI was addressed as part of the RI activities (FE 2015). The collection and analysis of indoor air samples from structures within AOU-1 to address the need for time-critical removal actions is detailed in other documents (FE 2015; EA 2015; EA 2016a,c; EA 2017c). The indoor air sampling results and other information were evaluated to determine if VI was occurring and concentrations of PCE and its degradation products related to VI were greater than the established action levels and whether an interim removal action was required. As a result of these investigations, interim action is being conducted at one location – 0040-H. VA is conducting a removal action at 0040-H in accordance with CERCLA guidance, the FFA Section XVIII Removal and Emergency Actions, and Executive Order 12580 in coordination with EPA and UDEQ. Because of the need for these actions, 0040-H is being addressed separately, and a future final remedy for 0040-H (if required) will be developed as part of OU-2 (Section 2.2).

The HHRA addresses PCOPCs found in groundwater, soil vapor, surface water, soil, and indoor air at AOU-1. The HHRA was prepared using methods that were laid out in the Risk Assessment Work Plan (Appendix E of the RI Work Plan [FE 2015]). The HHRA process, which included the steps summarized in the following sections, is consistent with guidance developed by the EPA (EPA 1989; EPA 2004b; EPA 2009; EPA 2015c; EPA 2017a,b; EPA 2018).

9.1.1 Data Evaluation and Identification of COPCs

The data evaluation process identified chemical analysis results and other information available and appropriate for use in 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.

The analytical data used in this risk assessment, referred to hereafter as the HHRA data set, include indoor air, soil gas, groundwater, soil, and surface water data collected during site investigations conducted from 2015 to 2017. These data were determined to be of sufficient quality to meet the objectives of the HHRA (Section 6.2 and Section F2.2 of Appendix F). As explained in Section 6.2, some of the 2015 data was not usable and this was not included in the HHRA data set. Indoor air samples used in the HHRA were collected during baseline conditions (i.e., the building was not pressurized or depressurized during the time the sample was collected). Additional information related to the VI (indoor air and soil gas) data, including pressure control testing performed to assess VI potential, are presented in the 2016 and 2017 VI Investigation Field Data Reports (EA 2016h; Appendix H-4).

Indoor air and soil gas samples were collected and analyzed on site using the HAPSITE® portable gas chromatograph/mass spectrometer (GC/MS). Where HAPSITE® results indicated possible VI, additional samples were collected using passivated stainless-steel canisters (SUMMA® canisters) and analyzed by an off-site laboratory using EPA Method TO-15. HAPSITE® samples were generally collected over a 10-minute sample duration, while canister samples were collected for a 24-hour duration. The purpose of the HAPSITE® analyses was primarily to identify those locations where indoor air concentrations of PCE, TCE, or cis 1,2-DCE exceeded residential indoor RBSLs and did not appear to be attributable to a background source, so that those locations could be targeted for additional sampling (i.e., canister sampling) and EPA Method TO-15 analysis. For the purpose of this HHRA, the HAPSITE® sampling results are considered for use as part of the risk-based screening (i.e., do concentrations exceed the indoor air RBSL based on a target cancer risk level of 1 x 10^{-6} or a target non-cancer hazard quotient of 1).

The data reduction steps performed during the preparation of the HHRA dataset are described in Section F2.4 of Appendix F. A summary of the available samples included in the HHRA data set are presented in Table F-1 of Appendix F. Summary statistics of the samples results are presented in Tables F-2, F-3, and F-4 of Appendix F.

COPCs are chemicals that are related to the site release and typically exceed one or more RBSLs and are therefore carried through the quantitative HHRA process. A description of the RBSLs in the identification of COPCs is presented in Section 2.6 of Appendix F. The results of the quantitative HHRA are used to identify and prioritize those COPCs which are estimated to pose risk at levels that may warrant actions to manage risk, and which are then referred to as contaminants of concern (COCs). Six PCOPCs were identified in the Risk Assessment Work Plan (Appendix E of the RI Work Plan [FE 2015]): PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, VC, and 1,4-dioxane. Trans-1,2-DCE was originally included as a PCOPC in the Risk Assessment Work Plan; however, it was eliminated during development of the QAPP update (EA 2016a). PCE may have been associated with historic dry-cleaning operations at the VAMC. TCE, cis-1,2-DCE, and VC are degradation products of PCE but can also be from other sources. 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 PCOPC (EA 2016a).

Other analytes included in the site analytical dataset were 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). With the exception of cis-1,2-DCE, each of these PCOPCs was detected at least once in concentrations that exceeded risk-based screening levels for VI (e.g., in groundwater, soil gas, or indoor air) and was retained as a COPC for the quantitative risk assessment. Additional information related to the COPC identification is provided in Section F2.6 of Appendix F.

9.1.2 Exposure Assessment

A pathway between the contaminated media (i.e., impacted by the COPCs in high enough concentration to result in risk) and a human receptor must be complete for a risk to human health to exist. When potentially complete exposure pathways are identified, 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 describes the exposure setting including human receptors, potentially complete exposure pathways and their significance, and a description of the methods for quantifying lifetime exposures.

The exposure assessment is used to identify and assess the means by which potential receptors under current land use conditions and reasonably anticipated potential land uses, could come into contact with COPCs present in media of concern (indoor air, soil gas, groundwater, soil and surface water). The exposure assessment also identifies the receptors that might be exposed, the routes by which these individuals might become exposed, and the magnitude, frequency, and duration of potential exposures.

The exposure assessment step of the HHRA includes the following tasks:

- Development of a conceptual site exposure model (CSEM)
- Calculation of exposure point concentrations (EPCs) for each medium of concern
- Compilation of exposure assumptions for potentially complete exposure pathways
- Calculation of chemical exposure estimates for COPCs.

9.1.2.1 Development of a Conceptual Site Exposure Model

The updated CSM is presented in Section 8. The CSEM addresses the conceptual aspects related to the human exposure pathways. The CSEM provides a graphical depiction of the current understanding of the sources of contamination, physical setting, land use, and the potentially complete human exposure pathways. Information generated during previous site investigations has been incorporated into this CSEM to identify potential exposure pathways. A CSEM was created according to standard-of-practice risk assessment guidance (EPA 1989) with the use of professional judgment and information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with AOU-1.

An exposure pathway can be described as the physical course a chemical migrates from the point of release to a receptor. Chemical intake or route of exposure is the means by which a chemical enters a receptor. For an exposure pathway to be complete, all of the following components must be present:

- Source (i.e., contaminated groundwater at AOU-1)

- Mechanism of chemical release and transport (i.e., groundwater flow, volatilization, vapor migration)

- Environmental transport media (i.e., groundwater, vapors, soil particulates)

- Exposure point (i.e., a point of potential human contact with a contaminated medium)

- Exposure route (i.e., a route for chemical intake by a receptor - ingestion, inhalation, and dermal contact - at the exposure point)

- Receptor or exposed population (i.e., receptors in contact with contaminated media).

In the absence of any one of these components, an exposure pathway is considered incomplete and, by definition, there is no adverse health risk or hazard. Figure 9-1 is a 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.

The exposure assessment addresses residential and commercial, current and future use of the site. These scenarios best reflect actual current, and expected future, receptors at the site, which are (1) residential, and (2) commercial, church and school workers. Evaluation of the commercial scenario provides an upper bound on risks for other non-residential populations, such as school students, because these other populations will have shorter exposure frequencies and durations relative to full-time, year-round workers. Exposure pathways are discussed below.

Groundwater, Soil Gas, and Indoor Air

The CSEM identifies AOU-1 shallow, VOC-impacted groundwater as the primary contaminated media from which subsequent impacted media are derived. COPCs present at the water table in groundwater (Table F-2 of Appendix F) may volatilize into soil gas where it may enter occupied structures through VI pathways. Known detections of PCE at or near the water table at concentrations in exceedance of the EPA residential VI SL for PCE (EPA 2017b) suggest that further assessment of VI as a potentially complete exposure pathway is warranted. Currently, residents (adult and children) and commercial, school, and church workers and students (estimated exposures based on workers) may contact COPCs that migrate from groundwater-to-soil gas-to-indoor air.

Surface Water

Potential exposure to COPCs in surface water was evaluated in the Risk Assessment Work Plan (Appendix E of the RI Work Plan [FE 2015]). Seeps and springs are present within AOU-1 ESS area (Figure 1-2) and samples collected from these surface water features had detectable concentrations of PCE (see Section 6.6). 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. People (adult and child residents and workers) 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. Site-specific SLs were calculated to assess this exposure pathway (Section 6.3). The COPCs surface water concentration at AOU-1 (Table F-3 of Appendix F) are far below the site-specific SLs and thus, the surface-water direct-contact pathway is considered potentially complete but insignificant and is not evaluated further in the HHRA.

Soil

Potential exposure to COPCs in soil was evaluated in the Risk Assessment Work Plan (Appendix E of the RI Work Plan [FE 2015]). VOCs in seeps and springs could partition to organic matter in soil, which residents (adults and children) 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 using a linear soil-water partitioning coefficient (Kd) (EPA 2018). These estimated soil concentrations were then compared to the residential soil EPA regional screening levels (RSLs) (EPA 2017a) and shown to be orders of magnitude below the RSLs (Table F-4 of Appendix F). In accordance with the RI Work Plan, three soil samples were collected within AOU-1: one sample in an area where PCE was not detected in the associated shallow groundwater sample, and two samples near springs where shallow groundwater samples exhibited elevated PCE concentrations. The results of the sample collected outside of the PCE-impacted area were non-detect and not included in the risk evaluation. The results of the two soil samples adjacent to springs with PCE detections were less than the residential RSLs (Table F-4 of Appendix F). Only PCE was detected (0.022 mg/kg) at less than the residential RSL of 24 mg/kg. Thus, the soil-to-surface-water exposure pathway is considered potentially complete but insignificant and is not evaluated further in the HHRA.

Homegrown Produce

Potential exposure to COPCs in homegrown produce was evaluated in the Risk Assessment Work Plan (Appendix E of the RI Work Plan [FE 2015]). 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. Findings of researchers at Utah Study (Doucette et al. 2007) suggested that, based on the levels of PCE detected in soil or the levels in soil impacted by surface water (calculated based on the approach discussed in the previous section), detectable fruit and vegetable uptake of PCE and its chlorinated-ethane daughter products is unlikely at AOU-1. In addition, modeling of potential plant uptake and dietary exposure (Appendix E of the RI Work Plan [FE 2015]) indicated that the homegrown produce pathway is considered potentially complete but insignificant and is not evaluated further in the HHRA. As shown in Table F-3 of Appendix F, the COPC surface water concentrations at AOU-1 are far below the modeled site-specific SLs.

9.1.2.2 Calculation of 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 usable VOC analytical results from groundwater, soil gas, and indoor air samples collected during the RI will be the basis of the EPCs. Insufficient number of samples are available in proximity to a home (groundwater, soil gas) or within a home (indoor air) to calculate central tendency concentrations such as the mean or upper confidence limit on the mean to represent the EPC. Therefore, the concentration from each sample are considered the EPCs of this HHRA. This was done in order to estimate risks on a sample-by-sample basis. This will provide risk managers with a sense of the range of potential exposures and associated risks. EPCs are presented in Attachment 2 of Appendix F.

9.1.2.3 Estimating Chemical Exposure for COPCs

The estimates of exposure were 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. 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.

Estimates of RME exposure were calculated using methods described in the EPA Risk Assessment Guidance for Superfund (RAGS) series of guidance—in particular, RAGS Part A (General) (EPA 1989) and Part F (Inhalation) (EPA 2009) and are provided in the Attachment 3 of Appendix F. For the VI exposure pathway (i.e., exposure through the inhalation exposure route), a lifetime averaged exposure concentration will be estimated from exposure models that combine various exposure factors related to behavior, such as exposure time, frequency, duration, and an exposure averaging time. Separate exposure equations for the adult (industrial/school worker) and age-weighted (residential) scenarios.

Residential exposures are age weighted (assuming 6 years as a child and 20 years as an adult) for a total exposure duration of 26 years (EPA 2014d). Residential exposure assumes 350 days per year to account for time spent away from home (e.g., vacations). Worker exposures assume 250 days per year and a total exposure duration of 25 years (EPA 2014d).

9.1.3 Toxicity Assessment

Toxicity values are identified during the toxicity assessment and are used to quantitatively represent the relationship between the magnitude of exposure to a chemical and the likelihood of adverse health effects on potentially exposed populations (EPA 1989). The toxicity values 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. For the human health toxicity assessment, toxicity effects are 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. The toxicity values used in the HHRA and additional information related to the toxicity assessment are provided in the Section F4 of Appendix F.

9.1.4 Risk Characterization

This section summarizes the results of a quantitative risk characterization for the COPCs in groundwater, soil gas and indoor air samples. In this risk characterization step, quantification of risk is accomplished by combining the results of the exposure assessment (estimated chemical intakes) with the results of the dose-response assessment (toxicity values established in the toxicity assessment) to provide numerical estimates of potential health effects. The quantification approach differs for potential cancer (carcinogenic) effects and non-cancer (non-carcinogenic) effects.

For carcinogens, the excess lifetime cancer risk (ELCR) estimate 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). 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 were addressed in the uncertainty discussion (Section F6 of Appendix F).

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 a reference concentration (RfC) developed for a similar exposure period. This comparison will take the form of a ratio termed the hazard quotient (HQ), which will be calculated by dividing the lifetime average concentration by the RfC. The HQ for multiple chemicals were summed to calculate a hazard index (HI). However, in the case where the HI is greater than 1, the HI is calculated for chemicals with non-cancer toxicity that effects the same target organ or system with the body (for example, liver damage).

The National Oil and Hazardous Substance Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300) establishes acceptable risk criteria for carcinogens and for “systemic toxicants” (i.e., chemical exhibiting non-cancer effects). The calculated risk results are presented in the context of the acceptable levels described in the NCP (40 CFR Section 300):

- For chemicals with cancer-causing properties, ELCR estimates are compared with the risk-management range of 1 x 10^{-6} to 1 x 10^{-4} (1 excess cancer case over a lifetime per a population of 1 million to 1 per a population of 10,000), as opposed to a single value. ELCR values less than this range indicate no further action is required while values greater than this range usually indicate the need for further action. ELCR values within this range could warrant a risk management decision that includes evaluating site-specific characteristics and exposure scenario factors to assess whether further action (e.g., remediation or mitigation) is warranted (EPA 1991b).

- For non-cancer effects estimated using the exposure and toxicity evaluation methods described previously, the acceptable exposure level would result in an HI less than one. HI values greater than one indicate that there is some potential for adverse non-cancer health effects associated with exposure to the COC (EPA 1991b) and generally warrant consideration of remedial action. The HI estimates evaluated are for the chemicals that target the same system or organ in the human body (i.e., systemic effects).

EPA uses the 1 x 10^{-6} to 1 x 10^{-4} cancer risk range as a “target range” within which the EPA strives to manage risks as part of a Superfund cleanup (EPA 1991b). In practice, if cumulative ELCRs are between 1 x 10^{-6} to 1 x 10^{-4}, risk managers will weigh site-specific information in determining the need for future action, including exposure-related factors (such as exposure pathways and exposure to sensitive persons), technical factors (such as detection limits and background levels), and uncertainty factors (e.g., representativeness and reliability of sampling data, weight of scientific evidence regarding chronic health effects).

Although this HHRA produces numerical estimates of risk, these numbers might not predict actual health outcomes because they are derived primarily from hypothetical assumptions. Their purpose is to provide a frame of reference for risk management decision-making. Any actual risks are likely to be lower than these estimates and could even be zero. Interpretation of the risk estimates provided should consider the nature and weight of evidence supporting these estimates and the magnitude of uncertainty surrounding them.

The risk characterization results are summarized by exposure media and receptor below and in Table 9-1.

9.1.4.1 Residential Indoor Air Exposure Scenario

The indoor sampling results collected in 2016 and 2017 using the HAPSITE® were used to evaluate the need for future sampling to assess potential VI risk for current residential receptors (Appendix E of the RI Work Plan [FE 2015]). Only a limited number of indoor air HAPSITE® results were greater than the indoor air RSL: samples from locations 0053-H and 0054-H. Either PCE or TCE exceeded their respective RSL in indoor air HAPSITE® results collected at 0053-H and 0054-H. EPA Method TO-15 indoor air samples were not collected at location 0054-H as the HAPSITE® and pressure control data suggested that indoor air TCE concentrations resulted from an interior background source(s) or residual TCE from historical activities in the shop (EA 2016c). A canister (EPA Method TO-15) sample was collected from location 0053-H, because the HAPSITE® samples exceeded the residential indoor air RSL (EA 2016c).

The EPA Method TO-15 indoor air sampling results (EA 2016c; Appendix H-4) were used to assess the potential VI risk for current residential receptors. None of the indoor air ELCR estimates exceeded the upper end of the risk management range (1 x 10^{-4}). And the HI estimates range from 0.002 to 0.4 based on the EPA Method TO-15 analytical results. Indoor air ELCR estimates ranged from 1 x 10^{-7} to 4 x 10^{-6} based on the EPA Method TO-15 analytical results. The cumulative ELCR estimates at locations 0003-H, 0017-H, 0018-H and 0025-H slightly exceeded 1 x 10^{-6}.

Although no indoor air RBSLs were exceeded in canister samples collected at location 0017-H (based on EPA Method TO-15 sample results), the cumulative ELCR estimate (2 x 10^{-6}) is just above the lower end of the risk management range. Both PCE and TCE slightly exceeded the indoor air RBSLs samples collected at location 0018-H (EPA Method TO-15 samples) resulting in a cumulative ELCR estimate of 3 x 10^{-6}.

The characterization of potential VI risk was taken one step further as the analytical results and risk estimates for individual structures were further evaluated with regard to potential contribution from a background source. At locations 0003-H and 0025-H, there are lines of evidence available that indicate background sources, not a subsurface (i.e., VI) source, has impacted COPC concentrations in indoor air. In cases where the weight of evidence supports the conclusion that a background source was present, those risk assessment results for those locations were qualified. The range of ELCR estimates, with the locations with potential background sources noted above excluded, range from 1 x 10^{-7} to 3 x 10^{-6} and the HI estimates range 0.002 to 0.4.

9.1.4.2 Commercial/School Worker Indoor Air Exposure Scenario

The indoor sampling results were used to assess the potential VI risk for current commercial/industrial receptors. Indoor air samples were collected using the HAPSITE® in one building with a current occupational (commercial/school worker) exposure scenario - East High School (0045-S). Samples from location 0045-S, a location involving non-residential land use scenario, exceeded the residential indoor air RBSLs but not the worker scenario indoor air RBSLs. The chemical storage area of the East High School was identified as a potential background source. EPA Method TO-15 indoor air samples were not collected at 0045-S as the HAPSITE® and pressure control data suggested that indoor air TCE concentrations resulted from an interior background source(s) or residual TCE from historical activities in the shop (Appendix H-4).

9.1.4.3 Future Exposure Scenarios

A summary of the risk estimates for future residential and commercial/school worker exposure scenarios related to VI are presented in the following subsections. These may estimate potential risk to current receptors as well, in those locations that could not be accessed for indoor air sampling. The groundwater-to-indoor-air risk estimates and the soil-gas-to-indoor-air risk estimates are calculated using the same approach to estimate indoor air risks; however, a generic (i.e., conservative) AF is also applied to account for the attenuation (i.e., reduction in concentrations) of the VOCs in soil gas during migration in the soil zone and into a building. The groundwater-to-indoor air AF of 0.001 and the soil-gas-to-indoor air AF of 0.03 that were used are based on empirical data compiled and analyzed by USEPA (EPA 2012b; EPA 2015c). Based on the lack of significant indoor air concentrations measured in the buildings within AOU-1, as discussed above, the use of generic AFs likely results in an overestimation of ELCR and non-cancer hazard.

Groundwater-to-Indoor Air – Residential Exposure Scenario

The groundwater concentrations from samples collected in 2016 during AOU-1 investigation activities were used to assess the potential VI (groundwater-to-indoor-air) risk for residential receptors under a future exposure scenario. None of the samples collected from the AOU-1 monitoring wells exceed an ELCR of 1 x 10^{-4} (Table F-9 of Appendix F). Groundwater-to-indoor-air risk estimates for future residential receptors range from 9 x 10^{-9} to 6 x 10^{-6} with several locations exceeding an ELCR of 1 x 10^{-6}. None of the samples collected from the AOU-1 monitoring wells exceed a target-organ-specific HI of 1. The locations with an ELCR greater than 1 x 10^{-6} include locations with a total ELCR of 2 x 10^{-6} in GW-007, GW-009, GW-013, GW-027, GW-051 due to PCE and in GW-014 and GW-018 due to TCE. PCE is the primary risk driver in GW-053, GW-011, GW-028, GW-052, and GW-053 with cumulative ELCR estimates of 3 x 10^{-6}, while TCE is the primary risk driver in GW-050 (5 x 10^{-6}) and GW-059 (6 x 10^{-6}).

The groundwater concentrations in these wells represent a potential for VI concerns for future receptors. However, based on the available actual indoor air concentrations, which, as discussed previously, result in risk estimates within the risk management range, the groundwater concentrations do not likely represent a concern for future receptors assuming stable or decreasing PCE and TCE plume concentrations.

Soil Gas-to-Indoor Air – Residential Exposure Scenario

The soil gas sampling results were used to assess the potential VI (soil gas-to-indoor-air) risk for future residential receptors. None of the samples collected from the AOU-1 soil gas exceed an ELCR of 1 x 10^{-4}; none of the samples collected from the AOU-1 soil gas exceed a target-organ-specific HI of 1. ELCR estimates ranged from 8 x 10^{-9} to 7 x 10^{-6} based on the EPA Method TO-15 analytical results and 4 x 10^{-9} to 2 x 10^{-6} based on the HAPSITE® measurements. Only location 0053-H results exceeded an ELCR of 1 x 10^{-6} (Table F-10 of Appendix F). The soil gas concentrations at 0053-H represent a potential for VI concerns for future receptors (ELCR = 2 x 10^{-6} to 7 x 10^{-6}). However, based on the available indoor air concentrations, which, as discussed below, result in risk estimates below the risk management threshold, the soil gas concentrations do not likely represent a concern for future receptors. None of the indoor air concentrations at 0053-H result in ELCR estimates greater than 1 x 10^{-6} or target-organ-specific HI > 1 (see Section 9.1.4.1).

Groundwater-to-Indoor Air – Commercial/School Worker Exposure Scenario

The groundwater sampling results were used to assess the potential VI (groundwater-to-indoor-air) risk for future commercial/school workers. No groundwater samples had concentrations that resulted in groundwater-to-indoor-air risks for a future commercial/school worker scenario greater than the risk management thresholds (i.e., ELCR estimates were not greater than 1 x 10^{-6} and no target-organ-specific HI were greater than 1).

Soil-Gas-to-Indoor-Air – Commercial/school Worker Exposure Scenario

The soil gas sampling results were used to assess the potential VI (soil-gas-to-indoor-air) risk for future commercial/school workers. No soil gas samples had concentrations that resulted in soil-gas-to-indoor-air risks for a future commercial/school worker scenario greater than the risk management thresholds (i.e., ELCR estimates were not greater than 1 x 10^{-6} and no target-organ-specific HI were greater than 1).

9.1.5 Uncertainty Discussion

There is uncertainty associated with the components of the HHRA process (including, sampling and analysis, derivation of the EPC, dose estimates, toxicity values, exposure factors, and models used to calculate risk. The uncertainty discussion in Section F6 of Appendix F describes 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, and provides guidance to risk managers and other stakeholders with information on how the uncertainties might affect site-management decision making. The key site-specific uncertainties are summarized below.

Uncertainties can exist related to the completeness and representativeness of the indoor air, soil gas, and groundwater data used in the HHRA. The RI included 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

- Sampling indoor air 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 VI

- Use of real-time, sensitive chemical analysis using the HAPSITE® instrument and conducting building depressurization to increase confidence regarding the occurrence of VI and to identify structures impacted by background indoor VOC sources (EA 2016c; Appendix H-4)

- Additional information related to the sampling and analysis methods are presented in Section 5.5, VI Sampling.

Section 6 discusses additional information related to the completeness and representativeness of the AOU-1 sampling results.

A reporting limit evaluation was performed to assess the impact of elevated reporting limits on the use of the data in the HHRA (Appendix F). A number of elevated reporting levels were noted, for TCE and to a lesser degree for VC; however, given the fact the MDLs are only slightly greater than the RBSLs, the impact on the risk assessment conclusions is likely minimal.

Indoor air risk estimates were based on samples collected using passivated stainless-steel canisters (analyzed using EPA Method TO-15) but also measurements using the HAPSITE® portable GC/MS instrument to provide an additional line of evidence regarding potential risk. While the canisters are used to sample over a 24-hour time-period to assess potential fluctuations during a day of sampling to get a time-integrated concentration that is more representative of exposure conditions for residential receptors, the HAPSITE® samples analyzed only for a short duration (typically 15 minutes). The use of the HAPSITE® samples, which reflect only a short duration during the day, may under- or over-estimate risks.

Samples in some locations were collected in the presence of identified background sources (0045-S, 0003-H, 00025-H and 0054-H). VI may still be occurring in a limited fashion in these locations; however, the background sources are currently contributing more significantly to the estimated risks. Locations where background sources may be present but were not identified would result in overestimation of risks.

Future groundwater and soil gas concentrations were assumed to be equal to existing concentrations. This assumption does not account for fate and transport processes likely to occur in the future (see Section 7). Therefore, if groundwater concentrations decrease over time, the exposure point concentrations may overestimate actual risk for future exposure scenarios.

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the period of exposure. These tend to simplify and approximate actual site conditions. In general, these assumptions are upper-bound assumptions intended to be conservative and yield an overestimate of the estimate of risk or hazard.

The toxicological database was also a source of uncertainty. EPA has outlined some of the sources of uncertainty in RAGS, Part A (EPA 1989). These sources might include or result from the extrapolation of toxicities from high to low doses and from animals to humans; the species, gender, age, and strain differences in a toxin’s uptake; metabolism, organ distribution, and target site susceptibility; and the human population’s variability with respect to diet, environment, activity patterns, and cultural factors.

The approach used in this HHRA does not account for the possibility that constituents act synergistically or antagonistically. Therefore, there is uncertainty associated with the risk calculations and potential risks may be overestimated or underestimated.

The groundwater-to-indoor air AF and the soil-gas-to-indoor air AF that were used to assess VI risks for future receptors are based on empirical data compiled and analyzed by the EPA and are considered a "reasonably conservative generic attenuation" (EPA 2012b; EPA 2015c). Use of an AF that is not specific to conditions at AOU-1 may result in an under- or over-estimation of future VI risks. Based on the lack of significant indoor air concentrations measured in the buildings within AOU-1, as discussed above, the use of generic AFs likely results in an over-estimation of cancer risk and non-cancer hazard.

9.1.6 Summary

An HHRA was prepared to assess potential exposures to COPCs in groundwater, soil gas, indoor air, soil and surface water under various land use scenarios within AOU-1. A sewer line originating from a former dry-cleaning facility in the VAMC was identified as a potential source of contamination from PCOPCs, which included PCE and its breakdown products (TCE, cis-1,2-DCE, trans-1,2-DCE and VC) and 1,4-dioxane (FE 2015). 1,4-dioxane was added as an additional COPC as requested by the EPA. Trans-1,2-DCE was subsequently removed as a PCOPC (EA 2016a). Based on at least one RBSL exceedance in groundwater, soil gas, or indoor air sampling data collected within this area, the following COPCs were identified for quantitative evaluation in the HHRA: PCE, TCE, and VC.

The following potentially complete exposure pathways were evaluated for current and future residential and commercial/school worker receptors:

- Indoor inhalation of site-related COPCs in indoor air for current residential receptors and workers
- VI from groundwater-to-indoor air future residential receptors and workers
- VI from soil gas-to-indoor air for future residential receptors and workers.

The COPCs in surface water, soil, and homegrown produce were also assessed and considered insignificant (i.e., no RBSL exceedances); therefore, exposure to these media are not included in the quantitative risk characterization (i.e., risk estimates were not calculated).

A summary of the ELCR estimates and HI estimates for the potentially complete exposure pathways, which were derived based on the assessment of the available sampling data and current site understanding, is presented in Table 9-1 and discussed below.

Based on the evaluation of available data and information, VI is likely not a pathway of concern that would result in cumulative ELCR exceeding the risk range of $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$ or an HI of 1 for the current residential scenario. As noted previously, location 0040-H is being addressed separately through a removal action. The indoor air HAPSITE® sampling results collected in 2016 and 2017 were used to evaluate the need for further sampling to assess potential VI risk for current residential receptors (Appendix E of the RI Work Plan [FE 2015]). Only a limited number of indoor air HAPSITE® results were greater than the indoor air RBSL: samples from locations 0040-H, 0045-S, 0051-H, 0053-H, 0054-H, and 0059-H (Table 6-6). EPA Method TO-15 indoor air samples were not collected at 0045-S and 0054-H as the HAPSITE® and pressure control data suggested that indoor air TCE concentrations resulted from an interior background source(s) or residual TCE from historical activities in the shop (Appendix H-4). A canister (EPA Method TO-15) sample was collected from 0053-H, because the HAPSITE® samples exceeded the residential indoor air RSL and was not attributable to a background source. Risk estimates calculated for samples collected from location 0053-H are included as part of the discussion of the EPA Method TO-15 sampling results below.

The EPA Method TO-15 indoor air sampling results were used to assess the potential VI risk for current residential receptors. None of the indoor air ELCR estimates exceeded the upper end of the risk management range (1 x 10^{-4}). Indoor air ELCR estimates ranged from 1 x 10^{-7} (0023-H) to 4 x 10^{-6} (0025-H) based on the EPA Method TO-15 analytical results. The cumulative ELCR estimates at locations 0023-H, 0026-H, 0029-H, 0036-H, 0037-H, 0051-H, 0053-H, and 0064-H were 1 x 10^{-6} or below. The cumulative ELCR estimates at locations 0003-H, 0017-H, 0018-H and 0025-H slightly exceeded 1 x 10^{-6} and the HI estimates range from 0.002 to 0.4. At locations 0003-H and 0025-H, there are lines of evidence available that indicate background sources, not a subsurface source, has impacted COPC concentrations in indoor air. Although no RBSLs were exceeded in samples collected at location 0017-H (based on EPA Method TO-15 sample results), the cumulative ELCR estimate (2 x 10^{-6}) is just above the lower end of the risk management range. Both PCE and TCE slightly exceeded the RSLs in samples collected at 0018H (EPA Method TO-15 samples) resulting in a cumulative ELCR estimate of 3 x 10^{-6}.

Based on the evaluation of available groundwater and soil gas data, there is a potential for VI for future residential exposure scenarios. However, none of the groundwater-to-indoor-air or soil-gas-to-indoor air ELCR estimates exceeded the upper end of the risk management range (1 x 10^{-4}) and none of the maximum target-organ-specific non-cancer HI estimates exceed 1, indicating the lack of a strong VI source. PCE is the primary risk driver in several other locations; however, the cumulative groundwater-to-indoor-air ELCR estimates are only slightly greater than 1 x 10^{-6} (ranging from 2 x 10^{-6} to 6 x 10^{-6}). TCE is the primary risk driver in several locations; however, the cumulative ELCR estimates are only slightly greater than 1 x 10^{-6} (ranging from 2 x 10^{-6} to 4 x 10^{-6}).

Based on the evaluation of available data and information, VI is not a pathway of concern for the current and future commercial/school worker scenario. The indoor sampling HAPSITE® results and pressure control data were used to assess the potential VI risk for current commercial/school workers. Indoor air samples were collected in one building with a current commercial worker exposure scenario - East High School (0045-S). PCE and TCE were detected in samples collected at 0045-S though at levels less than the commercial RSLs. Pressure control testing data indicated the presence of background sources. No groundwater samples had concentrations that resulted in groundwater-to-indoor-air risks for a future commercial/school worker scenario greater than the risk management thresholds (i.e., ELCR estimates were not greater than the low end of the risk management range [ELCR estimate of 1 x 10^{-6}] and no target-organ-specific HI were greater than 1). No soil gas samples had concentrations that resulted in soil-gas-to-indoor-air risks for a future commercial/school worker scenario greater than 1 x 10^{-6} and no target-organ-specific HI were greater than 1.

9.2 Ecological Evaluation

A SL ecological risk assessment (SLERA) was completed in support of the RI for AOU- 1 (presented as Appendix G of this RI report). The overall objective of this SLERA was to quantitatively or qualitatively evaluate baseline exposure and risks to ecological receptors and domestic pets from target contaminants of potential ecological concern (COPECs) in surface water and groundwater associated with the PCE plume. The SLERA was completed in the absence of any actions to control or mitigate releases and will be used to support RI risk management decisions under CERCLA.

This SLERA was conducted under the following assumptions and constraints:

- All evaluation of current exposures is derived from existing conditions and future land use is assumed to remain the same as current use.

- The abiotic media of primary ecological concern are groundwater and surface waters that may be impacted by the 700 South 1600 East PCE plume.

- Ecological receptors evaluated are those that may be commonly found in residential and/or commercial settings as well as domestic dogs.

- Chemicals evaluated in this SLERA are limited to PCE and its degradation products: cis-1,2-DCE, 1,4-dioxane, TCE, and VC (i.e., target COPECs).

- Each chemical is as bioavailable as the chemical on which the toxicity information is based when used for estimating direct exposure to chemicals in surface water and groundwater.

- Toxicological information used represents information currently available from literature and database searches.

A conservative evaluation of potential risks was conducted using the available groundwater and surface water (seeps/springs) data for AOU-1. Surface water samples collected from surface features including seeps/springs along AOU-1, as well as groundwater samples from the PCE plume were evaluated in this SLERA. Potential exposure pathways from groundwater would only be complete if the water reached the surface. However, both surface water and groundwater were evaluated to provide a conservative assessment.

In addition, ecological risk assessments do not typically evaluate potential risks to domesticated species. However, given that the site is predominantly urban/residential, domesticated dogs were included in this SLERA in response to stakeholder concerns.

9.2.1 Wildlife Screening and Domestic Pet Screening

The following exposure pathways were evaluated for AOU-1:

- Direct contact with surface water or groundwater by aquatic organisms
- Direct contact/root uptake of surface water or groundwater by plants
- Incidental ingestion of surface water or groundwater by urban wildlife
- Incidental ingestion of surface water or groundwater by domestic pets.

Exposure assumptions used in the SLERA provide a conservative estimate of potential exposure and risk. Actual exposure and potential risks are expected to be lower as (1) maximum detected concentrations are 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.

Groundwater and surface water SLs for aquatic organisms were obtained from the literature and represent chronic exposure levels. Water SLs for birds, mammals, and domestic pets were back calculated media-based values for each receptor/chemical pair. SLs for all receptor groups are referred to collectively as Water Screening Levels (WSLs).

The maximum detected concentrations of the target COPECs in surface water and groundwater were compared to the most conservative WSL for each analyte. There were no exceedances of chronic and/or no-effect level-based WSLs for aquatic organisms, plants, wildlife (birds and mammals), or domestic dogs under the conservative assumptions of the SLERA (Table 9-2). Figure 9-2 is an ecological risk CSEM showing the plausible potential exposure pathways for AOU-1 and identifies their potential completeness and significance.

9.2.2 Scientific Management Decision Point

Based on the available site investigation data, compared to the WSLs, PCE and its degradation products: cis-1,2-DCE, 1,4-dioxane, TCE, and VC in either groundwater or surface water of AOU-1 are recommended for no further action for ecological receptors and domestic pets.

TABLE 9-1

Summary of Human Health Risks and Contaminants of Concern

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

					Residential						**Commercial/School Worker**					
					ELCR (a)		**Maximum Target-Organ-Specific HI (b)**				**ELCR (a)**		**Maximum Target-Organ-Specific HI (b)**			
Exposure Timeframe	**Medium**	**Analytical Method**	**Number of Samples**	**Number of Samples with a COPC detection**	**Min**	**Max**	**Number of Samples with ELCR > 1×10^{-4}**	**Min**	**Max**	**Number of Samples with Max HI > 1**	**Min**	**Max**	**Number of Samples with ELCR > 1×10^{-4}**	**Min**	**Max**	**Number of Samples with Max HI > 1**
Current	Indoor Air	TO-15	24	20	1.E-07	**4.E-06**	0	0.002	0.4	0	--	--	--	--	--	--
		TO-15 (samples with background impact removed (c))	NA	NA	1.E-07	**3.E-06**	0	0.002	0.4	0	2.E-08	5.E-07	0	0.0004	0.09	0
					COC: PCE and TCE (0017-H and 0018-H)			COC: none			COC: none			COC: none		
Future	Soil Gas	TO-15	7	4	8.E-09	**7.E-06**	0	0.002	1	0	2.E-09	1.E-06	0	0.0005	0.3	0
					COC: PCE and TCE (based on TO-15)			COC: none			COC: none			COC: none		
	Groundwater	SOM02.3	65	55	9.E-09	**6.E-06**	0	0.002	1	0	2.E-09	1.E-06	0	0.0005	0.4	0
					COC: TCE, PCE			COC: none			COC: none			COC: none		

NOTES:

a. Sample-specific cumulative ELCR

b. Maximum HI presents the highest target-organ-specific HQ. Target organs identifed in Table F-6.

c. Range of risk estimates for locations without background sources identified. Risk estimates not included for the following location with background sources identified: 0045-S, 0003-H, 0025-H, and 0054-H. See Table F-11.

-- = No samples collected based on HAPSITE® sampling results.

COC = Contaminant of concern.

COPC = Contaminant of potential concern

ELCR = Excess lifetime cancer risk.

HI = Hazard index.

HQ = Hazard quotient.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

Bold values = ELCR > 1×10^{-6} or maxium HI > 1

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TABLE 9-2

Surface Water and Groundwater Screening for Screening Level Ecological Risk Assessment

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Analyte	Maximum Concentration (1) (mg/L)	Ecological Screening Levels (mg/L)							No Effect Level Hazard Quotients (2)						
		Aquatic Organisms	Plants	American Robin	Deer Mouse	Dog - Small/Toy	Dog - Medium	Dog - Large	Aquatic Organisms	Plants	American Robin	Deer Mouse	Dog - Small/Toy	Dog - Medium	Dog - Large
Surface Water															
1,4-Dioxane	<0.002	22	trv	trv	65	103	133	145	<1	trv	trv	<1	<1	<1	<1
cis-1,2-Dichloroethene	0.00069	0.59	100	trv	305	486	628	685	<1	<1	trv	<1	<1	<1	<1
Tetrachloroethene	0.082	0.12	10	trv	9.5	15	19	21	<1	<1	trv	<1	<1	<1	<1
Trichloroethene	0.0023	0.35	10	trv	4.7	7.5	10	11	<1	<1	trv	<1	<1	<1	<1
Vinyl chloride	<0.0005	0.93	trv	trv	11	18	24	26	<1	trv	trv	<1	<1	<1	<1
Groundwater															
1,4-Dioxane	0.0027	22	trv	trv	65	103	133	145	<1	trv	trv	<1	<1	<1	<1
cis-1,2-Dichloroethene	0.0039	0.59	100	trv	305	486	628	685	<1	<1	trv	<1	<1	<1	<1
Tetrachloroethene	0.061	0.12	10	trv	9.5	15	19	21	<1	<1	trv	<1	<1	<1	<1
Trichloroethene	0.0077	0.35	10	trv	4.7	7.5	10	11	<1	<1	trv	<1	<1	<1	<1
Vinyl chloride	<0.0005	0.93	trv	trv	11	18	24	26	<1	trv	trv	<1	<1	<1	<1

NOTES:

1. < indicates analyte was not detected above the method detection limit.
2. <1 indicates site concentration is below screening level

mg/L = Milligrams per liter.
trv = No toxicity reference value available.

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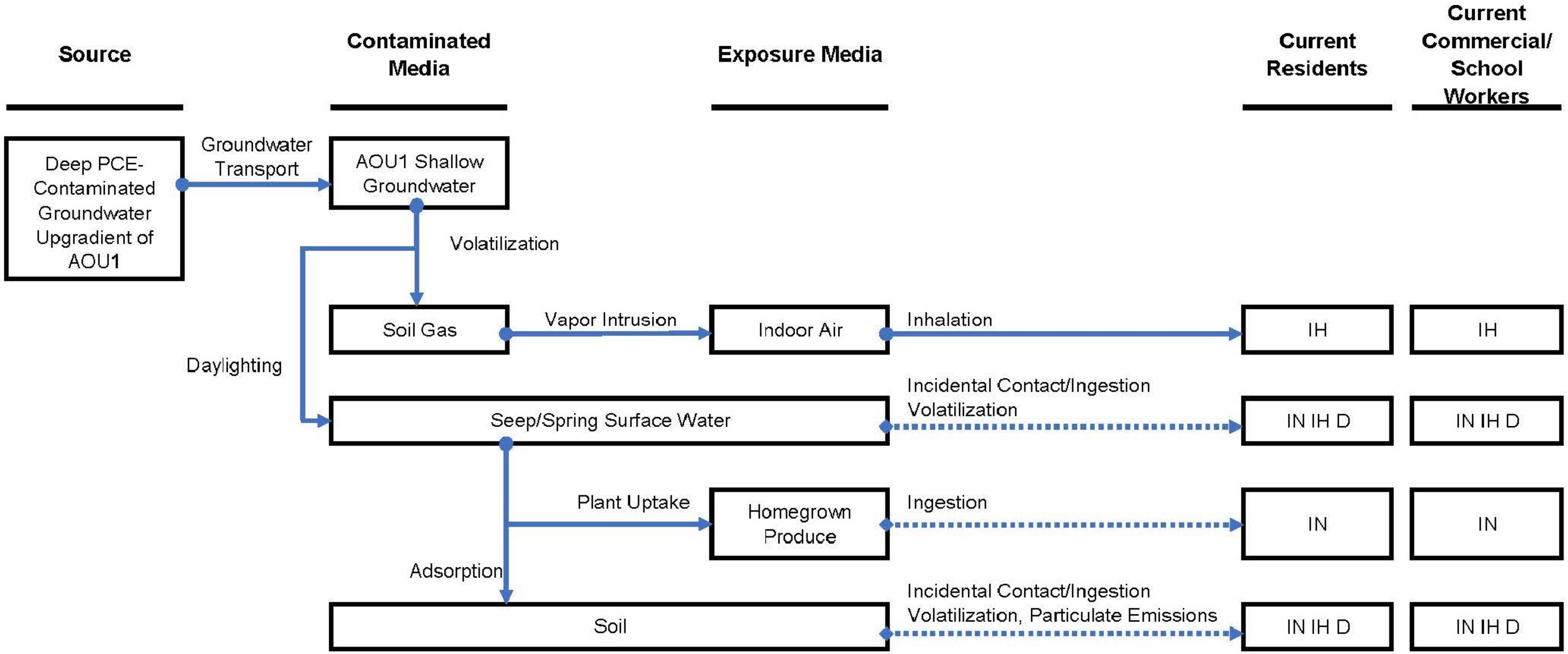


LEGEND

●━━━━▶ Complete or Potentially Complete Pathway

◆┅┅┅┅▶ Potentially Complete but Insignificant Pathway

IN - Ingestion; IH - Inhalation; D - Dermal Contact

FIGURE 9-1 CONCEPTUAL SITE EXPOSURE MODEL
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

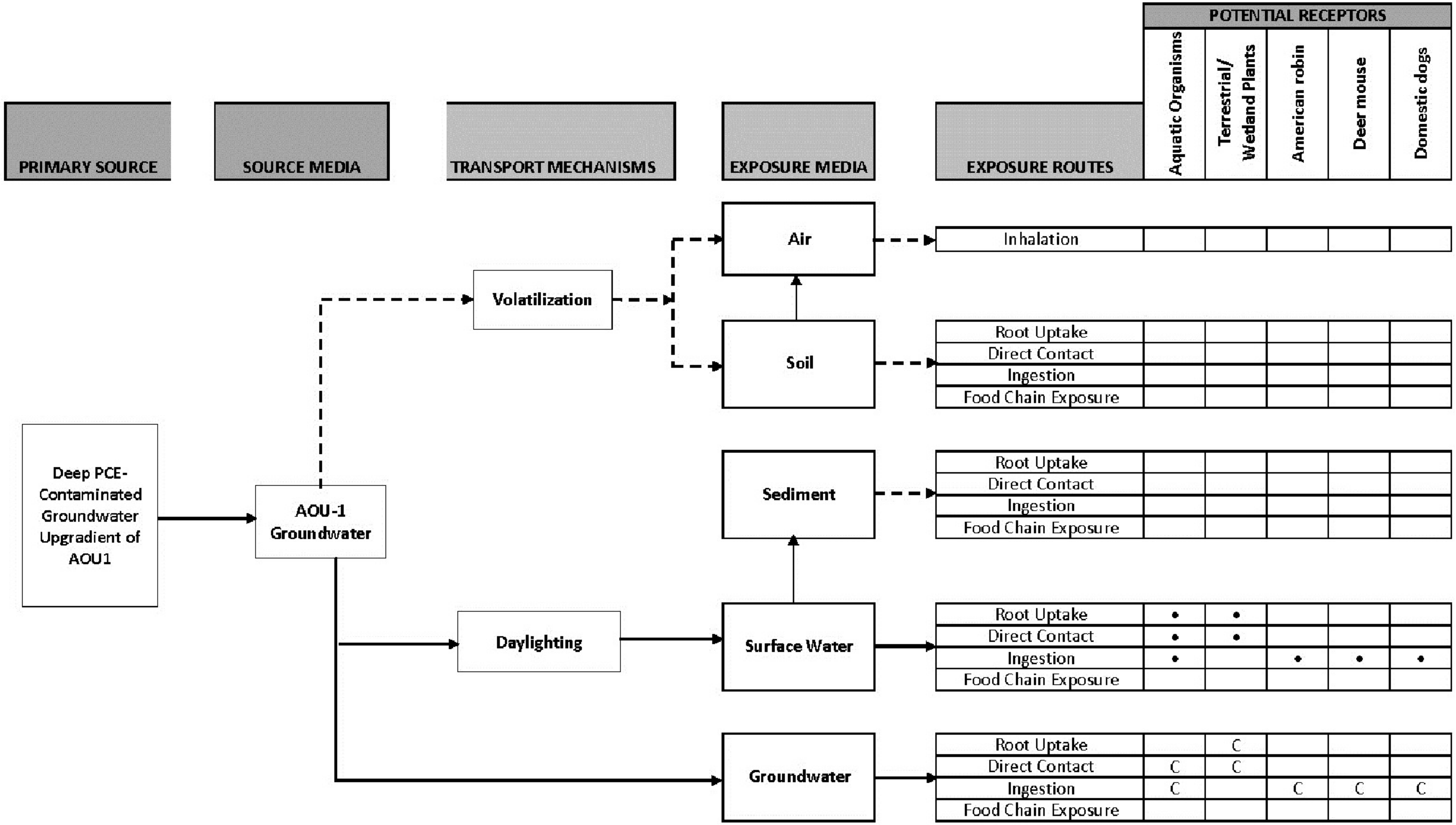
US Department of Veterans Affairs

DATUM: NA
PROJECTION: NA

DATE 6-15-18
DWN. BP
SCALE NA
APPRVD.

SHEET 1 of 1

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Figure 9-1 Conceptual Site Exposure Model.mxd bpawling 6/5/2018 2:34:07 PM



EXPOSURE MEDIA	EXPOSURE ROUTES	Aquatic Organisms	Terrestrial/ Wetland Plants	American robin	Deer mouse	Domestic dogs
Air	Inhalation					
Soil	Root Uptake					
	Direct Contact					
	Ingestion					
	Food Chain Exposure					
Sediment	Root Uptake					
	Direct Contact					
	Ingestion					
	Food Chain Exposure					
Surface Water	Root Uptake	•	•			
	Direct Contact	•	•			
	Ingestion	•		•	•	•
	Food Chain Exposure					
Groundwater	Root Uptake		C			
	Direct Contact	C	C			
	Ingestion	C		C	C	C
	Food Chain Exposure					

LEGEND

- - - - ▶	Incomplete exposure pathway
- · · - · · ▶	Potentially complete but minor exposure pathway
——▶	Potentially complete exposure pathway evaluated quantitatively
•	Exposure route quantitatively evaluated assuming potential migration of groundwater to surface water
C	Exposure route quantitatively evaluated to be conservative.

FIGURE 9-2 ECOLOGICAL CONCEPTUAL SITE MODEL
700 South 1600 East PCE Plume, AOU-1: East Side Springs
Remedial Investigation Report
Salt Lake City, Utah

US Department of Veterans Affairs

DATUM: NA
PROJECTION: NA

DATE 6-15-18
DWN. BP
SCALE NA
APPRVD.

SHEET 1 of 1

File: Albuquerque EA \\lovetongis\GISdata\Federal\West\Utah\SaltLakeCity_VeteransAffairs\MXD\RI Report\Figure 9-2 Ecological conceptual site model.mxd bpawling 6/5/2018 2:34:25 PM

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10.0 Summary and Conclusions

10.1 Summary of PCOPC Results

This RI was conducted specifically to evaluate VI at the AOU-1 ESS area of the 700 S 1600 E PCE Plume Site. Five PCOPCs were evaluated during the AOU-1 RI: chlorinated VOCs─PCE, TCE, cis-1,2-DCE and VC, as well as 1,4-dioxane. The potentially contaminated media that was investigated included shallow groundwater, surface water, stormwater, soil, soil gas, and indoor air at 23 structures. Shallow groundwater contamination is daylighting within the ESS area at the surface as seeps and springs and is presenting a potential VI risk. Characterization data obtained during the AOU-1 RI is summarized in the following subsections.

10.1.1 Groundwater

The results of the 2016 groundwater investigation showed exceedances of PCE and TCE above the respective RBSL, trace detections of 1,2-DCE, no detections of VC and one detection of 1,4-dioxane as summarized below.

- PCE above the RBSL of 15 µg /l at 11 locations, with a maximum concentration of 61 µg /l at GW-052

- TCE above the RBSL of 1.2 µg /l at 6 locations with a maximum concentration of 7.7 µg/L at GW-059

- Trace amount of cis-1,2-DCE at 3 locations with a maximum concentration of 3.9 µg /l at GW-059

- No detections of VC

- One detection of 1,4-dioxane below the RBSL of 2900 µg /l, at a concentration of 2.7 µg /l at GW-052.

The highest concentrations of PCOPCs were detected in the area where groundwater is between 0 to 20 ft bgs. The post RI AOU-1 approximate area is north of Michigan Avenue, south of 700 South, East of the East Bench Fault, and West of 1300 East as shown on Figure 7-2.

10.1.2 Surface Water and Stormwater

Surface water samples were collected from identified and accessible seeps, springs, sumps, and Red Butte Creek to assess the lateral extent of PCOPC contamination. Several of the springs discharge to the municipal storm sewer conveyance system. Therefore, water samples were collected from selected Salt Lake City storm sewer manholes, located in and downgradient of the approximate AOU-1 area, to determine if groundwater seepage and discharge from foundation drains is impacting stormwater. A total of 50 surface water and stormwater locations were sampled during the 2016 investigation. No surface water or stormwater sample results exceeded PCOPC RBSLs, however PCE, TCE and cis-1,2-DCE were detected in most locations as summarized below.

- PCE was detected in all but 3 surface water samples with a maximum concentration of 82 µg/L at location SW-35.

- TCE was detected in all but 8 locations with a maximum concentration of 2.3 µg/L at location SW-36.

- Cis-1,2-DCE was detected in 20 locations, with a maximum concentration of 0.69 µg/L at SW-36.

There were no detections of VC or 1,4-dioxane in surface water/stormwater samples.

10.1.3 Soil

Three surface soil samples were collected from 0 to 6 inches bgs and analyzed for PCOPCs. There was only one detection of PCE at a concentration of 0.022 mg/kg (below the RBSL of 24 mg/kg); this detection was adjacent to stormwater sampling location SW-26.

10.1.4 Vapor Intrusion

The VI investigation was conducted between 2015 and 2017 at 55 structures through investigation of soil gas, outdoor air, and indoor air using both HAPSITE® screening and collection of samples for EPA Method TO-15 analysis. VI data associated with 38 of the 55 structures was deemed to meet project DQOs and usable for the RI risk evaluation. VI investigation sampling results are summarized below by media.

10.1.4.1 Soil Gas Sampling

Soil gas sampling was conducted adjacent to 22 of the 38 structures that were sampled for VI. Samples were collected adjacent to structure slabs and foundations concurrently with the indoor air sampling. Screening was conducted for 18 samples using a HAPSITE®, samples were collected at 5 structures for EPA Method TO-15 analysis, and both methods were used at one location. Samples were collected between 4 and 8.5 ft bgs. Results are summarized below.

- PCE was detected in HAPSITE® soil gas samples at 14 locations, with a maximum concentration of 627.7 µg/m^3 at structure 0053-H. Confirmation sampling was conducted at this location and PCE was detected at concentrations from 1,500 to 2,000 µg/m^3 using EPA Method TO-15, exceeding the RBSL of 370 µg/m^3.

- TCE was detected in HAPSITE® soil gas samples at 3 structures, with a maximum concentration of 18 µg/m^3 at structure 0053-H. Confirmation sampling was conducted at this location and TCE was detected at concentrations from 18 to 21 µg/m^3 using EPA Method TO-15, exceeding the RBSL of 16 µg/m^3.

- Cis-1,2-DCE was detected at 5 locations: 4 locations using a HAPSITE® and one location in a sample analyzed using EPA Method TO-15. The maximum concentration was 2.8 µg/m^{3,} detected at 0030-H using EPA Method TO-15.

There were no detections of VC or 1,4-dioxane in the soil gas samples that were analyzed using EPA Method TO-15.

10.1.4.2 Outdoor Air Sampling

Outdoor air samples were collected in open field locations at ambient conditions at 27 locations. Sampling was conducted using HAPSITE screening outside of 25 structures. Analysis of samples using EPA Method TO-15 was conducted at 1 additional structure, and 1 structure had both HAPSITE screening and EPA Method TO-15 analysis. No PCOPCs were detected in outdoor air.

10.1.4.3 Indoor Air Sampling

Indoor air was sampled in all 38 structures that were evaluated for VI. Sampling was conducted using HAPSITE® screening at 29 structures and analysis of samples using EPA Method TO-15 at 23 structures. The following is a summary of the EPA Method TO-15 analyses.

- PCE was detected in 19 of the 23 structures with a maximum concentration of 74 µg/m^3 at structure 0040-H. PCE concentrations were greater than the RBSL (11 µg/m^3) in structures 0003-H, 0011-H, 0018-H, 0040-H, and 0053-H.
- TCE was detected in 4 of the 23 structures with a maximum concentration of 5.4 µg/m^3. The TCE indoor air RBSL (0.48 µg/m^3) was exceeded in 2 of these structures, 0018-H and 0040-H.
- Cis-1,2-DCE was detected in one structure 0040-H at concentrations ranging from 0.39 to 0.58 µg/m^3.
- VC was detected in one structure, 0001-H, at a concentration of 0.17 µg/m^3 which is equivalent to the RBSL.
- 1,4-dioxane was detected in samples collected at two structures with a maximum concentration of 2.3 µg/m^3 at 0025-H, which exceeds the RBSL of 0.56 µg/m^3.

10.1.5 Anomalous TCE Results

TCE detections in groundwater, surface water, stormwater, soil gas, and indoor air typically coincide with locations where PCE was detected, as shown in Figure 6-1 through 6-6. In these cases, TCE is often present at lower concentrations suggesting that it is a breakdown product of PCE. However, in some locations, TCE concentrations are higher than the reported PCE concentrations, such as at GW-009, GW-0050, where TCE exceeded RBSLs, but PCE did not. Similarly, EPA Method TO-15 analysis of soil gas reported exceedances of the RBSL for TCE and not PCE at 0030-H. Given that there is not a direct correlation between PCE and TCE concentrations and little evidence of reductive dechlorination from the AOU-1 data, the spatial distribution of TCE and potential relationship with PCE is not well understood and will be further evaluated as part of the OU-2 RI.

10.2 Summary of Nature and Extent

PCE-impacted groundwater and springs and seeps occur in the ESS area. PCE-impacted groundwater also occurs in the vicinity of the VAMC and Mount Olivet irrigation well located upgradient of the ESS area. PCE concentrations in upgradient, unconfined shallow surface water aquifer northeast of the ESS area, (i.e., in the vicinity of MW-01S) exceed 200 µg/L and occurs at an elevation of approximately 4,508 ft amsl. Groundwater flow direction east of and within the ESS area is to the southwest. Concentrations of PCE in groundwater and springs in the ESS area ranged up to 61 µg/L and 82 µg/L, respectively, and occurs generally between 4,500 and 4,400 ft amsl. Based upon the groundwater flow direction and gradient, the shallow groundwater and seeps and springs in the ESS area appear to be hydraulically connected to the shallow aquifer in the vicinity of MW-01S. Migration of contaminated groundwater from the area upgradient is contributing to PCE in shallow groundwater and springs within the ESS area.

The occurrence of groundwater in exceedance of RBSLs within 50 ft of the surface, and the presence of PCE in surface water in this same area where groundwater is most heavily impacted with PCE is generally confined to the area of the fault scarp west of the East Bench Fault Spur and east of the East Bench Fault. This area is further refined on the Section 7 figures and was identified by comparing the AOU-1 RI results with the corresponding RBSLs. The groundwater gradient steepens dramatically in this area, as does the topography. Based upon concentrations in shallow groundwater and seeps and springs within the area of the fault scarp, compared to concentrations in shallow groundwater downgradient of the fault scarp (west of the East Bench Fault), it appears that the majority of the PCE in groundwater is escaping through the seeps, springs, and stormwater lines in the ESS area. This is supported by the reduction in contaminant concentrations in groundwater west of the East Bench Fault. There are some data gaps with regard to this supposition in the area downgradient of SW-06 in the vicinity of GW-033. Groundwater was not encountered prior to direct push refusal at these locations (at approximately 40 ft bgs), and SW-06 was not a surface seep, but was described as a well that would be more indicative of shallow groundwater. While PCE in shallow groundwater is bound to the west and south of this location, it is not bound directly southwest, in line with the axis of the southern portion of the PCE plume within the ESS area.

Although PCE concentrations generally decrease in a southwesterly direction across the fault scarp, distribution of PCE in groundwater occurs in two distinct areas. The shallow groundwater PCE may be due to anthropogenic features (e.g., road beds and compaction along 900 South) resulting in localized effects on direction and gradient, although this is not confirmed based on potentiometric surface within the ESS area (Figure 4-6). There may be other, naturally occurring preferential pathways along the fault scarp, although, again this is not supported by the potentiometric map which suggests a steep but uniform gradient. Groundwater will be investigated further in the OU-2 RI. Section 10.5 identifies data gaps in the current groundwater characterization and recommendations for that RI.

The steep groundwater gradient resulting in surface seeps with concentrations of PCE ranging up 82 µg/L has resulted in an area of increased risk for direct contact with contaminated media and intrusion of cVOC vapors into residences.

10.3 Human Health Risk Assessment Conclusions

The HHRA was prepared to assess potential exposures to PCOPCs in groundwater, soil gas, indoor air, soil and surface water within AOU-1. The results of the HHRA indicated potentially complete but insignificant risks associated with PCOPCs found in soil and surface water. In addition, insignificant risks were identified when PCOPCs in surface water were assumed to migrate to soil and homegrown produce. The potential for VI risks for current residential receptors and current workers were assessed further by evaluating PCOPC concentrations in indoor air.

The potential for VI risks for future residential receptors and workers were also assessed by evaluating PCOPC concentrations in groundwater and soil gas. A summary of the results of the assessment of VI risk is provided below.

- Concentrations of PCE and TCE in indoor air at location 0040-H exceeded RALs. Location 0040-H is being addressed separately, through a removal action.

- The HAPSITE® indoor air screening results at two locations (0053-H and 0054-H) exceed the RBSLs for PCE and TCE. Consequently, 24-hour SUMMA® canister samples were collected for EPA Method TO-15 analysis at location 0053-H to further evaluate potential risk (risk assessment associated with EPA Method TO-15 samples are summarized below). Further investigation was not conducted at location 0054-H due to the presence of a background source.

- None of the VI pathway risk estimates (for the current and future worker and residential exposure scenarios), based on indoor air samples (i.e., EPA Method TO-15), where there was no impact from a background source, exceed the upper end of the risk management thresholds (i.e., a cancer risk estimate [ELCR] of 1 x 10^{-4} or non-cancer HI of 1).

- ELCR estimates for the VI pathway for current residential receptors, based on indoor air concentrations, do not exceed 1 x 10^{-6} except for two locations (0017-H and 0018-H). ELCR estimates at other buildings (0003-H and 0025-H) exceed 1 x 10^{-6}; however, there is supporting evidence of the presence of background sources within the structures (i.e., a source other than the PCE plume) as detailed in Appendix F, Table F-11.

- The maximum indoor air non-cancer HI estimate for residential indoor air exposures is 0.4 (less than the HI threshold of 1).

- Risks estimated for VI pathway for future residential receptors slightly exceed the risk management thresholds based on assessment of VI from groundwater or soil gas into residences. For groundwater-to-indoor air, the maximum ELCR estimate was 6 x 10^{-6} at GW-59. For soil gas-to-indoor air, the maximum ELCR estimate was 7 x 10^{-6} at Structure 0053-H.

- Indoor air samples were collected using the HAPSITE® in one building with a current occupational (commercial/school worker) exposure scenario - East High School (0045-S). PCE and TCE were detected in samples collected at 0045-S at levels less than the commercial/industrial RBSLs.

- Cancer risk estimates for the VI pathway for future worker (commercial, school, church, etc.) exposure scenarios, based on groundwater and soil gas concentrations, do not exceed a ELCR of 1 x 10^{-6} or a non-cancer HI of 1.

There is the potential for VI in those areas with PCE and TCE in exceedance of RBSLs in groundwater and soil gas where groundwater is less than 10 ft bgs. However, indoor air concentrations of PCOPCs measured during the RI do not result in risk in exceedance of the risk range. Whether VI is resulting in risk in exceedance of 10^{-4} could be attributable to structure-specific characteristics. For example, at 0040-H, groundwater/surface water is present within an on-slab drain in the attached garage of the structure, and there is evidence of surface water, shallow groundwater infiltration into the subgrade portions of the structure. This has likely contributed to the indoor air concentrations measured inside structure 0040-H.

10.4 Screening Level Ecological Risk Assessment Conclusions

With regard to the ecological risk evaluation, there were no exceedances of chronic and/or no-effect level-based WSLs for aquatic organisms, plants, wildlife (birds and mammals), or domestic dogs under the conservative assumptions of the SLERA. Therefore, no further action for ecological receptors and domestic pets is recommended for the PCOPCs in groundwater and surface water.

10.5 Data Limitations, Data Gaps, and Recommendations for Future Work

Data limitations, data gaps, and recommendations for future work are described below, based on a comparison to the three DQOs that were established in the RI Work Plan (FE 2015a).

1. *Does VI present a complete pathway to structures overlying AOU-1 and is it significant*?

   The AOU-1 RI confirmed that there is a complete VI pathway at some structures in the AOU-1 area. At one location, 0040-H, the measured VI levels exceeded the risk management threshold and a time critical removal action is being performed. For the other structures assessed, the HHRA has determined that current risks are below the 1 x 10^{-4} risk management threshold. However, there is possible cumulative risk above the 1 x 10^{-6} risk management level from COPCs at the four locations identified below.

   A total of 55 of approximately 102 structures within the ESS area were sampled using HAPSITE® or EPA Method TO-15 between 2015 – 2017, with one structure (0040-H) exceeding RALs resulting in a removal action. However, the data associated with 17 of the structures did not meet DQOs and is not usable for the risk evaluation. The data for the remaining 38 structures was used for the risk evaluation.

   In addition, it is noted that because of the effect of building structure on VI, the RI cannot conclude that there is no risk from indoor air for structures that have not been assessed in those areas where VI is possible based on groundwater concentrations, depth to groundwater, or soil gas concentrations. This limitation of the data is inherent in VI assessments.

   There are three variables which vary seasonally and may affect the potential for VI in structures: 1) groundwater concentrations, 2) depth to groundwater and 3) soil gas concentrations. To decrease these uncertainties for VI, the FFS will develop remedial options that take seasonal fluctuations of these variables into consideration, such as:

   - Verification that groundwater concentrations, depth to groundwater and, to a lesser extent soil gas, remain at levels that would not cause an increase potential for VI exposures

   - Groundwater monitoring would encompass enough years to ensure that high water season can be used as a surrogate for assessing the area likely impacted by VI.

   If groundwater concentrations and soil gas concentrations increase in a manner that would cause VI potential to increase, then indoor VI sampling would be considered at structures within the areas where concentrations of COPCs in groundwater/soil gas or depth to groundwater cause concern. Consideration should also be given to conducting follow-up monitoring at the following structures if they also are present within an area of increasing COPC concentrations in shallow groundwater:

Structure 0011-H, where indoor air concentrations for PCE exceeded the RBSL, and no background source was identified

- Structure 0017-H because the cumulative VI risk exceeded 1 x 10^{-6} and no background source was identified
- Structure 0018-H where cumulative VI risk exceeded 1 x 10^{-6}, both PCE and TCE exceeded RBSLs, and no background source was identified
- Structure 0053-H, where soil gas concentrations were much greater than the RBSL, where both PCE and TCE indoor air samples exceeded the RBSL, and no background source was identified (Tables 10-1 and 10-2)

Although East High School is not included within the post-RI AOU-1 boundary, VA will conduct future monitoring and/or sampling at East High School due to its use/sensitivity, to ensure no future impact from VI.

2. *What is the lateral extent of AOU-1 groundwater contamination that may result in complete pathway and significant VI in overlying structures*?

The lateral extent of groundwater contamination and the associated potential VI exposure is shown in the Section 7 figures. Additional data to further delineate the groundwater contamination and potential VI risk is needed and is planned for the OU-2 RI. The following is a list of data gaps and recommendations for future RI work:

- PCE in groundwater immediately southwest of the East Bench Fault along the axis of the PCE plume (i.e., near GW-54, downgradient of SW-06) could not be assessed due to drilling refusal. Additional groundwater investigation is recommended in this area to identify depth to groundwater and concentrations of COPCs.
- Groundwater monitoring is warranted under the OU-2 RI to evaluate trends in PCE, TCE, cis-1,2-DCE and VC concentrations to determine whether COPC concentrations in the plume within the ESS area are increasing, stable, or decreasing (i.e., reductive dechlorination processes).
- Groundwater investigation to address data gaps related to a complete understanding of contaminant concentrations, the hydrogeology at AOU-1, the unknown geology between the suspected release site(s), and the influence of pumping stresses that may be mixing the upper unconfined aquifer and lower confined aquifer are also to be addressed under OU-2 RI.
- An evaluation of the effect of pumping at the Mount Olivet irrigation well was not studied as part of the AOU-1 RI and should be considered in the OU-2 RI.
- Data is not available for COPCs in groundwater at the SLC-Eighth South Well. This well should be sampled during the OU-2 RI.

- Conduct monitoring of groundwater, soil gas, or indoor air concentrations to identify increasing trends in PCE, TCE, and/or VC concentrations that may result in a health risk.
- Conduct groundwater monitoring to assess whether the PCE/TCE plume is stable or declining. If concentrations are increasing, there is the potential for additional instances of VI.

3. *Are there potential unacceptable impacts to human health through direct exposure to AOU-1 cVOCs in surface water or soil*?

   No potential unacceptable impacts to human health were identified through direct exposure to surface water or soil based on the sampling and analysis conducted during this AOU-1 RI. Collection of data at one additional surface water monitoring point is recommended. Data is not available for the Liberty Park drinking water fountain. Obtaining data on concentrations of COPCs in drinking water is recommended to compare to surface water RBSLs.

10.6 Recommended Remedial Action Objectives

The recommended Remedial Action Objective for AOU-1 is as follows:

Prevent human exposure to indoor air COPC concentrations that are present due to VI and are above their respective residential (in the case of homes) and industrial (in the case of industrial/commercial buildings) action levels.

Additional detailed objectives may be identified during the development of the FFS to more specifically identify appropriate action levels for AOU-1.

TABLE 10-1

Summary Statistics for the AOU-1 VI Remedial Investigation

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Description	**Number**	**Structure IDs**
Indoor Air Samples with TO-15 Analysis	34	See Table 5-10
Structures Sampled	23	See Table 5-10
Indoor Air, TO-15 Exceedances of RBSL for PCE	5	0003H, 0011-H, 0018-H, 0040-H, 0053-H
Indoor Air, TO-15 Exceedances of RBSL for TCE	2	0018-H, 0040-H
Indoor Air, TO-15 Exceedances of RBSL for VC	1	0001-H
Indoor Air, TO-15 Exceedances of the RALs	1	0040-H
Confirmed Background Sources Identified	3	0003-H, 0025-H, 0045-S
Greater than 1 X 10^{-6} cumulative VI risk	4	0003-H, 0017-H, 0018-H and 0025-H
Greater than 1 X 10^{-4} cumulative VI risk	0	

NOTES:
ID = Identification.
PCE = Tetrachloroethene.
RBSL = Risk-based screening level.
TCE = Trichloroethene.
VC = Vinyl chloride.
VI = Vapor intrusion.

TABLE 10-2

Summary of Structures with AOU-1 VI Remedial Investigation Exceedances of RBSLs or 1 X 10^{-6} Cumulative VI Risk

700 South 1600 East PCE Plume AOU-1: East Side Springs Remedial Investigation Report

Department of Veterans Affairs Salt Lake City Health Care System

Description	**0001-H**	**0003-H**	**0011-H**	**0017-H**	**0018-H**	**0025-H**	**0040-H** **(1)**	**0045-S**	**0053-H**
Indoor Air, TO-15 Exceedances of RBSL for PCE		X	X		X		X		X
Indoor Air, TO-15 Exceedances of RBSL for TCE					X				X
Indoor Air, TO-15 Exceedances of RBSL for VC	X								
Indoor Air, TO-15 Exceedances of the RALs							X		
Greater than 1 X 10^{-6} cumulative VI risk		X		X	X	X			
Confirmed Background Sources Identified		X				X		X	

NOTES:

1. A Time Critical Removal Action is already being conducted at Structure 0040-H.

RAL = Removal action level.

PCE = Tetrachloroethene.

TCE = Trichloroethene.

VC = Vinyl chloride.

VI = Vapor intrusion.

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