Public Health Assessment for

EVALUATION OF CONTAMINANTS IN INDOOR AIR, SOIL, AND SURFACE WATER

(Public Comment)

700 SOUTH 1600 EAST PCE PLUME

ACCELERATED OPERATING UNIT 1 (AOU-1): EAST SIDE SPRINGS

SALT LAKE CITY, SALT LAKE COUNTY, UTAH

EPA FACILITY ID: UTD981548985

JUNE 30, 2023

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

Comment Period Ends:

JULY 31, 2023

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR. This revised document has now been released for a 31-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

Evaluation of Contaminants in Indoor Air, Soil, and Surface Water

700 South 1600 East PCE Plume
Accelerated Operating Unit 1 (AOU-1): East Side Springs
Salt Lake City, Salt Lake County, Utah

EPA CERCLA ID: UTD981548985

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Foreword

Congress established the Agency for Toxic Substances and Disease Registry (ATSDR) in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency (EPA) and the individual states regulate the investigation and cleanup of the sites.

Since 1986, the CERCLA statute requires ATSDR to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Environmental and health scientists from ATSDR and states with which ATSDR has cooperative agreements carry out public health assessments. The public health assessment process allows ATSDR scientists and cooperative agreement partners flexibility in the format of the document when they present findings about the public health impact of hazardous waste sites. The flexible format allows health assessors to convey to affected populations important public health messages in a clear and expeditious way.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data are needed.

Health Effects: ATSDR uses existing scientific information to evaluate the possible health effects that may result from exposures. If the review of the environmental data shows that people have or could contact hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children more sensitive and vulnerable to hazardous substances and thus considers the health impact to children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and highly exposed people) also receive special attention during the evaluation.

Community: ATSDR also needs to learn from the local community about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, ATSDR distributes an early version to the public for their comments. ATSDR addresses all public comments related to the document in the final version of the report.

Conclusions: The report presents conclusions about the public health threat posed by a site. ATSDR then recommends ways to stop or reduce exposure in the public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA or other regulatory agencies. However, if there is an urgent

health threat, ATSDR can issue a public health advisory warning people of the risks. ATSDR can also recommend health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

SUMMARY

INTRODUCTION The VA Medical Center (VAMC), Salt Lake City, UT, operated an on-site dry cleaning facility from approximately 1976 through 1984 [EPA 2012]. Like most dry cleaners of that era, the facility used tetrachloroethylene (PCE) as a cleaning solvent. PCE that is released into soil and water will migrate from the spill site and end up in ground water and will form a number of volatile organic chemical (VOC) byproducts. The VOCs are then able to enter buildings. This public health assessment (PHA) examines the potential health effects from exposure to PCE and trichloroethylene (TCE), a PCE breakdown product, found in a groundwater plume that lies beneath the East Side Springs section of Salt Lake City.

In May 2013, US Environmental Protection Agency (EPA) placed the 700 South 1600 East Plume on the National Priorities List (NPL). Pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986, the Agency for Toxic Substances and Disease Registry (ATSDR) is required to conduct public health assessment activities for sites listed or proposed for the NPL. This PHA evaluates human exposures from site contaminants and recommends actions needed to reduce or stop exposures, if necessary. Characterization of the site has been ongoing since 2013, and future monitoring data will be analyzed in a subsequent PHA. This PHA evaluates data through 2018. ATSDR used environmental data collected by Utah Department of Environmental Quality (UDEQ) and the Veteran's Authority (VA) to evaluate exposure scenarios and draw conclusions. ATSDR staff presented ATSDR's PHA process to the community in a public meeting sponsored by the VA (September 2015) and later at Superfund Community Advisory Group (CAG) meetings (October 2016 and May 2018). ATSDR will sponsor another community meeting at the time this document is released.

CONCLUSIONS ATSDR reached six conclusions in this PHA:

Conclusion 1: Breathing site-related tetrachloroethylene (PCE) and trichloroethylene (TCE) found in indoor air sampled in different seasons in homes of the East Side Springs neighborhood (AOU-1) is not likely to harm residents' health.

Basis for Conclusion: Data collected since 2016 suggest that current exposures to site contaminants do not pose a health risk above a level of concern. Conservative exposure estimates based on 2016 and 2017 indoor air sampling indicate a small theoretical increase in cancer risk associated with vapor intrusion; however, the risks are so small they are not a health concern. The concentrations of PCE and TCE are below levels associated with non-cancer health effects based on conservative exposure estimates.

In one home, the exposure appears to have been related to an in-home vehicle maintenance shop (no longer in use).

In some homes, PCE measured in the air of basement sumps, floor drains, and nearby soil gas is contaminated with PCE at significantly elevated levels; however, air in the home's living spaces remains below levels of concern. Several uncertainties exist for future exposure in these homes. The fate and transport of contaminants in groundwater is not completely understood. Not all homes have been tested, and temporal (seasonal) effects on vapor intrusion (VI) have not been assessed.

Next Steps: The VA is currently recruiting additional homes for testing and is re-testing many homes**.** ATSDR supports continued periodic sampling of homes to evaluate the efficacy of remedial actions in place and any effects of seasonal or building changes over time on indoor air concentrations.

As groundwater sampling expands and the conceptual site model improves, ATSDR supports the VA continually re-evaluating which areas and homes are at risk for VI. Additionally, ATSDR recommends that the VA re-test the living space in structures with elevated levels of VOCs in sumps and floor drains. If high soil gas concentrations near homes continue to be detected, then further indoor air testing should be performed. EPA supports the VA decision to offer additional VI sampling.

Conclusion 2: We do not have enough information to conclude if breathing PCE and TCE at levels that existed prior to 2015 could harm people's health.

Basis for Conclusion: Little is known about exposure prior to 2015, when VA began sampling the indoor air, the shallow groundwater, and soil gas in the East Side Springs neighborhood.

Next Steps: We are working with UDOH to identify pre-2015 epidemiological data that may offer insight into incidence of certain cancers that are related to PCE and TCE exposure. There are many limitations to such an analysis and cancer incidence data would not imply exposure had necessarily occurred. The Utah Department of Health (UDOH) will prepare a cancer incidence review and present findings to the community during an upcoming ATSDR public meeting for the site.

Conclusion 3: Breathing air currently in the one home (0040H) where the VA conducted a time critical removal action is unlikely to harm the residents' health. The portable air filters installed in the home are protective of health, but the filters do not prevent the potential for a future health risk. The home has a permanent furnace filtration removal system installed, but the homeowner is not using it. The permanent system also requires ongoing maintenance to prevent future exposure.

Basis for Conclusion: To date, the air filtration system has been successful in reducing PCE and TCE vapors; however, it is not a permanent solution to migration of chemicals from the groundwater to indoor air in the home. A sub slab system would not address the diffusion problem either. Exposures are possible when the homeowners sell their home because new owners may not understand the need to regularly change filters, or if the system is modified or not maintained.

Next Steps: Groundwater cleanup is unlikely to be completed in the near future, but an engineered solution to drain water near the foundation could provide a permanent solution since groundwater is so shallow and diffusion into the basement is ongoing. In the meantime, ATSDR supports the VA's continued efforts to maintain the portable air filtration system for the current residents of home 0040H and develop/implement groundwater remediation through the Superfund process. ATSDR recommends that 1) The VA and EPA continue to work toward a remedy that would remove future risk, such as a drain system to divert water away from the outside of the basement; 2) The VA and EPA define a mechanism for monitoring change of occupancy in the home and inform future residents of the need to filter the air. ATSDR remains available to consult with present and future residents of the home.

Conclusion 4: People who drink tap water from the Salt Lake City municipal system have not been exposed to levels of PCE that are likely to have harmed their health in the past nor pose a current risk.

Basis for Conclusion: The municipal water system serves homes in the East Side Springs area, where private wells have not historically been a source of drinking water. The Salt Lake City municipal water system detected PCE in one well that supplies the municipal system; however, PCE was not detected in the water supply (the water is a blend of wells) delivered to the tap. The PCE levels in the single well were below ATSDR screening values for consumption. Salt Lake City Department of Public Utilities (SLCDPU) removed the well from service and monitors wells used for the drinking supply in accordance with the Safe Water Drinking Act.

Next Steps: The well remains off-line. The SLCDPU is aware of the contaminant plume and taking steps to ensure continued compliance with the Safe Water Drinking Act. The other wells in the municipal system are tested regularly. To date, PCE has not been detected. Nearby wells are tested through the Superfund program to assess potential plume migration into the municipal water supply.

Conclusion 5: People incidentally touching water (through wading or irrigation) flowing from neighborhood springs and nearby wetted soils are unlikely to experience adverse health effects from PCE or TCE.

Basis for Conclusion: ATSDR evaluated exposure to spring water and soil next to springs during play and irrigation. A person might incidentally ingest or touch contaminants from some of this water and soil; however, based on a health-protective scenario, the amount of PCE and TCE entering the body is below a level that would adversely affect health.

Next Steps: Continued groundwater investigations and refinement of the site conceptual model will determine the need for additional sampling of the seeps, springs, and nearby soils.

[1]Conclusion 6: The indoor air data needed to evaluate the East High School and Mount Olivet Cemetery caretaker's home were not available at the time of the report initial preparation in 2019. Indoor air samples during hot and cold seasons are needed to evaluate the possible exposure during conditions most likely to cause vapor intrusion.

Basis for Conclusion: Only one round of indoor air data was collected at East High School. While the data revealed PCE and TCE below detection limits in indoor air, an additional round of sampling is needed. The cemetery caretaker's home overlies the groundwater plume and had not yet been sampled at the time of the report initial preparation in 2019.

Next Steps: ATSDR recommended that VA or EPA collect indoor air samples at both the East High School and the Mount Olivet Cemetery caretaker's home. These data are now available and will be the basis for a follow-up document to be completed in late 2022.

Public Health Action Plan

ATSDR will take the following public health actions following release of this PHA:

- ATSDR will continue to evaluate data to determine if there is an unforeseen risk to public health with AOU-1. Specifically, ATSDR will review the next rounds of VI sampling to determine if new information changes conclusions or recommended remedial actions.
- ATSDR will plan to review future data and remedial systems to ensure that the remedy at home 0040H is protective.
- ATSDR will determine the need to evaluate public health risks from the broader groundwater investigation (OU-2) as more data become available.
- ATSDR will evaluate recent data to determine VI risk at the residence located at Mt. Olivet Cemetery. Preliminary groundwater data suggest this home overlies the groundwater plume.
- ATSDR will evaluate recent data to determine VI risk at East High School. While previous one-time sampling at East High School revealed PCE and TCE below detection

[1] ATSDR received indoor air data in 2022 for both locations and will summarize potential health risk findings in a subsequent document.

limits, further sampling is needed to determine if there is a concern at other times of the year.

- ATSDR will continue to be available to the community to answer public health questions.
- ATSDR will collaborate with the VA, Utah Department of Health (UDOH) and Salt Lake City officials to publicize the value in identifying and repairing cracks in basement floors that are conduits for contaminant migration in homes above the plume.

FOR MORE INFORMATION

If you have questions or comments, you can call ATSDR toll-free at 1-800-CDC-INFO and ask for information on the 700 South 1600 East Plume Site. Detailed information about the toxicology of tetrachloroethylene, trichloroethylene, and other chemicals mentioned in the document is available in ATSDR's Toxicological Profiles at https://www.atsdr.cdc.gov/toxprofiledocs/index.html.

PURPOSE AND HEALTH ISSUES

This public health assessment (PHA) examines the potential health effects from exposure to tetrachloroethylene (PCE) and trichloroethylene (TCE) found in a groundwater plume that lay beneath the East Side Springs section of Salt Lake City. The plume and the homes built above contaminated groundwater are part of the 700 South 1600 East Plume Superfund Site ("the site"). The health evaluation that follows focuses on the area with the greatest potential for residents of homes inhaling PCE and TCE vapors and/or contacting contaminated surface waters. There are not data at this time to evaluate non-residential exposure at East High School. For the purposes of the site cleanup, site regulators labelled the area in question Accelerated Operating Unit 1 (AOU-1).

In May 2013, US Environmental Protection Agency (EPA) placed the 700 South 1600 East Plume on the National Priorities List (NPL). The site is located on the George E. Whalen Department of Veterans Affairs Medical Center (VAMC) property and within the nearby East Side Springs neighborhood of Salt Lake City, Utah. There are no occupied buildings impacted by the plume on the VAMC campus. Pursuant to the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986, the Agency for Toxic Substances and Disease Registry (ATSDR) is required to conduct public health assessment activities for sites listed (or proposed) to the NPL.

An ATSDR PHA provides advice on specific public health issues that occur because of actual or potential human exposure to hazardous material in the environment (ATSDR 2005). The Salt Lake City Department of Public Utilities (SLCDPU) first detected PCE in 1990 during routine monitoring an irrigation well at the Mt. Olivet Cemetery. EPA and UDEQ Superfund Site Assessment programs investigated groundwater, and a Veteran's Administration (VA)-led groundwater investigation is underway to support Superfund remediation. The VA and the EPA have designated the groundwater cleanup as Operating Unit 2 (OU-2).

The groundwater and indoor air quality data collected to date provide the basis for this health evaluation; however, in coming years, the VA will continue to investigate the extent of groundwater contamination and sample more homes. As more data become available, ATSDR will consider the need to develop follow-up health consultations to assess risks not evaluated herein. A follow-up health consultation could document whether the situation is getting worse or better.

The presence of PCE and TCE (a breakdown product of PCE) in groundwater and surface water pose several potential health issues. PCE and TCE are toxicants, which may adversely affect human health depending on the dose and duration of exposure. In addition to TCE, two other PCE breakdown products, a single detection of cis-1,2-dichloroethene (cis-1,2-DCE) and a single detection of vinyl chloride (VC) have occurred in indoor air sampling at two separate houses (out of 34 homes sampled, with each home sampled at least twice). While not widespread, we evaluate the health implications of breathing these chemicals in this evaluation.

At this site, the primary way PCE and TCE may affect health is inhalation of PCE and TCE evaporating from the groundwater and migrating into homes. Residents of the East Side Springs area drink municipal water. Groundwater and surface water from the contaminated plume are not currently drinking water sources.

Springs and seeps in the area are shallow surface waters and not amenable to swimming. Land use descriptions and community discussions have not suggested the springs are fishable. Nevertheless, intermittent exposures to contaminated surface waters through play and irrigation are possible. As contaminated springs flow over land, nearby soil may become contaminated. We also examine the potential health effects of contacting spring water and soil.

BACKGROUND

Site Description and History

The 700 South 1600 East PCE Plume site encompasses a volatile organic compound (VOC) contaminated groundwater plume and connected surface waters on the east side of Salt Lake City. The site covers approximately 300 acres, roughly centered at the intersection of 900 South and 1200 East (see Figure 1). The site boundaries correspond to the groundwater plume (with a 100-foot buffer) that emanates from a source at the VAMC and migrates in a predominantly southwest direction. Since the site regulators have not defined the plume with a high level of resolution, the site boundaries are approximate.

VAMC operated an on-site dry-cleaning facility from approximately 1976 through 1984 [EPA 2012]. Like most dry cleaners of that era, the facility used tetrachloroethylene (PCE) as a cleaning solvent. PCE is a manufactured chemical used for dry cleaning and metal degreasing [ATSDR 2014b]. It is a nonflammable colorless liquid. PCE is known by many other names, including tetrachloroethylene, perchloroethylene, perc, and tetrachloroethene.

The dry cleaner disposed of the condensate from the dry-cleaning solvent recovery system into a drain, which connected to the municipal sewer system [EPA 2012]. Based on Salt Lake City Department of Public Utilities (SLCDPU) reports of solvent odors during sewer maintenance at the VAMC, regulators consider leaks from this plumbing are likely the source of PCE that entered the aquifer [EPA 2012]. EPA named the VA as a CERCLA Potentially Responsible

Party (PRP). The VA is remediating the site with oversight from the EPA and the Utah Department of Environmental Quality (UDEQ).

For the purposes of environmental remediation, the PRP and site regulators divided the site into two operating units (OUs). Accelerated Operating Unit 1 (AOU1) is a geographic designation limited to the East Side Springs (ESS) neighborhood. AOU-1 represents a 100-foot boundary around the shallow aquifer PCE plume defined by PCE detection in springs and/or groundwater within 50 feet of the surface. Operating Unit 2 (OU2) is the groundwater plume, including the presumed source area at the VAMC.

AOU-1, the focus of this health evaluation, represents the portion of the site with the greatest potential human exposure. AOU-1 covers about 300 acres centered at the intersection of 900 South and 1200 East. The boundary varies with groundwater values (and a 100-foot buffer) and is outlined in Figure 1. Here, shallow groundwater (defined as maximum of 50 feet below ground surface) contaminated with PCE lay beneath a predominantly residential neighborhood and intersects the ground surface near the Wasatch Fault Scarp (i.e., a steep slope on topography caused by subsurface movement along the fault). Depth to groundwater in most of AOU-1 is between 15 ft deep and the surface. The migration of gases evaporating from the shallow groundwater toward the surface presents a risk of vapor intrusion into homes. The groundwater plume (contaminated with PCE and TCE) emerges from the subsurface in seeps and springs. The daylighting of contaminated groundwater at springs and seeps presents risk through wading, irrigation, and touching nearby soils that have absorbed contaminated water.

Site Geology and Hydrogeology as they Relate to How People are at Risk

The site is along the eastern edge of the Salt Lake Valley, an alluvial basin geologically associated with erosion of the Wasatch Range. The East Bench Fault (a segment of the Wasatch Fault) aligns along the north-south axis through the site. The geological processes of this fault have led to a high degree of heterogeneity in the deposits which comprise multiple aquifers and confining layers [VA 2019]. Springs and seeps occur where the groundwater intersects the land surface (largely along the scarp).

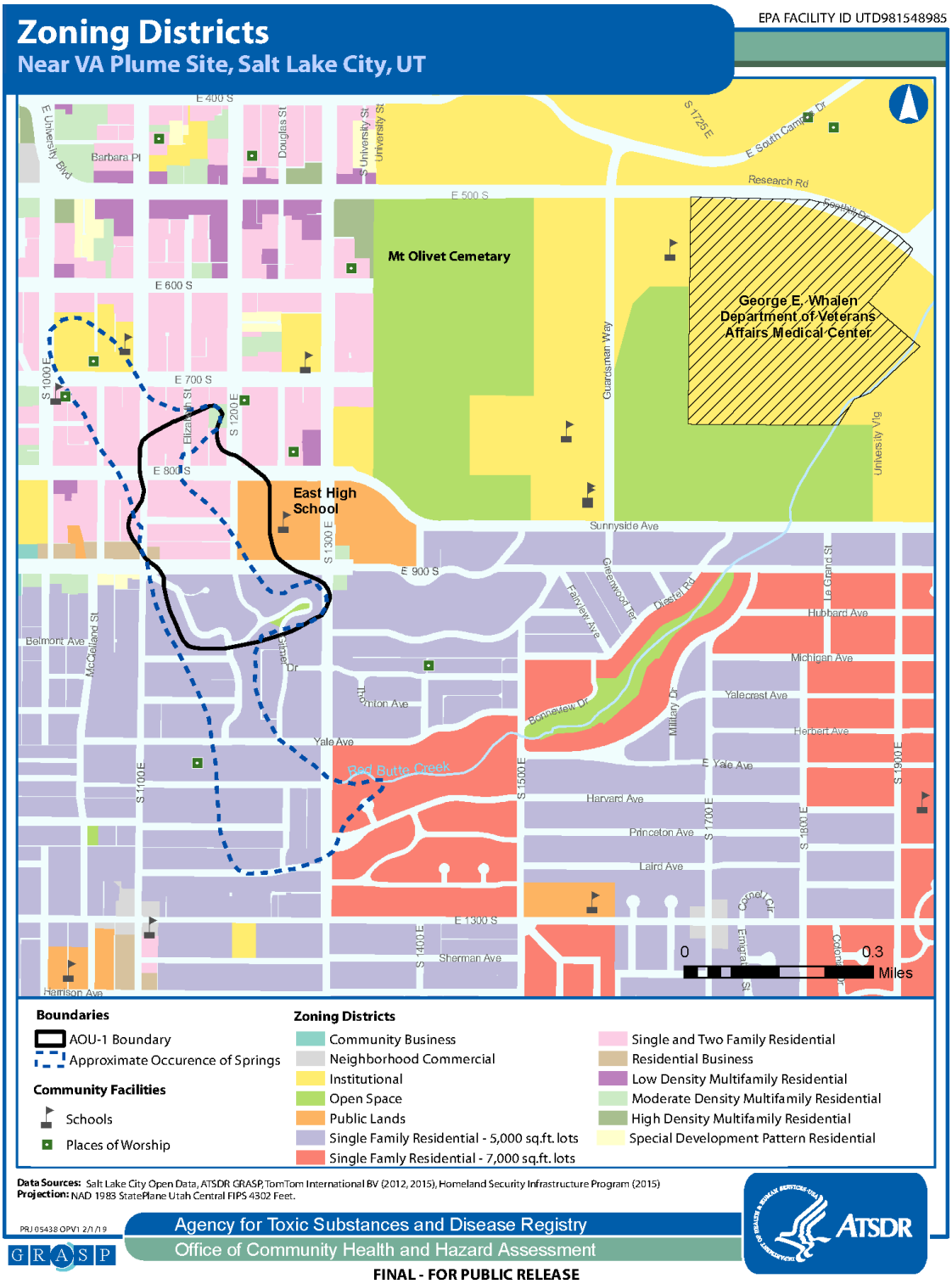
Beneath the VAMC and East Side Springs neighborhood, a principal deep aquifer lay approximately 150 to 500 feet below surface. Above that lay a shallow unconfined aquifer about 100 feet below surface [VA 2019]. Though the geology and hydrogeology of the site are complex, the health risks present clearly in contaminated shallow groundwater and the scarp geology, resulting in dissolved phase VOCs near or at the surface. The proximity of shallow groundwater and springs contaminated with VOCs to residences is the core of the risk to human health. The depth to groundwater is just a few feet for many homes. Minimum groundwater level is at the surface in many locations, as natural springs emanate throughout the OU and beyond it downgradient.

Hydrogeological investigations of the Wasatch Front Range [Anderson et al. 1994] indicate that the PCE plume and source area are in the groundwater recharge zone. The coarse-grained shallow aquifer permits a high rate of flow (i.e., hydraulic conductivity) from surface to groundwater resources. The potential for continued spread of contamination combined with the

complexity of the regional subsurface contributes to uncertainty of public health evaluation in areas not well characterized.

Regionally groundwater flows from the northeast to the southwest [VA 2019], which is consistent with a conceptual model of dissolved phase contaminants flowing from the VAMC to the Mt. Olivet cemetery (where PCE was first detected) and to the East Side Springs area (Figure 1). Investigations to better understand flow in the shallow aquifer are ongoing; however, recent mapping of shallow groundwater pressure in the East Side Springs indicated that groundwater in the shallow, unconfined aquifer flows to the southwest as well. ATSDR will continue to review data for this site as more data become available.

Figure 1: Site Location and Overview Map



Red Butte Creek, located 1,500 feet southeast of the AOU-1, is the predominant surface water feature in the East Side Springs area. Red Butte Creek flows west-southwest from headwaters in the Wasatch Range to a confluence with the Jordan River.

Numerous seeps and springs of the area emerge at the interface of groundwater (contaminated at some points) and the ground surface along the Wasatch scarp. Some springs are evident; but, in many cases, water trickles from these seeps. The approximate area in which springs occur is outlined in Figure 1 (surface water sampling points are presented in Figure 3). The flow paths of the resultant surface waters are varied. Some landscaping integrates these discharges into land features; others divert the flow to the municipal storm water system. Some of this water is discharged through sumps and foundation drains [VA 2019].

Early Site Investigations

The PCE plume was first discovered in 1990 at the Mount Olivet cemetery when Salt Lake City municipal government detected PCE in water (at 30 ug/L) during routine monitoring of an irrigation well [UDEQ 2000]. Additional sampling from 1995-1999 confirmed the presence of PCE and PCE breakdown products in soil gas and groundwater. Monitoring wells installed to the east and southeast provided information about groundwater flow and the extent of contamination. In 1997, EPA measured 184 ug/L [UDEQ 2000] at the Mt. Olivet well, though subsequent concentrations in more recent sampling has been lower [VA 2019] (RI/FS) and suggest a downward trend in concentration.

SLCDPU detected PCE at levels ranging from non-detect to 1.4 µg/L from 1997 to 2004 in a single municipal well (Water Well #18) that contributes to the water delivered at the tap [EPA 2012]. SLCDPU did not detect PCE prior to 1997. The Salt Lake City municipal water system blends water from multiple wells, and PCE was not detected using EPA methods in drinking water (delivered to the tap) during this time. [EPA 2012]. Salt Lake City removed Water Well #18 from service 2004.

Surface water samples taken in the East Side Springs neighborhood following the 2010 Chevron pipeline spill into Red Butte Creek revealed that the PCE contamination was more widespread than suspected. PCE and TCE were detected in waters emanating from seeps and springs along the fault scarp. A 2011 CERCLA Site Groundwater sampling at the East Side Springs identified another PCE groundwater plume. The “Mt. Olivet Cemetery Plume” and the “East Side Springs” plumes both refer to the contamination more broadly referred to today as the “700 South 1600 East” Superfund site. Sampling within and around residences in the area was not initiated until 2015.

Site Contaminants Sampled

In environments with limited oxygen, as often found in the subsurface, PCE breaks down sequentially into TCE, cis-1,2-dichloroethene, and vinyl chloride (VC). 1,4-dioxane has been associated with chlorinated solvent manufacturing [EPA 2017a], and the VA has routinely sampled for this chemical as well. The VA does not have any known source of 1,4-dioxane outside of what may be associated with the PCE present. EPA identified these five chemicals as the initial contaminants of concern (COCs) for the site.

Recent Site Investigations

The shallow aquifer is not a source of drinking water; therefore, ATSDR did not evaluate groundwater as an ingestion pathway (i.e., drinking water source), but rather indirectly as inhalation exposure from evaporation into homes. The PCE plume emanates from a point outside AOU-1, and the groundwater is OU-2. The OU-2 investigation is ongoing. ATSDR will consider the need to further examine groundwater when the OU-2 investigation is complete.

The VA commenced sampling of contaminant vapors in homes, groundwater, and soil gas in 2015, and the investigation continues through the Superfund process. The VA and EPA established residential and commercial screening values and two-tiered Removal Action Levels (RALs) for the chemicals of concern. EPA/VA screening values provide a benchmark for further environmental sampling. EPA/VA indoor air screening values for PCE and TCE are 11 µg/m^3 and 2.1 µg/m^3, respectively. RALs are the decision point for installing technologies (e.g., filtration, ventilation) to reduce contaminant levels.

The VA conducted an initial residential vapor intrusion investigation from January to April of 2015, measuring VOCs in soil gas and indoor air in 35 structures that included residences, schools, a church, and an elder care facility. A data quality review noted issues with the 2015 data, which limits the use of the data in the health evaluation process [EA 2017a]. The VA eventually resampled these locations, providing data that is used in this report.

From February to June 2016, the VA collected indoor air samples from 10 residences and one school. In March and April of 2017, the VA's vapor intrusion investigation re-sampled 11 of the original 35 locations from the 2015 investigation and added an additional seven residences. Datasets from the 2016 and 2017 vapor intrusion investigations provide the clearest picture of health risk, and we evaluate those data in depth in the Environmental Health Evaluation Section of this PHA.[2]

From February to April 2016, the VA collected 62 samples from 42 temporary groundwater monitoring wells to characterize the shallow aquifer [VA 2019]. The groundwater investigation supported a conceptual model of migration of vapors from the saturated zone (i.e., the portion of the aquifer immersed in water) through the vadose zone (i.e., the upper portion of the subsurface where pores are not filled with water). Borings provided the basis for understanding the shallow subsurface geology. The maximum depth sampled was 37 feet; the minimum depth is at the surface, given the prevalence of natural springs fed by groundwater. Groundwater in the shallow aquifer flows toward the southwest.

The maximum PCE and TCE concentrations detected were 57 µg/L and 7.7 µg/L, respectively. There were no detections of VC (detection limit of 0.5 µg/L) and a single detection (detection

[2] In this health evaluation, ATSDR considered the 2015 VI set only qualitatively and to provide additional context to site exposure history. While the validated portion of the 2015 SUMMA® canister data is acceptable for analysis, the 2016 and 2017 VI investigation data sets provide more recent data and is better suited for quantitative analysis. In general, the validated 2015 data is consistent with the later sampling results; hence, ATSDR exposure calculations would not differ significantly were the 2015 incorporated into quantitative analysis. The VA and EPA used the 2015 data primarily to inform latter (2016 and 2017) sampling plans.

limit of 2.1 µg/L) of 1,4-dioxane at 2.7 µg/L. VC was not detected (within a 1.0 µg/L detection limit) in groundwater samples collected upgradient of AOU-1 in December 2019 as part of the OU-2 investigation (Mark Yalom, U.S. Department of Veterans Affairs, personal communication, February 19, 2020); 1,4-dioxane was not measured in this sample event.

The VA collected 24 soil gas samples over 22 locations from 2015 to 2017 in the East Side Springs area. In general, the soil gas values were consistent with groundwater sampling results. PCE in soil gas was detected at 14 of the 22 locations and values ranged from 1.4 µg/m^3 to approximately 2000 µg/m^3 in these homes. (see Appendix C). The VA subsequently tested the indoor air of the home (0053H) close to the highest soil gas concentration. PCE measurements ranged from non-detect (0.5 µg/m^3) to 24.1 µg/m^3 in this home TCE, VC and 1,4-dioxane were not detected in this home (detection limits of 0.5 µg/m^3, 0.13 µg/m^3 and 0.18 µg/m^3, respectively).

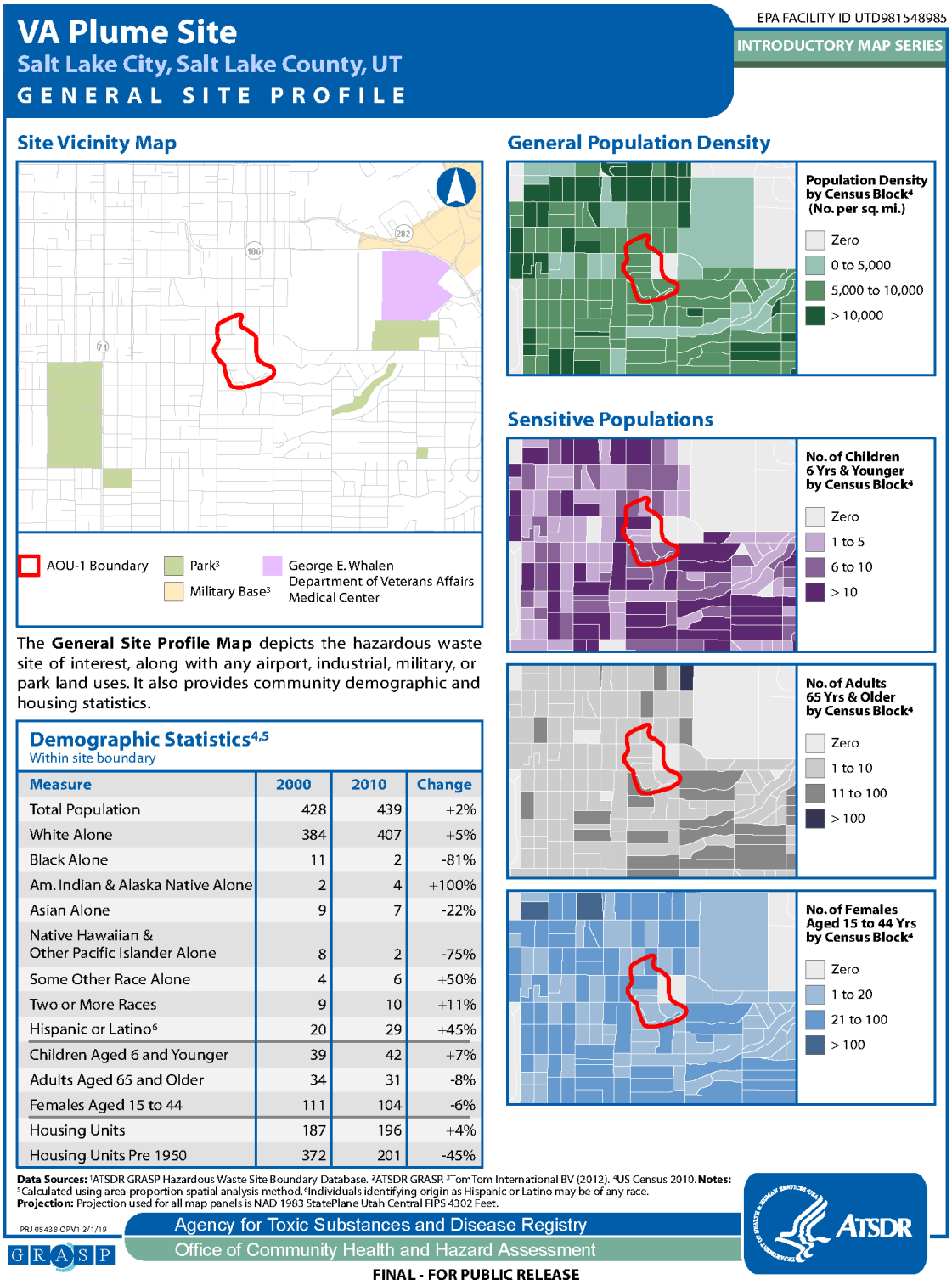
From February to May 2016, the VA collected surface water samples from Red Butte Creek, springs, creeks, sumps, and storm water collection lines to assess contaminant impacts to local surface waters. Surface water samples were collected along the Wasatch Fault line in the area just north of Michigan Ave and roughly bounded by S 1100 E and S 1200 E. The VA sampled 32 surface water locations from seeps, springs and sumps in addition to sampling Red Butte Creek [EA 2017b]. Also in this time frame, the VA collected three soil samples adjacent to seeps [EA 2016a].

There is also a caretaker residence on the grounds of Mount Olivet Cemetery. Well water from the irrigation well at the cemetery has been characterized, and data are pending for indoor air at the residence. At the request of EPA and the VA, these data will be evaluated in the future.

Time Critical Removal Action (TCRA)

Indoor air investigations in 2016 led to a Time Critical Removal Action (TCRA) in one home. A Time Critical Removal Action expedites contaminant mitigation in the Superfund process. The VA established a TCRA at the one home (Sample ID 0040H) in which some SUMMA® canister samples exceeded the PCE and TCE threshold values for remedial action. Following the 2016 indoor air sampling, the VA installed a portable filtration system and later a whole house filtration system for the home to capture VOCs present in the home. Ultimately, the resident preferred the portable filtration system, which is currently operating. The VA sampled to determine indoor air quality at multiple intervals from 2016 through 2019. ATSDR evaluates exposure and health risk for the TCRA in depth in the Environmental Health Evaluation Section in this PHA.

Figure 2: Demographic Overview AOU-1



Land Use and Demographics

Land use is primarily high density, single-family residences with limited commercial development mostly centered where 800 South and 900 South intersect 1300 East. The area developed from the 1910s through the 1940s. Two schools and one church are within or border AOU-1. Homes include small brick bungalows, wood frame cottages, and multistory homes. Some of the homes are built into the scarp. Salt Lake City planners do not expect major changes in land use in the near future.

Demographic analysis permits better identification of sensitive populations, such as young children and the elderly (see Figure 2). Based on 2010 census data, approximately 440 people live within the AOU-1 boundary. Four hundred and seven people identified as white; 29 as Hispanic; and the remainder in other categories. Approximately 10% of the population are children; 24% are women of childbearing age, and 7% are 65 or older.

EXPOSURE PATHWAY EVALUTION

An exposure pathway is the process by which contaminants migrate from a source to the human body. There are five elements to an exposure pathway:

1) source of contamination
2) environmental media (water, soil, air, waste, and biota)
3) point of exposure (residence, business, and recreational site)
4) route of exposure (ingestion, inhalation, and dermal contact)
5) receptor population (exposed people)

An exposure pathway includes all the elements that link a contaminant source to a receptor population. All five elements of the exposure pathway must be present in order for people to have potential health effects. The elements of an exposure pathway may occur in the past, present, or future [ATSDR 2005]. ATSDR conducted an exposure pathway evaluation, taking into consideration the concerns of the community to determine which pathways are completed.

ATDSR identified the following pathways for exposure (discussed in detail below).

- Contacting and incidental ingestion of surface water
- Contacting and incidental ingestion of contaminated soil
- Inhaling vapors from contaminated groundwater

ATSDR evaluated the potential for the drinking water pathway and determined that the pathway was incomplete. Appendix A summarizes the human exposures pathways.

Basis for Eliminating the Drinking Water Pathway

The Salt Lake municipal water system serves the residents of East Sides Spring. SLCDPU samples system's water regularly to determine compliance with the Safe Water Drinking Act. In 1997, Salt Lake City identified PCE in one municipal well (Water Well No. 18) of several that

contribute to municipal water [EPA 2012]. The city had not detected PCE in prior sampling. From 1997 to 2003, PCE values ranged from non-detect to 1.4 µg/L. SLCDPU blends water from several wells, and the blended, finished water remained at non-detect levels using EPA methods for PCE during this timeframe. However, as a point of reference, ATSDR's CREG is 12 µg/L; and, the Maximum Contaminant Level (MCL), EPA's regulatory standard, is 5 µg/L.

In 2004 sampling, PCE was detected at 2.33 µg/L in the Salt Lake Municipal Well #18) [UDEQ 2004]. Immediately following the detection, SLCDPU removed the well from service [UDEQ 2011]. Given the interval of testing (quarterly) and that the well was removed prior to a value in exceedance of the MCL, ingestion of tap water is not a pathway of concern.

Two drinking water wells owned by the University of Utah are located approximately 2,000 feet northwest of the Mount Olivet Cemetery well at 1511 East 500 South. Site documentation indicates that PCE has not been detected [UDEQ 2000] in these wells [VA 2019]. The SCLDPU samples the Liberty Park drinking fountain, an artesian well located down gradient of the PCE groundwater contamination plume, for regulated VOCs [SLCDPU 2017]. To date there have not been detections of PCE or TCE [SLCDPU 2017; UDEQ 2011]. The Mt. Olivet irrigation well, where routine sampling first identified PCE contamination in 1990 remains in use for watering the cemetery; however, it is not a source of drinking water.

Surface Water and Adjacent Soils Pathways (Completed)

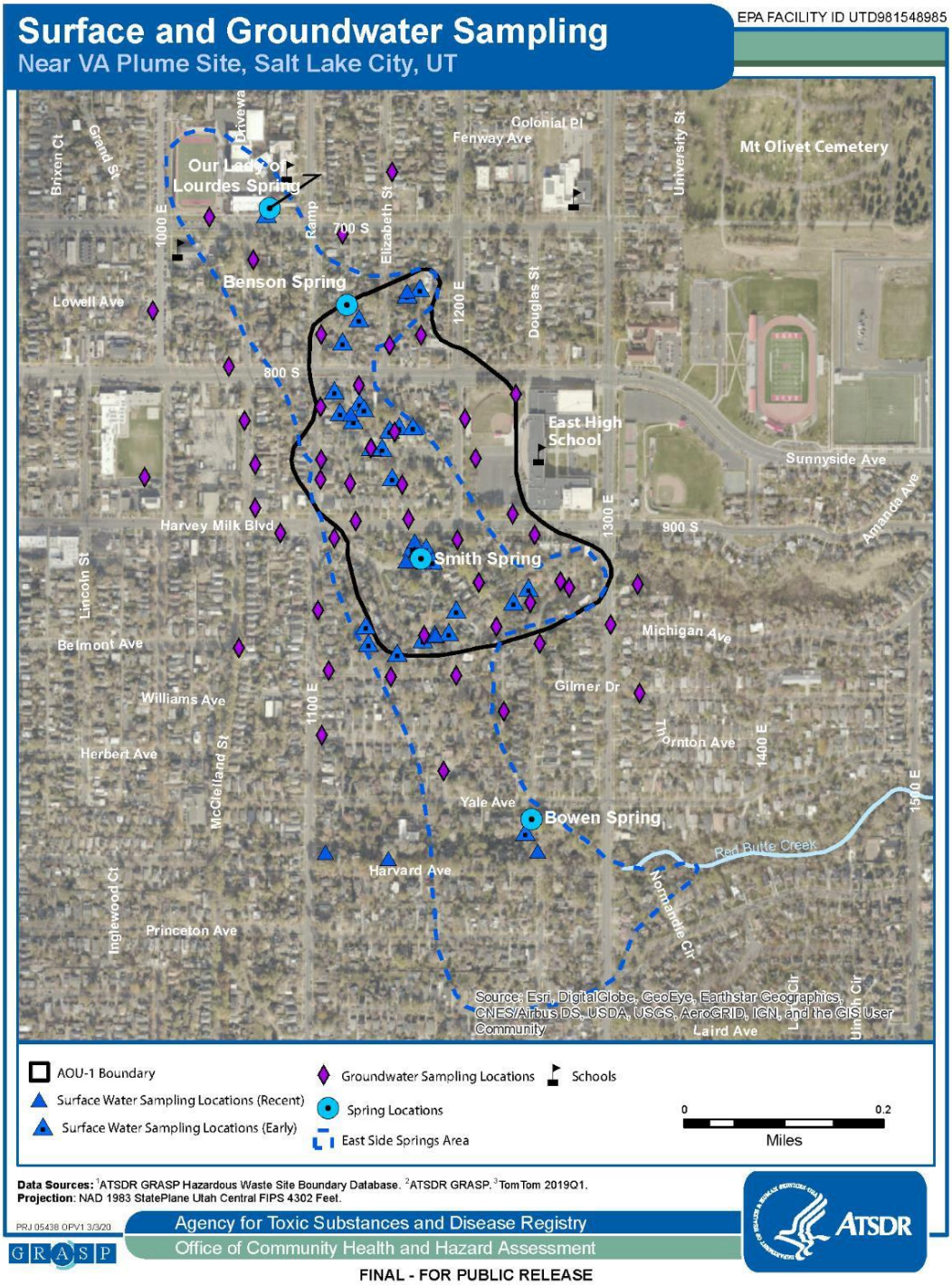
As groundwater emerges in springs and seeps in the area (see Figure 3), people may wade in, touch, or accidentally ingest small quantities of the water during play and irrigation. Similarly, they may touch contaminated soils near the springs. The seeps and springs are not drinking water sources; people do not swim or fish in them.

Incidental ingestion of and dermal absorption of contaminants in spring water is a potential exposure pathway for the past, present, and future. Touching and incidentally eating small amounts of soil is also a potential exposure pathway for the past, present, and future.

Inhalation Pathway (Completed) -- Vapor Intrusion and Diffusion

As chemicals evaporate from groundwater, they may migrate into homes (i.e., vapor intrusion). Vapor intrusion occurs if a pressure gradient favors movement of gas from groundwater through soil to the home interior. The chemicals may accumulate in homes, resulting in concentrations that present a risk to health. In homes where the basement may intersect the water table when precipitation causes the water table to rise, contaminants may diffuse from the water absorbed onto the foundation or basement walls into the breathing zone. This phenomenon ("diffusion"), relevant in one AOU-1 home (0040H), is similar but not the same as vapor intrusion. The health implications, namely VOCs in the breathing zone, are analogous. While many homes in this part of Salt Lake City experience diffusion and groundwater management is a well-known problem, home 0040H is the only one with demonstrated indoor air contamination at a level of concern.

Figure 3: Surface Water Sample Locations within AOU-1



The VA has measured VOCs in multiple residential indoor air samples. Breathing the chemical vapors from contaminated groundwater is a completed past, present, and future exposure pathway.

ENVIRONMENTAL DATA AND HEALTH RISK SCREENING

For each chemical detected on site, ATSDR compares maximum contaminant concentrations for each completed pathway to ATSDR comparison values (CVs) to screen chemicals for further evaluation. CVs are doses (health guidelines) or substance concentrations (environmental guidelines) set well below levels that are known or anticipated to result in adverse health effects. CVs permit screening data in a consistent manner. CVs are not thresholds of toxicity and do not predict health effects or establish cleanup levels. A concentration above a comparison value does not necessarily mean harm will occur. CVs indicate the need for further evaluation. We do not evaluate maximum contaminant concentrations below comparison values further, because it is unlikely these lower contaminant concentrations would cause adverse health effects.

In screening PCE, TCE, 1,4-dioxane, 1,2 cis-DCE, and VC at this site for the soil ingestion and vapor intrusion pathway, ATSDR relied on the following CVs.

- ATSDR Cancer Risk Evaluation Guides (CREGs)
- ATSDR Environmental Media Evaluation Guides (EMEGs)
- ATSDR Reference Media Evaluation Guides (RMEGs)

The detections of VC and 1,4-dioxane are rare and may be attributed to background or their presence in household chemicals. ATSDR reviewed the groundwater and soil gas sampling and did not find sufficient evidence to support VC and 1,4-dioxane as likely contaminants associated with the site. Nevertheless, as there is a single detection of each (in separate homes), we evaluate risk individually for those homes.

The VA collected data in accordance with quality assurance and quality control (QA/QC) protocols and data quality objectives identified in work plans [FE 2015], quality assurance plans [EA 2016b], and sampling and analysis plans [FE 2014]. The plans followed EPA guidance for collection and laboratory analysis of data. The VA, EPA, UDEQ, and ATSDR reviewed field data reports for consistency with data quality objectives.

Indoor Air

For the inhalation (i.e., VI) pathway, maximum concentrations detected (i.e., screening all the indoor air data collected from multiple homes) exceed ATSDR CVs for PCE, TCE, VC, and 1,4-dioxane. Table 1 below summarizes the comparison; Appendix B provides a complete list of all the air CVs for these contaminants.

ATSDR does not have an inhalation CV for cis-1,2 DCE; however, the highest detection of 3.05 µg/m³ is well below the CV of 790 µg/m³ for the stereoisomer trans-1,2 DCE. The trans-1,2 DCE is a reasonable substitute for screening; hence, ATSDR would not expect adverse health effects from breathing this concentration of cis-1,2 DCE.

Please note that maximum indoor air contaminant concentrations detected are used here for screening the vapor intrusion pathway. In the Environmental Health Evaluation section, we develop plausible exposure scenarios to evaluate the likelihood of adverse health risks.

Contaminant concentrations in groundwater and soil gas also provide insight into indoor air concentrations. Vapors travel from contaminated groundwater through soil and into homes. We compared the maximum groundwater and soil gas concentrations for the shallow aquifer (2016 and 2019 data) to ATSDR comparison values for vapor intrusion. The comparisons, which offer a sense of magnitude, are presented in Appendix D, and necessitate further evaluation of PCE, TCE, and VC. In this health assessment, we evaluate indoor air measurements collected in 2016 and 2017 to determine the possibility of harmful effects in people. The indoor air concentrations can be used as a direct measure of exposure. We note that the VA protocol provides for follow-up indoor air sampling in homes when soil gas values approach or exceed screening levels.

Table 1: Contaminant Screening to ATSDR Indoor Air Comparison Values

Contaminant Name	Exposure Medium	Maximum Site Concentration (indoor air)	Unit	ATSDR Recommended CV	ATSDR CV Type	Selected for Further Evaluation?
TETRACHLOROETHYLENE	Air	78	µg/m³	3.8	CREG	Yes
TRICHLOROETHYLENE	Air	9.3	µg/m³	0.21	CREG	Yes
VINYL CHLORIDE	Air	0.19	µg/m³	0.11	CREG	Yes
1,4-DIOXANE	Air	2.3	µg/m³	0.20	CREG	Yes

Soil

In May 2016, the VA collected three soil samples adjacent to seeps and measured PCE, TCE, 1,4-dioxane, cis-1,2-DCE, and VC [EA 2016a]. Table 2 summarizes how ATSDR has screened soil contaminant values for further evaluation. The maximum PCE value (at location A-SS-26) is below the ATSDR CVs for children and adults; therefore, PCE in soils and sediment was not selected for further evaluation. We present the detection limits (also below the respective CVs) for the remaining chemicals as conservative substitutes for detections.

Table 2: Soil Contamination Compared to ATSDR Soil Comparison Values

Contaminant Name	Exposure Medium	Maximum Site Concentration	Unit	ATSDR Recommended CV	ATSDR CV Type	Selected for Further Evaluation?
TETRACHLOROETHYLENE	Soil/Sediment	0.022	ppm	180	CREG	No

TRICHLOROETHYLENE	Soil/Sediment	<0.01	ppm	5.6	CREG	No
1,4-DIOXANE	Soil/Sediment	<0.12	ppm	3.9	CREG	No
1,2-DICHLOROETHENE, CIS-	Soil/Sediment	<0.01	ppm	100	RMEG Child	No
VINYL CHLORIDE	Soil/Sediment	<0.01	ppm	0..8	CREG	No

The soil concentrations shown in Table 2 are below ATSDR's screening values, indicating that these chemicals are not present in soil at quantities that would pose risk to health; hence, no further evaluation for the soil ingestion pathway is included here. Although the number of samples are limited, the existing data suggest that contact with soils does not present a health risk.

Surface Water Pathway

ATSDR does not have comparison values for surface water. Instead, we develop an exposure scenario and model the dose to determine if there is a health risk.

In assessing potential exposures to the seeps and springs in AOU-1, ATSDR evaluates direct contact with surface waters during intermittent play (including wading) and irrigation. The springs and seeps are features of some residential properties. When people contact the surface water, they may absorb contaminants through their skin. This surface water is not a drinking water source; nor is it used for swimming or fishing.

In the first half of 2016, the VA collected surface water samples from Red Butte Creek, springs, creeks, sumps, and stormwater collection lines (see Figure 3) to assess contaminant impacts to local surface waters. The VA sampled 32 surface water locations from seeps, springs and sumps in addition to sampling Red Butte Creek [EA 2017b]. In March 2109, the VA resumed surface water samples [Jacobs 2019]. Table 3 below presents the highest values detected for each chemical. Note that 1,4-dioxane and VC were not detected within the 0.5 µg/L detection limit (both chemicals) and are not considered for the dermal exposure pathway.

To develop a conservative scenario for children and adults touching surface water, we have assumed that someone might wade (or landscape) at a contaminated spring for approximately one hour (duration), three days per week for six months per year. Assuming exposure through childhood, we estimated total cancer risk from birth to age 21. For adults the model assumes a thirty-three-year duration. These assumptions are likely overly conservative, but such an approach accounts for the uncertainty in the exposure scenario.

People's contact with contaminated surface waters is intermittent and likely not necessarily uniformly distributed over the area sampled. ATSDR cannot discern a clear pattern of potential contact – individual property owners would likely contact the surface water on their property; children may or may not play on neighbor's properties. Although sampling to date is well distributed spatially, site investigations have not yet determined how concentrations vary over

time. For these reasons, we have taken a conservative approach and used the highest concentration in evaluating potential health effects from contacting surface water.

PCE and TCE are volatile chemicals and tend to evaporate as water trickles from the stream through the landscape diversions on many properties. Though this physical-chemical process is, in this case, too variable to model; the change of phase and subsequent mixing likely means the dermal contact exposure model calculation is likely based on exaggerated concentrations.

For all three chemicals detected, estimated doses are below the ATSDR MRL (see Table 3 below), indicating that adverse non-cancer health effects are not anticipated from contacting surface water at the site [ATSDR 2018]. Table 3 shows the adult dose, which is below the MRL. The estimated doses for children are well below the MRL. ATSDR has not developed a chronic MRL cis-1,2-DCE; however, the intermediate MRL for trans-1,2-DCE (0.3 mg/kg/day) serves here as a reasonable substitute

Table 3: Non-Cancer Health Risk for Chemicals Detected in Surface Water

Chemical	Maximum Concentration (µg/L)	Sample Location	Estimated Adult Dose* (µg/kg/day)	ATSDR MRL (µg/kg/day)	Above or Below ATSDR MRL
PCE	82	SW-35	0.14	8.0 (chronic)	Below
TCE	2.8	SW-53	0.0013	0.5 (chronic)	Below
Cis-1,2-DCE	0.7	SW-53	0.00026	300 (intermediate)	Below

***Surface Water Dermal Absorbed Dose is derived from the following equation** ADD = $(DA_{event} \times SA \times EV \times EF) / (BW \times ABS_{GI})$ ADD = Administered Dermal Dose (mg/kg/day), DA_{event} = Absorbed Dose per Event (mg/cm^2/event), SA = Surface Area Available for Contact (cm^2), EV = Event Frequency (events/day), EF = Exposure Factor (unitless), BW = Body Weight (kg), ABS_{GI} = Gastrointestinal Absorption Factor (unitless). Dermal doses were calculated using ATSDR's PHAST v1.7.
~Vinyl chloride has a higher vapor pressure and diffuses rapidly at the surface, thus is unlikely to be found in surface water

Using the same exposure scenario, ATSDR estimated cancer risk for PCE and TCE. We present the numerical results derived from ATSDR'S Public Health Assessment Site Tool (PHAST) v1.7 in Table 4 below. There is "inadequate information to assess the carcinogenic potential" to cis-1,2-DCE [EPA (IRIS) 2010]; therefore only non-cancer endpoints have been considered for cis-1,2-DCE.

Table 4: Excess Cancer Health Risk for Chemicals Detected in Surface Water

Chemical	Concentration (µg/L)	Sample Location	Estimated Adult Cancer Risk	Estimated Child Cancer Risk	Cancer Risk Conclusion
PCE	82	SW-35	1.2E-7	1.0E-07	Low
TCE	2.3	SW-36	2.6E-08	3.4E-08	Low

Estimated cancer risks for PCE and TCE are 1 cancer in every 10 million people similarly exposed (PCE) and 3 cancers in every 100 million people similarly exposed. The actual cancer risk is probably much lower because of the conservative assumptions used in estimating the risk (e.g., contact three times a week for 26 weeks a year for up to 33 years). As such, these cancer

risk estimates are not a concern. The quantitative cancer risk assessment for TCE considers TCE's mutagenic mode of action (MOA) for carcinogenesis [ATSDR 2014b]. Age-dependent adjustment factors (ADAFs) were applied to the calculation of cancer risk [EPA 2005].

Intermittent contact and incidental ingestion of surface water from the seeps and springs is unlikely to cause health effects. We did not evaluate the data further.

ATSDR Screening and VA/EPA Screening: Differences and Similarities

Both ATSDR and the VA refer to "screening" chemicals. ATSDR's screening process differs from the VA's indoor air screening process because the screening methods and processes are different. The VA screens indoor air initially with portable field GC/MS analysis to determine if analytical (laboratory) sampling (EPA Method TO-15) is necessary. The VA uses the results to evaluate if the risk is within (or exceeds) the EPA target risk range and if future actions are needed. ATSDR screens sampling data (i.e.,) using media-specific concentrations to determine if the potential exposure warrants further evaluation for determining possible health effects.

The VA screening levels for carcinogens are based on a 10^{-4} cancer risk, which is the lower value in EPA's cancer risk range of 10^{-4} to 10^{-6} used for deciding clean up actions. This risk range equates to 1 in 10,000 to 1 in 1,00,000 excess lifetime cancer risk[‡]. For non-carcinogens, the VA screening level is the hazard index equal to one [CH2M HILL 2015]. For PCE, the VA screening value is based on cancer and for TCE it is based on non-cancer. The VA bases the decision to install a mitigation system in a home if data collected with Method TO-15 exceed their Removal Action Level (RAL). The residential Tier 1 RALs for PCE and TCE correspond to ATSDR's MRLs.

While ATSDR's screening process (in the evaluation of data) is different, Table 5 below presents a comparison of ATSDR's comparison values to the VA/EPA indoor air screening level (IASL) and removal action level (RAL).

Table 5: ATSDR Indoor Air Comparison Values

Chemical	CREG ($\mu g/m^3$)
PCE	3.8*
TCE	0.22*
Cis-1,2 DCE[+]	NA
VC	0.11*
1,4-Dioxane	0.20*

[+]ATSDR does not have an MRL for cis-1,2 Dichloroethene; however, an MRL for the stereoisomer, trans-1,2 Dichloroethene is substituted here. * ATSDR recommended CV.

[‡] EPA defines excess cancer risk as the additional or extra risk of developing cancer due to exposure to a toxic substance incurred over the lifetime of an individual. EPA's Regional Based Screening Levels can be found at https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

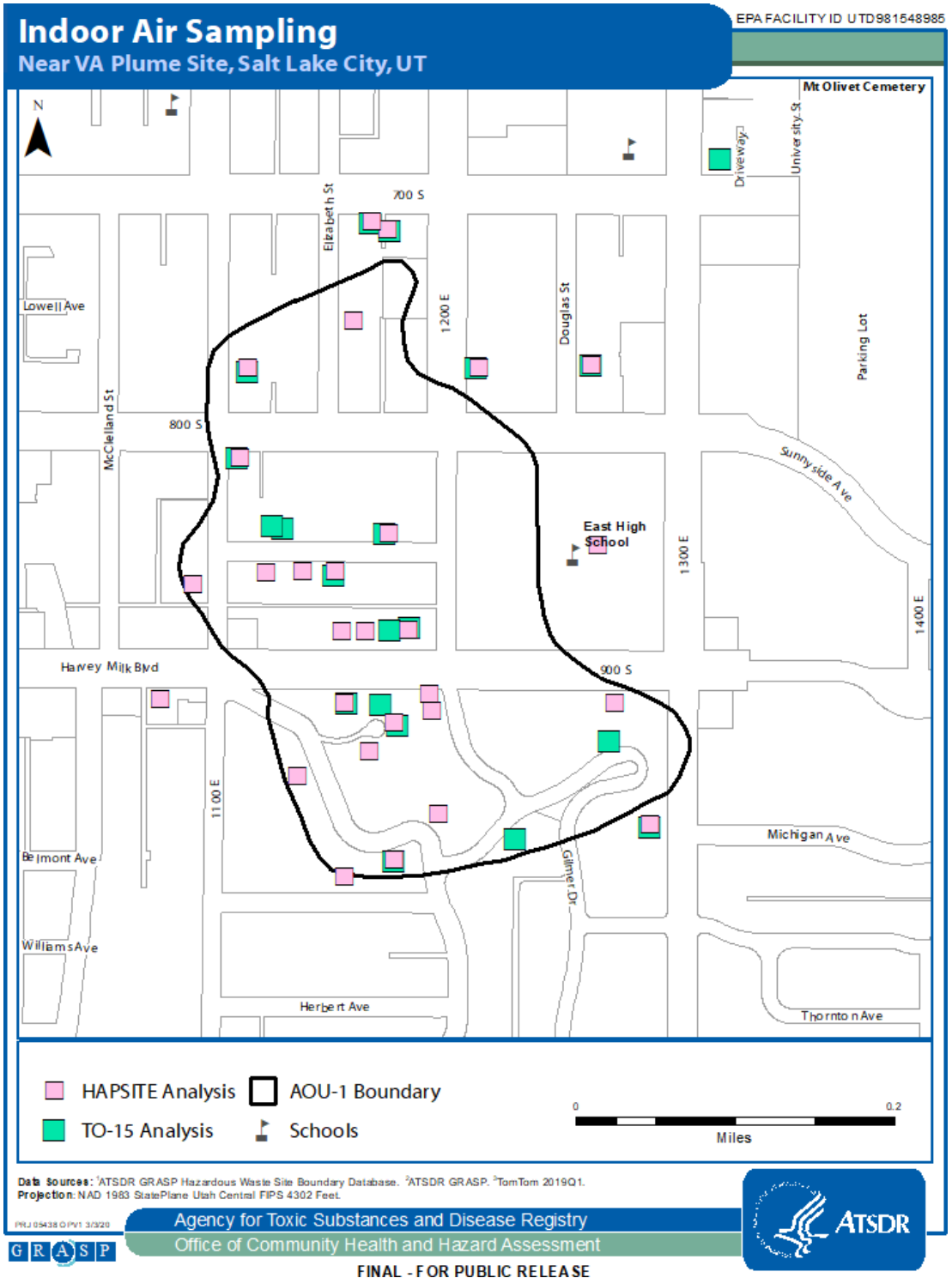
ENVIRONMENTAL HEALTH EVALUATION

An ATSDR MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse, non-cancer health effects over a specified duration of exposure.

Indoor Air

Indoor air varies from home to home, and our health evaluation considers each home (identified by sample number) separately. For each home, we have screened the maximum concentrations of each chemical against the ATSDR CREG to determine if further health evaluation is needed for that home. Of the 34 homes (see Figure 4) sampled for indoor air, 22 had indoor air concentrations that did not exceed the ATSDR screening value for the chemical selected as contaminants of concern. Appendix C provides the home-by-home screening for each COC. Health evaluation for the remaining 12 homes with an exceedance of any contaminant above an ATSDR CV (i.e., CREG) follows. Since the CREG is lower than the MRL (a screening tool for non-cancer health effects), ATSDR finds that adverse non-cancer health effects are unlikely in 22 homes that are below the initial screening using the CREG.

Figure 4: Indoor Air Sample Locations



EPA Method TO-15 provides higher quality data than portable GC-MS data. Since a SUMMA® canister (the sample collection vessel in EPA Method T0-15) collects for 24 hours and averages values over time, EPA Method TO-15 offers a better characterization of exposure. For these reasons, ATSDR has relied on the EPA Method TO-15 whenever available. Our analysis relies on data collected with portable GC-MS for homes where the VA did not conduct further sampling with EPA Method TO-15. The sampling methodology is sound; however, we do not completely understand temporal variation of indoor air concentrations at this time. Substantial variation in vapor intrusion rates can occur due to changes in factors such as temperature, barometric pressure, heating and ventilation [EPA 2017b]. For this reason, we have chosen to evaluate the risk of harmful effects using the highest detection in each home although the analysis may be overly conservative.

During the investigations, which measured breathing zone air, the VA also measured VOCs in three floor cracks and in some sumps [CH2M HILL 2017; VA 2016]. These measurements are not directly applicable to exposure within the home's livable space; however, high values lead to a recommendation for further sampling in the absence of groundwater remediation. Building construction and the condition of the home effect the transfer of vapors into the home [ATSDR 2016].

PCE and TCE are present in the environment at background concentrations. The potential presence of some of the site chemicals associated with ambient and indoor air (e.g., from household solvents and cleaners) complicates evaluation of chronic risk from vapor intrusion because the source of the contaminant may not be certain [EPA 2017b]. Our analysis does not consider source, only the measurement. Given the multiple factors in air quality at a vapor intrusion site, ATSDR adopts a "multiple lines of evidence" approach in evaluating the potential for vapor intrusion [ATSDR 2016]. This means ATSDR looks at available air data from multiple methods and multiple locations in a building, when available, and looks at water data too.

The dataset includes a single detection of 1,4-dioxane and a single detection of VC; however, detection of these chemicals is notably absent from the dataset as a whole (i.e., groundwater, indoor air, and soil gas). The very low frequency and concentrations of VC and 1,4-dioxane detected in air suggest that these chemicals do not contribute to health risk (cancer or noncancer) for the residents at the site.

One home (Sample ID 0040H) is unique in that the VA installed two systems (water and air) to reduce contaminant levels in indoor air. During the TCRA, the VA sampled the home on many occasions unlike homes sampled only once during 2016-2017. The data from multiple sampling events offer the statistical confidence to develop a health evaluation based on the entire data set for this home rather than a single maximum value. Portions of the home, including a living space in the northwest corner are below grade [Welsh 2016]. Seeps and springs are visible in the eastern and northern sections of the property. Groundwater wicks into basement walls when spring runoff raises the water table. At this home, both diffusion from basement seeps and vapor intrusion from soil may be contributing to indoor air quality.

Cancer Classification of Contaminants of Concern

PCE By weight-of-evidence characterization, EPA classifies PCE as "likely to be carcinogenic in humans by all routes of exposure." [EPA (IRIS) 2012]. EPA bases this characterization on suggestive evidence of carcinogenicity in human epidemiologic studies and conclusive evidence that the administration of tetrachloroethylene, either by ingestion or by inhalation to sexually mature rats and mice, increases tumor incidence. The National Toxicology Program (NTP) classifies PCE as "reasonably anticipated to be a carcinogen" (https://ntp.niehs.nih.gov/whatwestudy/assessments/cancer/roc/index.html)

Human epidemiologic studies associate PCE exposure with bladder cancer, non-Hodgkin lymphoma, and multiple myeloma using precise assessment methodologies [EPA (IRIS) 2012]. Epidemiologic studies with less precise exposure assessment methodologies associate PCE exposures with esophageal, kidney, liver, cervical, and breast cancer effects [ATSDR 2014a].

TCE By weight-of-evidence characterization the EPA classifies TCE as "carcinogenic to humans" by all routes of exposure [EPA (IRIS) 2011]. EPA bases this characterization on suggestive evidence of carcinogenicity in human epidemiologic studies. NTP classifies TCE as a "known human carcinogen".

Human epidemiologic studies associate TCE exposure with kidney cancer, non-Hodgkin's lymphoma and liver cancer [EPA (IRIS) 2011]. Some epidemiologic data provide suggestive evidence of an association between TCE exposure and bladder, esophageal, prostate, cervical and breast cancer, and childhood leukemia [ATSDR 2014b]. Multiple studies identify some of the same cancer target tissues in rats and mice, including the kidney, liver, and lymphoid tissues.

Indoor Air Excess Cancer Risk

ATSDR evaluated cancer risk from breathing PCE, TCE, 1,4-dioxane and VC in the 12 residential properties where one or more chemicals exceeded ATSDR's recommended CV for cancer. We consider the home with Sample ID 0040H in a separate section below. Appendix C details the screening of homes for all chemicals compared to the ATSDR CREG. In each home with a value higher than the CREG, the highest indoor air concentration multiplied by the Inhalation Unit Risk (IUR) calculates theoretical excess cancer risk (see Appendix E for detail). We adjust risk for early life exposure to TCE and VC to account for the mutagenic mode of action.

ATSDR has made conservative assumptions about the magnitude and frequency of exposure for all scenarios considered. The cancer risk model assumes someone resides in their home and breathes the given concentration in air for 365 days per year for 33 years, 24 hours per day and lives for 78 years. The scenario assumes time from birth to capture the most vulnerable infant and child developmental period (21 years as a child and 12 years as an adult). For a residential scenario, we screen using the worst-case scenario in which people are in their homes all the time breathing the air with the highest detection. For comparison, the central tendency (i.e., a scenario more reflective of actual trends, but not the one adopted here) exposure scenario assumes 12 years of exposure. Twelve years is average time someone lives in a residence before moving. See Appendix E.

Only field GC/MS analysis was performed in homes 0041H and 0047H, and the analysis did not include 1,4-dioxane or VC. Since the portable instrumentation could not detect these chemicals below screening values, the VA instead demonstrated that 1,4-dioxane and VC were in general not present above screening values with additional sampling with EPA Method TO-15 [EA 2015]. In examining both indoor air data as a whole and soil gas data, ATSDR determined that PCE and TCE, not VC or 1,4-dioxane, drive risk at the site. For these homes, the detection limit for TCE is higher (0.5 µg/m^3), which affects the upper bound risk value. Though the lack of VC and 1,4-dioxane and the increased detection limit for TCE for these homes add a small degree of uncertainty, it is unlikely that the additional uncertainty affects our conclusions.

The EPA describes its risk management range for cancer as "one in ten thousand to one in a million cancers in exposed people *in excess* of what would normally appear in the population." The numerical equivalent is 10^{-4} to 10^{-6} (also written as E-4 to E-6). Cancer is common, with one in two men and one in three women developing some form of cancer in their lifetimes in the U.S.

ATSDR has calculated the theoretical excess cancer risk for each chemical detected in each home (see Table 6 below)

Table 6: Theoretical Excess Cancer Risk from Continuous Breathing of Indoor Air by Home†

Home	Excess Cancer Risk PCE	Excess Cancer Risk TCE	Total Excess Cancer Risk	Cancer Risk Conclusion
0002H	2E-07	6E-07	8E-07	Low
0011H	1E-06	0 to 6E-07*	2E-06	Low
0017H	1E-06	9E-07	2E-06	Low
0018H	1E-06	2E-06	3E-06	Low
0023H	2E-07	4E-06	4E-06	Low
0037H	4E-07	0 to 6E-07*	1E-06	Low
0041H	5E-07	0 - 1E-06*	2E-06	Low
0047H	8E-07	0 to 1E-06*	2E-06	Low
0051H	2E-07	6E-07	8E-07	Low
0053H	3E-06	0 to 1E-06*	4E-06	Low
0054H(a)	3E-06	2E-05	2E-05	Low to Moderate

0054H(b)	3E-07	6E-06	7E-06	Low
0056H	8E-07	0 to 1E-06*	2E-06	Low

Upper 95% confidence limit (UCL) of the arithmetic mean used to generate risk estimates.
* These cancer risks are based on a non-detect concentration and assume the concentration is zero for the lower bound estimate and the detection limit for the upper bound estimate.
† Risk calculations assume a 78-year lifespan with exposure 24 hours per day, 365 days per year for 33 years. Calculations made with the RAIS Contaminated Media Risk Calculator [RAIS].

All homes (except 0040H discussed in detail below) have cancer risk estimates that are very low and not a health concern. Because many protective assumptions went into estimating the cancer risk (i.e. 33 years exposure to the maximum concentration), the cancer risk from exposure to these chemicals is likely much lower than the risks shown in Table 6.

The residents of home 0054H stored and used chemicals in their basement to maintain their motorcycles. The maximum PCE and TCE values were 21.4 µg/m^3 and 9.3 µg/m^3, respectively. The maximum PCE and TCE measurements dropped to 2.8 µg/m^3 and 2.9 µg/m^3 when the VA removed chemicals from the shop. After removing the basement chemicals, the total cancer risk drops from 2E-5 (2 in 100,000) to 7E-6 (0.7 in 100,000). Vapor intrusion from the contaminant plume did not appear to be the primary VOC source for this home.

For home 0054H prior to removal of the in-home chemicals (value 0054(a) in Table 6), the total (PCE and TCE) calculated cancer risk is two excess cases per 100,000 people exposed; however, that calculation assumes that the indoor air measurements taken in the basement shop are present throughout the home. PCE values in the other parts of the home (excluding the shop) ranged from 2.6 µg/m^3 to 6.9 µg/m^3, and TCE values ranged from 1.4 µg/m^3 to 5.5 µg/m^3 Eleven other indoor measurements taken in different living spaces were less than the shop, though most were above the CREG for TCE and PCE. In general, ATSDR considers the overall cancer risk to be low for this home for the sample timeframe. Both TCE and PCE indoor air values were lower in follow up sampling (value 0054(b) in Table 6). The homeowners removed the motorcycle maintenance chemicals in conjunction with the sale of the home (Susanne Fairclough, U.S. Department of Veterans Affairs, personal communication, 2019).

In an uninhabited section of the basement of home 0053H, the VA measured PCE values from non-detect (0.5 µg/m^3) to 24.1 µg/m^3 PCE. The estimated cancer risk from PCE exposure is 2E-6 (2 in a million) so the cancer risk is still below a level of concern. TCE was not detected within an 0.5 µg/m^3 detection limit. We excluded the TCE non-detects from cancer risk calculation since they do not represent exposure; however, the higher detections warrant VI monitoring over time. During the investigation with a portable GC-MS, the VA noted that the vapors emanated from a crack in the basement floor. The VA sealed these cracks to reduce vapor intrusion from the subsurface [Welsh 2016], and maximum PCE values fell below the VA IA screening values. Similarly, the VA reduced PCE indoor air concentrations from 4 µg/m^3 to below detection limits by sealing a basement crack in home 0037H.

In home 0059H, breathing zone concentrations of PCE and TCE were below the ATSDR CREG; however, a measurement taken when the probe of a portable GC-MS was placed in a basement floor drain were far higher (1071.2 µg/m^3 PCE and 12.35 µg/m^3 TCE). Although residents are not breathing VOCs at these concentrations, the relatively higher concentrations (along with higher values found in basement cracks and near sub-slab soil gas in other homes) speak to the need for follow up indoor air testing to ensure that conditions have not changed.

The VA measured a single indoor air detection (2.3 ug/m3) of 1,4-dioxane in home 0025H and single detection of VC (0.19 ug/m3) in home 0001H. Given that these detections were not reproduced in (and are not consistent with the groundwater and soil gas investigation), they appear to be anomalous. The exposures may be intermittent; however, following our conservative approach, we calculated the excess lifetime cancer risk for these detections to ensure longer exposures would not alter our conclusions about risk. The excess lifetime cancer risk for exposure to 1,4-dioxane (home 0025H) is 4E-06 (4 in a million), The excess lifetime cancer risk for exposure to VC at home 0001H is 1E-06. These estimated risks are very low and not a concern.

Over three sampling events in March 2016, the VA surveyed indoor air for cis-1,2-DCE, PCE, and TCE at 57 locations within East High School using field GC/MS [VA 2016]. During the Remedial Investigation, regulators ultimately excluded East High School from AOU-1; nevertheless, ATSDR believes screening the data in a health context is appropriate. Values were non-detect (less than 0.5 µg/m^3 for TCE and 0.7 µg/m^3 for PCE) for all areas where students and teachers spend their days. We did not identify a health risk associated with these data; however additional sampling is needed to understand seasonal changes because the previous samplings were collected over a single month (March).

The VA measured PCE at 1.4 µg/m^3 and TCE at 0.8 µg/m^3 in the breathing zone of the school's staff auto-maintenance shop. Field instrumentation detected PCE at 40 µg/m^3 in the chemical storage room in the auto shop. The data pattern suggests that detections are associated with chemicals used in the shop, not the site plume. School maintenance workers breathe and contact VOCs in the chemical storage room from occupational use. We note that the detections were below the ATSDR MRLs for TCE and PCE, and people breathe air in the room only intermittently. Table 5 provides the MRLs for the site contaminants.

Indoor Air Non-Cancer Risks

None of the homes (except for 0040H considered separately below for all chemicals) exceeded the MRL for PCE, and the single detections of 1,4-dioxane and VC are well below the respective ATSDR MRLs. Hence, we would not anticipate non-cancerous health effects from breathing the concentrations of PCE, 1,4-dioxane and VC detected. Maximum concentrations of TCE measured in home 0054H exceeded the TCE MRL of 2.1µg/m^3. Prior to clean out of the shop, indoor air TCE concentrations tested in the living spaces of home 0054H ranged from 3.2 µg/m^3 to 9.3 µg/m^3. After the clean out, concentrations ranged from non-detect to 2.8 µg/m^3.

In October 2014, ATSDR published an MRL of 2.1 µg/m^3 for longer-term TCE inhalation exposure [ATSDR 2014b]. ATSDR derived the MRL from an animal study, which observed an

increase in fetal cardiac malformations, the most sensitive health endpoint. ATSDR converted the effect level for fetal cardiac malformations to a human equivalent concentration (HEC) of 21 µg/m^3 for the critical exposure period of three weeks in early pregnancy where the developing fetal heart is most sensitive to the effects of TCE exposure. ATSDR applied a 10-fold uncertainty factor to the HEC to derive the chronic inhalation MRL.

The highest measured TCE concentrations (9.3 µg/m^3) in indoor air at 0054H exceed the MRL and approached levels (21 µg/m^3) shown in animals to cause cardiac malformations. A pregnant woman who breathed air with TCE at the detected concentrations may be at an increased risk of having her fetus develop a heart defect if she spent a large portion of time in the motorcycle maintenance shop. Note that it is likely that solvents used in the maintenance shop are a significant contributor to the TCE measured at 0054H. No pregnant women are currently living at this home.

Health Evaluation Home 0040H

The 2015 and 2016 indoor air sampling identified one home (Residence 0040H) with indoor air concentrations greater than the CVs for PCE and TCE. PCE values from 24-hour SUMMA® canisters measured 59 µg/m^3 and an estimated 78 µg/m^3 in the kitchen and the basement bedroom, respectively. The sampling detected TCE at a maximum of 5.4 µg/m^3 (basement bedroom). The basement living space is about 552 square feet and includes a storage area, a bedroom, and a utility room [Welsh 2018].

As an interim measure, the VA installed three portable air purifiers in residence 0040H to reduce VOC air concentrations in the home in May 2015. Subsequent sampling confirmed reductions of PCE and TCE [Welsh 2018].

In October 2016, the VA commenced a Time Critical Removal Action (TCRA), which provided for installation of a whole house air purifier at Residence 0040H [Welsh 2016]. The VA contractors retrofitted the existing furnace to include activated carbon filtration to capture PCE. To address increased noise from the furnace motor, the homeowner adjusted the system's flow rate, likely changing the efficacy of VOC removal from the home [VA 2018a]. In the months that followed, the VA contractors reset it to the design parameter [VA 2018c].

The VA monitored the system performance with SUMMA® canister placed in the home's basement bedroom, kitchen, and upstairs bedroom. Intermittent exceedances of the RALs observed in quarterly sampling led to changes in the frequency of activated carbon filter replacements [VA 2018a]. In January 2018, the VA increased the granulated activated carbon and permanganate (an oxidant to the filter media to improve system performance). At the recommendation of an HVAC technician, the VA contractors lowered the flow rate to the house purifier because the furnace was not designed to accommodate the increase air flow (i.e., the source of the noise) required to operate the whole house purifier.

The changing flow rate and tweaking of the filters introduce a measure of uncertainty to statistical calculation of representative PCE and TCE values. Nevertheless, we believe the body of data (from November 2016 through Jan 2019, labelled the "vapor mitigation system

determination period") is large enough to offer a reasonable assessment of health risk for this period. We approached this analysis by using the 95 UCL of the mean (n=31) for indoor air samples during this time frame as a conservative exposure concentration.

Testing of indoor air in April 2018 indicated that modifications to the system substantially improved the efficacy of VOC removal. [VA 2018b]. The homeowner ultimately preferred the portable air filters as a remedy, however. We note that EPA considers this an interim remedy.

Home 0040H Indoor Air Excess Cancer Risk

We divide the cancer risk evaluation into three overarching periods: 1. initial measurements from March 2016 that established the need for a mitigation system; 2. the vapor mitigation system determination period from November 2016 to January 2019; and, 3. the most recent measurements from January 2019 and June 2019, when the VA contractors optimized portable filters. This last measurement offers the best representation of current and future risk. The resident informed ATSDR that he lives in a winter home (away from Salt Lake City) for half of the year. We have adjusted the exposure scenario to 182.5 days per year (instead of 365) to more accurately calculate risk. The risk value would double assuming full time residency.

> **Initial Measurements**. Similar to the cancer risk for other homes, we use maximum concentrations detected in this sampling event to provide a conservative approach to evaluating cancer risk. We substitute detection limits for non-detect values for VC and 1,4-dioxane to provide an upper range calculation. The maximum PCE and TCE concentrations initially measured were 78J µg/m^3 and 5.4 µg/m^3 respectively (the J indicates at least one quality control criterion was not met but data can be accepted as valid). The combined estimated excess cancer risk was 1E-05 (1 in 100,000). The estimated cancer risk is very low.

Vapor Mitigation System Determination (November 2016 to January 2019) During this period the VA collected 22 distinct SUMMA® canister measurements for each COC. The analysis did not identify VC or 1,4-dioxane above detection limits. The analysis measured PCE and TCE in all samples. The PCE measurements demonstrate a gamma distribution; the TCE a normal distribution. Table 7 presents the basic statistics and the upper 95% confidence limit (UCL) of the arithmetic mean below.

Table 7: Residence 0040H Data from Nov. 2016 to Jan. 2019

Chemical	Detections	Range (µg/m^3)	Mean (µg/m^3)	Median (µg/m^3)	Upper 95% Confidence Limit (µg/m^3)
PCE	31/31	0.69 – 58.5	18.5	13	24.5
TCE	31/31	0.28 -3.6	1.4	1.4	1.64

Using the upper 95% confidence limit as a conservative estimate of exposure we estimated total excess cancer risk from all site COCs (presented in Table 8 below). Vinyl chloride (VC) and 1.4-dioxane were both non-detect and the limit of detection was low enough where they did not

contribute appreciably to cancer risk. The combined excess cancer risk during this period from PCE and TCE was 3E-06 (3 in a million), a value that is considered a low increased cancer risk.

Portable Filter Interim Remedy. We evaluate risk from the most recent datasets [VA 2020] separately to estimate current and future risk using an optimized portable filtration system. With a conservative approach, we have used the maximum value detected for each chemical. The maximum concentrations of PCE and TCE, respectively, were an estimated 12J µg/m^3 and 0.87 µg/m^3 (the J indicates at least one quality control criterion was not met but data can be accepted as valid). ATSDR calculated the combined excess cancer risk to be 2E-6 (2 in a million), a value that is considered a low increased cancer risk. The number would double for full-time residency and still be low.

Table 8: Summary Excess Cancer Risk 0040H

Period	Excess Cancer Risk Range PCE	Excess Cancer Risk Range TCE	Total Excess Cancer Risk Range
Initial Measurement	4E-06	6E-06	1E-05
System Determination	1E-06	2E-06	3E-06
Interim Remedy	7E-07	1E-06	2E-06

Home 0040H Indoor Air Non-Cancer Risk

PCE. T The maximum PCE concentration of 78 µg/m^3 detected in indoor air at 0040H exceeds ATSDR's chronic inhalation MRL for PCE of 41 µg/m^3, thus requiring further evaluation. The MRL is based on an occupational epidemiology study which found that dry-cleaning workers experienced altered color vision when exposed to 11,532 µg/m^3 [ATSDR 2014a]. Although the indoor air PCE concentration exceeds the MRL, it is still 150 times below effect levels. ATSDR does not expect non-cancer health effects from PCE exposure at these measured concentrations.

TCE. The maximum TCE concentration of 5.4 µg/m^3 in indoor air at 0040H exceeds ATSDR's chronic inhalation MRL for TCE of 2 µg/m^3 . However, the concentration is still well below levels expected to cause cardiac malformation in humans. Therefore, non-cancerous harmful effects are not likely. The 95% confidence limit for the system determination period (1.6 µg/m^3) was below the MRL, which supports the conclusion of unlikely to cause harmful effects. The recent values with first improvement to the whole house system and then switching to portable filters are below the MRL, suggesting remediation has recently reduced this risk to below the MRL, provided that the filters are properly maintained.

COMMUNITY HEALTH CONCERNS

ATSDR staff presented ATSDR's PHA process to the community in a public meeting sponsored by the VA (September 2015) and later at Superfund Community Advisory Group (CAG) meetings (October 2016 and May 2018). At those meetings a few citizens voiced public health concerns. One citizen called the ATSDR Regional Office in Denver with specific health concerns about *in utero* exposure to PCE. Through these activities, ATSDR gained a general

sense of site related health concerns in the community and these concerns are presented as questions and responses below.

Community Concern: Is there a blood test for PCE exposure; and, if so, what information can citizens gain from it?

ATSDR Response: *There are blood tests that measure serum levels of PCE, but these tests are not readily available at most clinical laboratories. It should be noted that blood measurements cannot predict health effects. PCE contamination is often found in outdoor and indoor air, and these background PCE concentrations are generally higher in urban areas such as Salt Lake City. A blood test cannot distinguish site-related PCE from background levels of PCE typically found in urban air. This phenomenon is further complicated by PCE's relatively short duration in blood (the liver constantly filters PCE from the blood). Also, studies are not available that correlate health effects with serum PCE levels from background low-level chronic exposure scenarios. Therefore, it is not possible to evaluate health risks associated with PCE exposure from a blood sample [ATSDR 2014a]. The test provides little information of value at this site. Toxicological studies and an evaluation of exposure from environmental samples provides a better understanding of health risks at this site.*

Community Concern: Did PCE exposure in the womb affect children's health?

ATSDR Response: *The lack of data prior to 2015 precludes a complete understanding of past exposure and possible toxicological effects. This includes exposure to workers at East High School and Mount Olivet Cemetery, in addition to residents of homes. PCE, TCE, and VC may affect fetal health [ATSDR 2006, 2014a, 2014b]. In most homes tested, the contaminant levels identified during indoor air sampling since 2015 are below the point where health effects involving the fetus are likely to occur. Based on the most recent data, we would not anticipate exposure during pregnancy to be a current concern; however, we cannot speak to exposure prior to 2015.*

At one home (0054H), however, TCE levels were high enough during one sampling event to be a concern. A pregnant woman who breathed air with TCE at the detected concentrations may be at an increased risk of having her fetus develop a heart defect if she spent a large portion of time in the motorcycle maintenance shop.

Community Concern: Is the community at a higher risk of cancer than other areas?

ATSDR Response: *Indoor air concentrations (beginning in 2015) in homes with elevated TCE and PCE are not a concern for an increased risk of cancer. We used health-protective assumptions in reaching that conclusion. Cancer risk is thus likely overstated (as seen in Table 6). We do not have data to assess risk prior to 2015. The Health Evaluation Section addresses this topic in depth.*

Community Concern: Can I smell PCE (associated with vapor intrusion) in my home?

ATSDR Response: *The indoor air concentrations detected at this site are below the odor threshold for PCE, which is about 7,000 µg/m^3 [ATSDR 2014a]. If residents smell a chemical*

odor in their home, and they are sure the odor is not coming from a source inside the home (such as another solvent), it is likely to be PCE.

Community Concern: My pet may occasionally drink water from the springs or get wet. Does the contamination in springs and seeps pose a risk to my pets?

ATSDR Response: *ATSDR did not find a risk of adverse health effects for humans who contact surface water emanating from the springs and seeps. It is advisable to prevent pets from drinking the water.*

Community Concern: Are cancer rates higher in the East Sides Springs Neighborhood?

ATSDR Response: *Cancer incidence studies require a population larger than the number of people living within the PCE plume area; hence, an evaluation of this type presents limitations. ATSDR has requested that due to the sample size constraint of the ESS area, additional census tracks be included in the analysis to provide a large enough sample size. The UDOH Cancer Epidemiology Program will do the analysis. UDOH will present their findings to the community during a public meeting for the site.*

CONCLUSIONS ATSDR reached six conclusions in this PHA:

Conclusion 1: Breathing site-related tetrachloroethylene (PCE) and trichloroethylene (TCE) found in indoor air sampled in different seasons in homes of the East Side Springs neighborhood (AOU-1) is not likely to harm residents' health.

Basis for Conclusion: Data collected since 2016 suggest that current exposures to site contaminants do not pose a health risk above a level of concern. Conservative exposure estimates based on 2016 and 2017 indoor air sampling indicate a small theoretical increase in cancer risk associated with vapor intrusion; however, the risks are so small they are not a health concern. The concentrations of PCE and TCE are below levels associated with non-cancer health effects based on conservative exposure estimates. In one home, the exposure appears to have been related to an in-home vehicle maintenance shop (no longer in use).

In some homes, PCE measured in the air of basement sumps, floor drains, and nearby soil gas is contaminated with PCE at significantly elevated levels; however, air in the home's living spaces remains below levels of concern. Several uncertainties exist for future exposure in these homes. The fate and transport of contaminants in groundwater is not completely understood. Not all homes have been tested, and temporal (seasonal) effects on vapor intrusion (VI) have not been assessed.

Next Steps: The VA is currently recruiting additional homes for testing and is re-testing many homes**.** ATSDR supports continued periodic sampling of homes to evaluate the efficacy of remedial actions in place and any effects of seasonal or building changes over time on indoor air concentrations.

As groundwater sampling expands and the conceptual site model improves, ATSDR supports the VA continually re-evaluating which areas and homes are at risk for VI. Additionally, ATSDR recommends that the VA re-test the living space in structures with elevated levels of VOCs in sumps and floor drains. If high soil gas concentrations near homes continue to be detected, then further indoor air testing should be performed. EPA supports the VA decision to offer additional VI sampling.

Conclusion 2: We do not have enough information to conclude if breathing PCE and TCE at levels that existed prior to 2015 could harm people's health.

Basis for Conclusion: Little is known about exposure prior to 2015, when VA began sampling the indoor air, the shallow groundwater, and soil gas in the East Side Springs neighborhood.

Next Steps: We are working with UDOH to identify pre-2015 epidemiological data that may offer insight into incidence of certain cancers that are related to PCE and TCE exposure. There are many limitations to such an analysis and cancer incidence data would not imply exposure had necessarily occurred. The Utah Department of Health (UDOH) will prepare a cancer incidence review and present findings to the community during an upcoming ATSDR public meeting for the site.

Conclusion 3: Breathing air currently in the one home (0040H) where the VA conducted a time critical removal action is unlikely to harm the residents' health. The portable air filters installed in the home are protective of health, but the filters do not prevent the potential for a future health risk. The home has a permanent furnace filtration removal system installed, but the homeowner is not using it. The permanent system also requires ongoing maintenance to prevent future exposure.

Basis for Conclusion: To date, the air filtration system has been successful in reducing PCE and TCE vapors; however, it is not a permanent solution to migration of chemicals from the groundwater to indoor air in the home. A sub slab system would not address the diffusion problem either. Exposures are possible when the homeowners sell their home because new owners may not understand the need to regularly change filters, or if the system is modified or not maintained.

Next Steps: Groundwater cleanup is unlikely to be completed in the near future, but an engineered solution to drain water near the foundation could provide a permanent solution since groundwater is so shallow and diffusion into the basement is ongoing. In the meantime, ATSDR supports the VA's continued efforts to maintain the portable air filtration system for the current residents of home 0040H and develop/implement groundwater remediation through the Superfund process. ATSDR recommends that 1) The VA and EPA continue to work toward a remedy that would remove future risk, such as a drain system to divert water away from the outside of

the basement; 2) The VA and EPA define a mechanism for monitoring change of occupancy in the home and inform future residents of the need to filter the air. ATSDR remains available to consult with present and future residents of the home.

Conclusion 4: People who drink tap water from the Salt Lake City municipal system have not been exposed to levels of PCE that are likely to have harmed their health in the past nor pose a current risk.

Basis for Conclusion: The municipal water system serves homes in the East Side Springs area, where private wells have not historically been a source of drinking water. The Salt Lake City municipal water system detected PCE in one well that supplies the municipal system; however, PCE was not detected in the water supply (the water is a blend of wells) delivered to the tap. The PCE levels in the single well were below ATSDR screening values for consumption. Salt Lake City Department of Public Utilities (SLCDPU) removed the well from service and monitors wells used for the drinking supply in accordance with the Safe Water Drinking Act.

Next Steps: The well remains off-line. The SLCDPU is aware of the contaminant plume and taking steps to ensure continued compliance with the Safe Water Drinking Act. The other wells in the municipal system are tested regularly. To date, PCE has not been detected. Nearby wells are tested through the Superfund program to assess potential plume migration into the municipal water supply.

Conclusion 5: People incidentally touching water (through wading or irrigation) flowing from neighborhood springs and nearby wetted soils are unlikely to experience adverse health effects from PCE or TCE.

Basis for Conclusion: ATSDR evaluated exposure to spring water and soil next to springs during play and irrigation. A person might incidentally ingest or touch contaminants from some of this water and soil; however, based on a health-protective scenario, the amount of PCE and TCE entering the body is below a level that would adversely affect health.

Next Steps: Continued groundwater investigations and refinement of the site conceptual model will determine the need for additional sampling of the seeps, springs, and nearby soils.

[§]**Conclusion 6:** The indoor air data needed to evaluate the East High School and Mount Olivet Cemetery caretaker's home were not available at the time of the report initial preparation in 2019. Indoor air samples during hot and cold seasons are needed to evaluate the possible exposure during conditions most likely to cause vapor intrusion.

[§] ATSDR received indoor air data in 2022 for both locations and will summarize potential health risk findings in a subsequent document.

Basis for Conclusion: Only one round of indoor air data was collected at East High School. While the data revealed PCE and TCE below detection limits in indoor air, an additional round of sampling is needed. The cemetery caretaker's home overlies the groundwater plume and had not yet been sampled at the time of the report initial preparation in 2019.

Next Steps: ATSDR recommended that VA or EPA collect indoor air samples at both the East High School and the Mount Olivet Cemetery caretaker's home. These data are now available and will be the basis for a follow-up document to be completed in late 2022.

Public Health Action Plan

ATSDR will take the following public health actions following release of this PHA:

- ATSDR will continue to evaluate data to determine if there is an unforeseen risk to public health with AOU-1. Specifically, ATSDR will review the next rounds of VI sampling to determine if new information changes conclusions or recommended remedial actions.
- ATSDR will plan to review future data and remedial systems to ensure that the remedy at home 0040H is protective.
- ATSDR will determine the need to evaluate public health risks from the broader groundwater investigation (OU-2) as more data become available.
- ATSDR will evaluate VI risk at the residence located at Mt. Olivet Cemetery when data are available. Preliminary groundwater data suggest this home overlies the groundwater plume.
- ATSDR will evaluate VI risk at East High School when data are available because, while previous one-time sampling at East High School revealed PCE and TCE below detection limits, further sampling is needed to determine if there is a concern at other times of the year.
- ATSDR will continue to be available to the community to answer public health questions.
- ATSDR will collaborate with the VA, Utah Department of Health (UDOH) and Salt Lake City officials to publicize the value in identifying and repairing cracks in basement floors that are conduits for contaminant migration in homes above the plume.

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Appendix A: Human Exposure Pathways, Completed and Potential

COMPLETED PATHWAY	COMPLETED EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Vapor intrusion into buildings	Dry cleaner solvent and daughter products from VAMC dry cleaner.	Ground-water or soil	Indoor air	Inhalation	Residents	Past, Present, and Future

POTENTIAL PATHWAY	POTENTIAL EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	POTENTIALLY EXPOSED POPULATION	
Surface waters	Ground-water plume emerging in seeps and springs	Surface Water	Outdoors, near homes	Dermal	Residents	Past, Present, and Future
Surficial soils	Surface water emerging in springs and seep	Surface Soil	Outdoors, near homes	Incidental Ingestion	Residents	Past, Present, and Future
Irrigation water	Well	Ground-water	Outdoors, sprinklers	Dermal	Cemetery worker	Past, Present and Future
Vapor intrusion into buildings	Dry cleaner solvent and daughter products from VAMC dry cleaner.	Ground-water or soil	Indoor air	Inhalation	Cemetery worker living on-site, occupants of high school	Past, Present, and Future

Appendix B: Maximum Air Contaminant Values (Site-wide) Compared to ATSDR Comparison Values

Contaminant Name	CASRN	Conc	Unit	Above or Equal to Recommended ATSDR CV?	Above or Equal to Other CV?	CREG	Chronic EMEG	Int EMEG	RMEG	Acute EMEG
TETRACHLOROETHYLENE	000127-18-4	78	µg/m³	Yes [1]	Yes [2]	3.8 [1]	41 [2]	41 [2]	40 [2]	41 [3] [a]
TRICHLOROETHYLENE	000079-01-6	9.3	µg/m³	Yes [1]	Yes [2]	0.21 [1]	2.1 [2]	2.1 [2]	2.0 [2]	NA
VINYL CHLORIDE	000075-01-4	0.19	µg/m³	Yes [1]	No	0.11 [1]	NA	77	100	1,300
1,4-DIOXANE	000123-91-1	2.3	µg/m³	Yes [1]	No	0.20 [1]	110	720	30	7,200

[#] ***Recommended ATSDR CV.***

[1] ***Recommended ATSDR CV met or exceeded.***

[2] ***Additional ATSDR CV met or exceeded.***

[3] ***Acute ATSDR CV met or exceeded.***

[4] ***Non-ATSDR value met or exceeded.***

[a] ***Consider AEGLs (https://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values), ERPGs (https://www.aiha.org/get-involved/aiha-guideline-foundation/erpgs , and acute CVs for acute exposure scenarios only.***

Appendix C: Screening of Maximum Detected Indoor Air Values Against ATSDR CVs for Homes

Detections in **bold** are detected values that exceed an ATSDR CREG.
TCE CREG: 0.21 µg/m^3; MRL: 2.1 µg/m^3
PCE CREG: 3.8 µg/m^3; MRL: 41 µg/m^3
Vinyl Chloride CREG: 0.11 µg/m^3; MRL: 77 µg/m^3 (Intermediate)
1,4-Dioxane CREG: 0.20 µg/m^3; MRL: 110 µg/m^3
N.S. Not sampled. Screening with Hapsite analysis did not include Vinyl Chloride and 1,4-Dioxane

Sample ID	Year	Type of Analysis	Vinyl Chloride (µg/m^3)	TCE, (µg/m^3)	PCE, (µg/m^3)	1,4-Dioxane (µg/m^3)	Chemicals exceeding the ATSDR CREG?	Chemicals exceeding the ATSDR MRL?	Further Risk Evaluation?
0003H	2016	TO-15	0.13 U	0.27 U	1.3	0.18 U	None	None	No
0011H	2016	TO-15	0.13 U	0.27 U	**12 J**	0.18 U	PCE	None	Yes
0017H	2016	TO-15	0.13 U	**0.39**	**10 J**	0.18 U	TCE, PCE	None	Yes
0018H	2016	TO-15	0.13 U	**0.83**	**12 J**	0.18 U	TCE, PCE	None	Yes
0023H	2017	TO-15	0.13 U	**1.83**	**1.4**	0.18 U	None	None	Yes
0037H	2016	TO-15	0.13 U	0.27 U	**4**	0.18	PCE	None	Yes
0040H	2016	TO-15	0.13 U	**5.4 J**	**78 J**	0.18 U	TCE, PCE	TCE, PCE	Yes
0041H	2016	Hapsite	N.S.	<0.5	**4.6**	N.S.	PCE	None	Yes
0047H	2016	Hapsite	N.S.	<0.5	**7.6** [1]	N.S.	PCE	None	Yes
0050H	2016	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0051H	2016	TO-15	0.13 U	**0.27**	2	0.18 U	None	None	Yes
0052H	2016	Hapsite	N.S.	<0.5	1.9	N.S.	None	None	No
0053H	2016	TO-15	0.13 U	<0.5	**24.1**	0.18 U	PCE	None	Yes
0054H (a)	2016	Hapsite	N.S.	**9.3**	**21.4**	N.S.	TCE, PCE	TCE	Yes

Sample ID	Year	Type of Analysis	Vinyl Chloride (µg/m^3)	TCE, (µg/m^3)	PCE, (µg/m^3)	1,4-Dioxane (µg/m^3)	Chemicals exceeding the ATSDR CREG?	Chemicals exceeding the ATSDR MRL?	Further Risk Evaluation?
0054H (b)	2016	Hapsite	N.S.	**2.9**	2.8	N.S.	TCE	None	Yes
0055H	2016	Hapsite	N.S.	<0.5	1.5	N.S.	None	None	No
0056H	2016	Hapsite	N.S.	<0.5	**6.9**	N.S.	PCE	None	Yes
0001H	2017	TO-15	**0.19**	0.27U	1.1	0.18 U	VC	None	Yes
0002H	2017	TO-15	0.13 U	**0.29**	1.4	0.18 U	None	None	Yes
0004H	2017	TO-15	0.13 U	0.27 U	0.34 U	0.18 U	None	None	No
0012H	2017	TO-15	0.13 U	0.27 U	2.3	0.18 U	None	None	No
0013H	2017	TO-15	0.13 U	0.27 U	0.34 U	0.18 U	None	None	No
0025H	2017	TO-15	0.13 U	0.27 U	0.37	**2.3**	1,4-Dioxane	None	Yes
0026H	2017	TO-15	0.13 U	0.27 U	2	0.18 U	None	None	No
0027H	2017	TO-15	0.13 U	0.27 U	0.34 U	0.18 U	None	None	No
0029H	2017	TO-15	0.13 U	0.27 U	2	0.18 U	None	None	No
0038H	2017	TO-15	0.13 U	0.27 U	0.34 U	0.18 U	None	None	No
0057H	2017	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0058H	2017	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0059H	2017	Hapsite	N.S.	<0.5 [2]	2.37 [2]	N.S.	None	None	No
0060H	2017	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0061H	2017	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0062H	2017	Hapsite	N.S.	<0.5	<0.7	N.S.	None	None	No
0063H	2017	Hapsite	N.S.	<0.5	3.25	N.S.	None	None	No

Sample ID	Year	Type of Analysis	Vinyl Chloride (µg/m^3)	TCE, (µg/m^3)	PCE, (µg/m^3)	1,4-Dioxane (µg/m^3)	Chemicals exceeding the ATSDR CREG?	Chemicals exceeding the ATSDR MRL?	Further Risk Evaluation?
0064H	2017	TO-15	0.13 U	0.27 U	1.9J	0.18 U	None	None	No

Notes

U: Reported value at or below quantitation level

J: At least one quality control criterion was not met but data can be accepted as valid. J values usually mean the concentration is estimated.

Samples noted (a) and (b) refer to values before and after sealing a basement crack in the home.

[1] 9 µg/m^3 was detected in an uninhabited mechanical room. The value presented in the table better represents maximum exposure.

[2] 1071.2 µg/m^3 PCE and 12.35 µg/m^3 TCE were detected when a portable instrument was inserted into a floor drain. Although, the measurement was not taken where people breath, it indicates that vapors beneath the home present a potential risk for VI.

Appendix D: Soil Gas and Groundwater Vapor Intrusion Screening Values

Soil Gas Contaminant Maximum Concentrations and SVI Screening Values

Contaminant Name	CASRN	Conc	Unit	Above or Equal to Recommended ATSDR CV?	Above or Equal to Other CV?	CREG	Chronic EMEG	Int EMEG	RMEG	Acute EMEG
TETRACHLOROETHYLENE	127-18-4	2,000	µg/m³	Yes [1]	Yes [2]	130 [1]	1,400 [2]	1,400 [2]	1,300 [2]	1,400 [3]
TRICHLOROETHYLENE	79-01-6	21	µg/m³	Yes [1]	No	7.0 [1]	70	70	67	NA
VINYL CHLORIDE	75-01-4	0.13U	µg/m³	No	No	3.7 [#]	NA	2,600	3,300	43,000
1,4-DIOXANE	123-91-1	0.18U	µg/m³	No	No	6.7 [#]	3,700	24,000	1,000	240,000

Groundwater Contaminant Maximum Concentrations and VI Screening Values

Contaminant Name	CASRN	Conc	Unit	Above or Equal to Recommended ATSDR CV?	Above or Equal to Other CV?	CREG	Chronic EMEG	Int EMEG	RMEG	Acute EMEG
TETRACHLOROETHYLENE	127-18-4	57	µg/L	Yes [1]	Yes [2]	5.3 [1]	57 [2]	57 [2]	55 [2]	57 [3]
TRICHLOROETHYLENE	79-01-6	7.7	µg/L	Yes [1]	Yes [2]	0.52 [1]	5.2 [2]	5.2 [2]	5.0 [2]	NA
VINYL CHLORIDE	75-01-4	0.5U	µg/L	Yes [1]	No	0.097 [1]	NA	68	88	1,100
1,4-DIOXANE	123-91-1	2.7	µg/L	No	No	1,000 [#]	560,000	3,700,000	150,000	37,000,000

U non-detect

[#]	***Recommended ATSDR CV.***
[1]	***Recommended ATSDR CV met or exceeded.***
[2]	***Additional ATSDR CV met or exceeded.***
[3]	***Acute ATSDR CV met or exceeded.***
[4]	***Non-ATSDR value met or exceeded.***

Appendix E: Cancer Calculations

Excess lifetime cancer risk (ELCR) was calculated by the following equation for **non-mutagenic carcinogens PCE and 1,4-dioxane:**

IUR * C_{air} * age-specific duration/78 years = ELCR

where IUR = Inhalation unit risk with units $(\mu g/m^3)^{-1}$

C_{air} = Maximum detected concentration or detection limit for non-detects in air with units $\mu g/m^3$

ELCR was calculated by the following equation for the **mutagenic carcinogen TCE:**

IUR * C_{air} * age-specific duration/78 * age-specific ADAF = ELCR

where ADAF = Age dependent adjustment factor for mutagenic carcinogens

Inhalation Unit Risk (IURs), $(\mu g/m^3)^{-1}$

1,4-Dioxane	5.0E-6
Tetrachloroethylene	2.6E-7
TCE ages 0-<2 years*	ADAF-adjusted*
TCE ages 2-<16 years*	ADAF-adjusted*
TCE ages 16 years & older	4.1E-6
Vinyl chloride	4.4E-6

*Includes ADAF (0-2yrs=10, 2-16yrs=3, >16yrs=1). Covers additive risk of kidney, liver, and NHL cancers. ADAF only applied to mutagenic mode of action for kidney cancer.