U.S. Army Corps of Engineers Kansas City District

88th Regional Support Command

U.S. Army Environmental Command

Final Proposed Plan

Operable Unit 2 (Vapor Intrusion Pathway) of the St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Site Code: 29955 (Facility ID: MO030)

1.0 Introduction

This **Proposed Plan** identifies the U.S. Army's **preferred alternative** for addressing the potential for future unacceptable indoor air human health risks from **vapor intrusion (VI)** related to the St. Louis Ordnance Plant, former Hanley Area (Figure 1). It provides a discussion of the site background and characteristics, the risks, **remedial action objectives (RAOs)**, remedial alternatives considered during the **feasibility study (FS)**, and describes the preferred alternative for the VI pathway for **operable unit 2 (OU-2)**[1,2].

Response actions at the former Hanley Area are divided into two OUs:

- OU-1: Actions addressing contaminated soil, **powder well** sediment, and **groundwater** (non-VI) concerns
- OU-2: Actions addressing the VI pathway

The OU-1 **remedy** (cleanup action) was presented in the OU-1 **Decision Document** (CH2M HILL 2011a) and the active remediation element of the cleanup action was completed in 2012 (CH2M HILL 2012). The Army is currently performing long-term management (LTM) activities for OU-1 that consist of annual groundwater sampling and inspections. OU-1 actions were considered

WHAT IS VAPOR INTRUSION?

Vapor intrusion is a way that chemicals in soil or groundwater can get into indoor air. Some chemicals can give off vapors or "volatilize" from groundwater at or near the top of the groundwater table and travel through soil and into nearby buildings through cracks, openings, and penetrations, contaminating indoor air.

USEPA 2012

[1]Words and phrases in bold type are defined in the glossary at the end of the document.

[2]Acronyms are defined before the glossary.

when selecting the preferred alternative at OU-2.

The U.S. Army Environmental Command (USAEC) is the Army agency responsible for cleanup activities at the former Hanley Area, which is owned by the 88th Regional Support Command (RSC). The U.S. Army Corps of Engineers (USACE), Kansas City District, manages the environmental investigation at the former Hanley Area on behalf of USAEC. Through a U.S. Department of Defense (DoD) State Memorandum of Agreement, the Army works with the Federal Facilities section of the **Missouri Department of Natural Resources (MDNR)** on Defense Environmental Restoration Program (DERP) properties in Missouri. Although the former Hanley Area is not on the National Priorities List, the Army cleanup follows the **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** process, as amended by the **Superfund Amendments and Reauthorization Act of 1986 (SARA)** and the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)**.

This Proposed Plan was developed by the Army with support from the MDNR.

The Army is soliciting public participation on the preferred alternative, as required under Section 117a of CERCLA and Section 300.430(f)(2) of the NCP. The intent is to give citizens an opportunity to submit written or oral comments and to participate in a public meeting during the **public comment period** (Table 1).

Table 1. Upcoming Events

Public Comment Period	
January 10 – February 10, 2018	The Army will accept written comments on the Proposed Plan during the public comment period.
Public Meeting	
January 24, 2018 6:00 pm The Omega Center 3900 Goodfellow Blvd. St. Louis, Missouri 63120 Phone: (314) 385-4100	The Army will hold a public meeting to solicit comments from the public. Oral and written comments will be accepted at the meeting. Written comments may also be submitted within 30 days of release of the Proposed Plan to the following address: Ms. Josephine Newton-Lund CENWK-PM-ES USACE-Kansas City District 601 East 12th Street Kansas City, MO 64106 Phone: (816) 389-3912 Email: Josephine.M.Newton-lund@usace.army.mil
Additional Information	
For additional information, review the administrative record at:	St. Louis Central Public Library 1301 Olive Street St. Louis, Missouri 63103 (314) 241-2288

2.0 Opportunities for Public Involvement

The Army will select a final cleanup action for contamination at the former Hanley Area after reviewing and considering all comments submitted during the 30-day public comment period. The Army may modify the preferred alternative or select another alternative presented in this Proposed Plan, based on new information or public comments.

Response to public comments will be provided in the decision document as part of the Responsiveness Summary. The decision document will present the final selected remedy for OU-2 of the former Hanley Area. More detailed information regarding the former Hanley Area, including documents such as the OU-2 **remedial investigation (RI)** and FS report, is available in the administrative record for the site at the St. Louis Central Public Library, 1301 Olive Street, St. Louis, Missouri. The public is encouraged to review this information.

3.0 Site Background

3.1 Site Location

The former Hanley Area (U.S. Army Reserve Site Code 29955, Facility ID MO030, 6400

Stratford Avenue) is located in the Mark Twain/I-70 Industrial neighborhood and consists of 14.68 acres on the western boundary of the city limits of St. Louis, 0.25 mile south of the intersection of I-70 and Goodfellow Boulevard (Figure 1) in St. Louis City. It borders the northern part of the Sverdrup U.S. Army Reserve Center (Center; Site Code 29967, Facility ID MO028) at 4301 Goodfellow Boulevard.

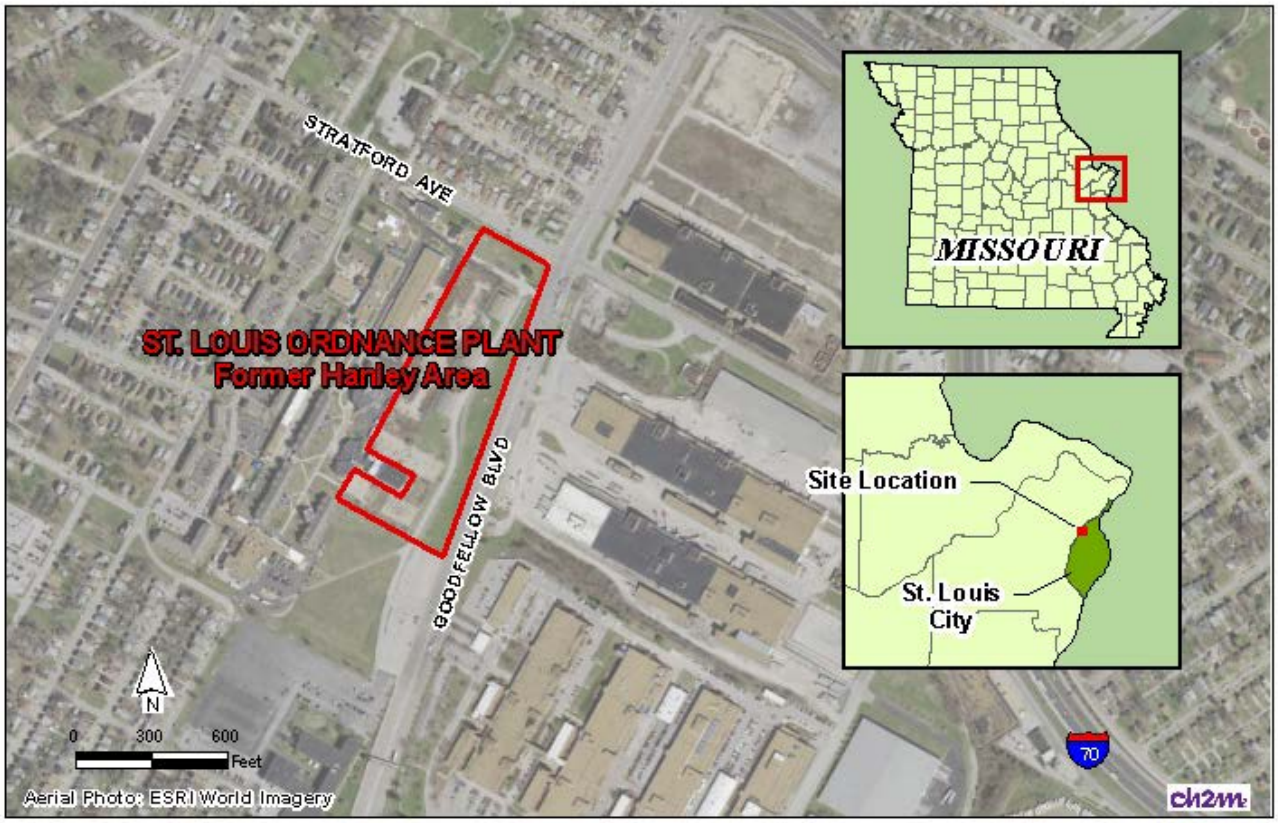

FIGURE 1
SITE LOCATION MAP

3.2 Site History

The St. Louis Ordnance Plant operated from 1941 to 1945 as a small arms ammunition production facility and consisted of Plant No. 1, located east of Goodfellow Boulevard, and Plant No. 2, located west of Goodfellow Boulevard. Between 1945 and 1959, several buildings located at Plant No. 2 were used as classrooms by the DoD Finance Center and for maintaining service records. Western portions of Plant No. 2 were transferred to the Department of Labor, which is currently occupied by the Job Corps Training Center. The Sverdrup U.S. Army Reserve Center was established in the southern portion of Plant No. 2.

The former Hanley Area takes its name from Hanley Industries, Inc., which conducted operations in the northeastern portion of Plant No. 2 between 1959 and 1979 (Figure 1). Hanley Industries, Inc. used the site for research, development, manufacturing, and testing of various explosives. Hanley Industries, Inc. used most of the buildings to load detonators and primers and to mix explosives.

3.3 Current and Surrounding Land Use

The former Hanley Area is no longer in use and is bordered by the Job Corps Training Center on the west, residential areas to the north, and commercial/industrial properties to the east. The site and surrounding area is zoned industrial, commercial, and residential.

The site contains underground rooms (former basements and bunkers), tunnels for service utilities, and a combined sanitary and stormwater sewer system. The underground

structures are still intact. Buildings, bunkers, and magazines at the former Hanley Area have been demolished, except for four small buildings that are used for storage. Powder wells at the site were used between 1941 and 1945 for sediment collection before discharging wastewater to the sewer system. The site is completely fenced (partially with iron fencing, the balance with a 6-foot-tall chain-link fence).

The 88th RSC occupies the Sverdrup U.S. Army Reserve Center, located south of the former Hanley Area.

The Job Corps Training Center lies west of the former Hanley Area. Buildings on Job Corps property consist of student dormitories, a gymnasium, several buildings for student training/education, and administrative buildings. The Job Corps buildings immediately west of the northern part of the former Hanley Area consist of a small combined classroom and welding shop and a large building that was previously used as a dormitory.

Single-family ranch-style homes are located north of the former Hanley Area within a block bordered by Stratford Avenue to the south, Goodfellow Boulevard to the east, Henner Avenue to the north, and Irving Drive to the west. Basements, basement garages, and garages converted to finished/partially finished walk-out basements were documented at several residences.

City-supplied drinking water is provided to residents and industries in the area. Soil in the area does not produce a sufficient quantity of groundwater for it to be a source of drinking water.

3.4 Investigation History

The Army conducted several environmental investigations at the site between 1979 and 2015. It is suspected that chemicals used in some of the previous site operations resulted in soil and groundwater contamination at the former Hanley.

A chronology of site investigations, beginning in 1979, is included in the OU-1 Decision Document (CH2M HILL 2011a). It summarizes the investigations that were completed to develop an understanding of the nature and extent of contamination in soil, groundwater, and powder well sediment at the former Hanley Area, and briefly describes the FS that was prepared to evaluate various cleanup actions to address the contamination. Only the investigation history and findings relevant to this OU-2 Proposed Plan and the VI pathway are described in Table 2.

3.5 Summary of Removal and Remedial Actions to Date

Decontamination efforts, removal of a leaking transformer, and demolition of buildings, bunkers, and magazines occurred between 1979 and 2007. In September 2011, the Army issued a decision document selecting the soil, powder well sediment, and groundwater cleanup actions for OU-1. The 2012 OU-1 site cleanup is described in the Interim Remedial Action Completion Report (**RACR**; CH2M HILL 2012) and consisted of soil and powder well sediment removal to address metals and polychlorinated biphenyls (soil only) contamination, in-situ groundwater treatment by mixing **zero-valent iron (ZVI)** into soil and groundwater to reduce levels of **volatile organic compounds (VOCs)**, groundwater monitoring, and **land use controls (LUCs)**.

The soil, powder well sediment, and groundwater cleanup actions have been completed at the former Hanley Area. Routine monitoring and sampling of groundwater is expected to continue until concentrations of VOCs meet cleanup standards. Although insufficient quantities of groundwater in the area prevent it from being used as a drinking water source, the City of St. Louis Ordinance 66777 also prohibits the use or attempted use of groundwater as a drinking water supply and the drilling or installation of wells for a potable water supply within the corporate limits of the City of St. Louis.

Table 2. Chronology of Site Investigations

Remedial Investigations
2008 – RI by CH2M
The 2008 RI was developed to fill remaining data gaps to fully delineate the nature and extent of contamination in soil and groundwater at the site. The 2008 RI identified VOCs, metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons in various media at concentrations exceeding conservative screening levels. Details regarding metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons are provided in the RI report (CH2M HILL 2009). Results from the 2008 RI revealed dissolved-phase groundwater VOC contamination in the northern part of the former Hanley Area. The apparent source of VOCs is the former Building 220 in the northern part of the site. The contamination consists of three distinct plumes (areas of impacted groundwater) comprising one or more chlorinated VOCs. In addition, other VOCs were detected at concentrations greater than the screening levels in isolated occurrences within and around the plumes. The finding of VOCs in groundwater during previous investigations prompted the Army to perform several investigations of the VI pathway, beginning in 2008 during the RI. In March 2008, groundwater samples were collected from temporary wells at residential properties north of Stratford Avenue and tested for VOCs. Attempts were made to collect exterior soil gas samples from several locations at select residences along Stratford Avenue, but the tight expansive clays prevented soil gas from being drawn through the soil and samples could not be collected. VOCs were not detected in the groundwater grab samples. Indoor and outdoor air samples were collected and tested for chlorinated VOCs from one residence located north of the former Hanley Area in March and May 2008. The residence was selected for indoor and outdoor air sampling because it is directly in the path of potential vapor migration and was vacant, which reduced the possibility of vapor contamination from locations other than the former Hanley Area. Three chemicals (1,2-dichloroethane [1,2-DCA], tetrachloroethene [PCE], and trichloroethene [TCE]) were detected at concentrations greater than screening levels in indoor air samples collected from the basement or in both the indoor air and outdoor air. Only the indoor air sample exhibited a TCE concentration greater than the recommended level that could potentially pose unacceptable risk to human health. Based on the TCE result, an additional round of indoor and outdoor air samples was collected during the RI in May 2008. Results from the May 2008 indoor and outdoor air samples indicated that chlorinated VOCs did not pose unacceptable risk to human health at that time.
2010 – Groundwater Investigation and VI Assessment by CH2M
A groundwater investigation was performed in August 2010 to determine the extent of onsite groundwater contamination that would require cleanup actions as part of OU-1 (CH2M HILL 2011b). During the investigation, groundwater samples were also collected from onsite and offsite wells and tested for VOCs. The Army, MDNR, and the U.S. Environmental Protection Agency (USEPA) agreed to perform a VI assessment at a residence on Goodfellow Boulevard because well MW-107 was located within 100 feet, and 1,2-DCA was detected at concentrations exceeding the screening level in 2010 and subsequent sampling events. The VI investigation consisted of indoor air, outdoor air, and subslab soil gas (that is, soil gas under the floor of a structure) sampling. A residence on Henner Avenue was also investigated at the request of a resident in response to a public meeting notification letter sent by the 88th RSC in November 2010. The stakeholders agreed that VI assessments would be performed at three additional residences on Stratford Avenue, north of the former Hanley Area, depending on the results from the residence on Goodfellow Boulevard. Both residences were sampled in May 2011. The Army initiated right-of-entry (ROE) requests to the property owners of the three additional residences to perform VI assessments.
2011-2012 – VI Assessments by CH2M
Three rounds of VI assessments were performed between May 2011 and June 2012 at the residence on Goodfellow Boulevard, two rounds were completed at the residence on Henner Avenue in May and December 2011, and one round was completed at two residences on Stratford Avenue in February 2012. Although three residences on Stratford Avenue were scheduled for VI assessments, one of the three could not be sampled due to lack of response to ROE request letters. Each VI assessment consisted of building surveys and chemical inventories, subslab soil gas sampling, and indoor and outdoor air sampling. Groundwater grab samples were also collected in the back yard and front yard of the residence on Henner Avenue, and a HAPSITE investigation was conducted in the residence on Goodfellow Boulevard. A HAPSITE is a portable instrument capable of providing quantitative data for VOC analysis. A third attempt was made to sample the residence on Henner Avenue in June 2012. However, the resident was unable to commit to a specific time in which the sampling team could enter the residence, so the assessment could not be performed. The residence was subsequently damaged by fire in August or September 2014, making it infeasible to conduct subsequent VI assessments. Results of the VI assessments were provided in technical memoranda format to the homeowners, the Army, MDNR, and Missouri Department of Health and Senior Services (MDHSS). Based on VI assessments performed at the residence on Goodfellow Boulevard in 2011 and 2012, contamination from the former Hanley Area does not appear to be contributing to VI and further VI monitoring at the residence was not warranted. It was determined that additional VI assessments at the two residences on Stratford Avenue were needed to further assess whether contamination from the former Hanley Area may be contributing to potential VI at the residences and to assess changes over time, which is consistent with USEPA final VI guidance. Because offsite groundwater contamination remains, and the potential for contaminant migration into offsite residences and non-residential buildings exists, additional VI pathway investigations were required, which served as the basis for the OU-2 RI.

Table 2. Chronology of Site Investigations

Remedial Investigations
2013-2015 – OU-2 RI by CH2M
The VI pathway was the primary focus of the OU-2 RI that was completed between October 2013 and January 2015. The OU-2 RI consisted of an onsite and offsite investigation of shallow groundwater, a shallow groundwater investigation near a day care center north of the former Hanley Area, conducting VI assessments at five residences north of the former Hanley Area and at a building located on the adjacent Job Corps Training Center, and conducting tunnel air sampling of the onsite main tunnel system (CH2M 2016). As part of the OU-2 RI, several colocated shallow and deep monitoring well pairs were installed, groundwater samples collected and tested, and subslab soil gas, indoor air, outdoor air, and onsite tunnel air samples collected and tested. Results of the residential and Job Corps Training Center VI assessments were provided in technical memoranda format to the homeowners, the Job Corps Training Center, the Army, MDNR, and MDHSS. Although not associated with the VI pathway, the OU-2 RI also included confirming the protectiveness of the Plume C OU-1 LUC boundaries (CH2M 2016). Chemicals of Concern (COCs) – Chemicals with concentrations that contributed to unacceptable risk to human health that were observed in groundwater during the 2008 RI were used as preliminary VI chemicals of potential concern (COPCs) during investigation of the VI pathway (OU-2 RI). COPCs are chemicals with maximum detected concentrations exceeding conservative screening levels. VOC concentrations in shallow groundwater, subslab soil gas, and indoor air were compared against conservative risk-based VI screening levels (VISLs). Figure 3 depicts the location of the areas investigated during the OU-2 RI. The site-related COPC, TCE, was detected at concentrations above the VISL in subslab soil gas at one residence on Goodfellow Boulevard and at one residence on Stratford Avenue. However, TCE was not detected above the VISL in the corresponding indoor air samples at these residences, meaning that indoor air was not significantly affected by subslab soil gas concentrations. No site-related COPCs were detected above VISLs in subslab soil gas and indoor air in the remaining residences. Carbon tetrachloride (CT) and chloroform detected above VISLs in onsite shallow groundwater at monitoring well MW-120S, located on the west Plume C OU-1 LUC boundary (Figure 3), prompted VI assessments at the nearby welding shop/classroom located at the Job Corps Training Center to the west of the site. TCE was detected slightly above the VISL in subslab soil gas at one of the two subslab soil gas samples locations during one of three sampling events. However, the absence of TCE in shallow groundwater at monitoring well MW-120S, located within 100 feet of the building, during three consecutive sampling events appears to indicate that the former Hanley Area is not the source of TCE detected in subslab soil gas. Additionally, TCE was not detected in groundwater from the deeper monitoring well MW-129, located approximately 75 feet east of the building (CH2M 2016). The OU-2 RI also assessed the VI pathway near a day care center located north of the former Hanley because VOCs in shallow groundwater wells located along Stratford Avenue exceeded VISLs. Three rounds of undetectable concentrations of site-related COPCs were observed in shallow groundwater in the wells associated with the day care center groundwater investigation; therefore, VI assessments were not warranted at the day care center. Shallow well MW-128S was installed to delineate the downgradient extent of TCE and 1,2-DCA detected above the screening levels in shallow groundwater at monitoring wells MW-107S and MW-108S (TCE only). Results of the indoor air and outdoor air samples associated with the onsite main tunnel system indicate the presence of naphthalene at concentrations greater than the VISL. The indoor air concentrations measured in December 2013 were within the same order of magnitude as the coinciding outdoor air concentrations, indicating an outdoor chemical source. Additionally, naphthalene has not been detected in groundwater at the onsite and offsite shallow and deep wells since 2008, when samples were first tested for this chemical. Three rounds of groundwater measurements recorded at Plume C OU-1 LUC boundary monitoring wells MW-120 and MW-121 and at monitoring well MW-118, located within Plume C, indicate that the depth remains greater than 10 feet below ground, limiting construction workers contact with contaminated groundwater in this area. Three rounds of groundwater sampling at the LUC boundary wells also indicate CT concentrations less than the OU-1 remediation goal, confirming that the LUC boundaries at Plume C do not need to be expanded. Additional groundwater plume delineation (defining the boundaries of the impacted groundwater) was required at Plume C because CT was measured at concentrations greater than the conservative screening level, but less than the OU-1 remediation goal, in deep groundwater at monitoring well MW-120, located on the west Plume C OU-1 LUC boundary. Monitoring well MW-129 was installed west of monitoring well MW-120 to delineate the western extent of CT concentrations greater than the screening level. Following three consecutive rounds of CT measured at concentrations less than the screening level at monitoring well MW-129, the extent of CT in groundwater is also now known to the west.

Table 2. Chronology of Site Investigations

Feasibility Study
2017 – OU-2 FS by CH2M
The OU-2 FS developed and evaluated remedial alternatives that address future potential unacceptable risks to human health and meet **applicable or relevant and appropriate requirements** (ARARs). RAOs were established based on regulatory requirements, standards, and guidance. General response actions were identified for the site to develop remedial alternatives. Based on the risks present at the site, the following alternatives were developed: Alternative 1, **No Action**; Alternative 2, Sealing and Monitoring; Alternative 3, Vapor Mitigation; Alternative 4, **In Situ** Treatment through Chemical Oxidation or Chemical Reduction at Plume C and Vapor Mitigation; and Alternative 5, Groundwater Source Removal by Excavation at Plume C and Vapor Mitigation. The alternatives were evaluated against seven feasibility evaluation criteria as defined in the NCP and CERCLA. The preferred alternative is presented in this Proposed Plan.

3.6 Community Involvement

In April 2004, the Army began community involvement efforts for environmental activities at the former Hanley Area, and the administrative record was established at the St. Louis Central Public Library. A notice announcing the availability of the record and points of contact for the USAEC and USACE, Kansas City District was published in the *St. Louis Post-Dispatch* and *The St. Louis American* in January 2005.

In June 2006, nearby residents were mailed a letter informing them of the Army's investigation of potential groundwater contamination near the former Hanley Area. A second letter dated September 17, 2007, notified residents and property owners that the Army would be seeking access to some properties to collect environmental samples.

In October 2013, nearby residents, civic groups and local churches, and the Job Corps Training Center were mailed a letter informing them of the Army's investigation for OU-2. The Army also sent ROE requests to the property owners of the offsite residences to perform VI assessments.

A notice announcing the November 20, 2013 public availability meeting was published in the *St. Louis Post-Dispatch* and *The St. Louis American* in November. The meeting was held at the local polling place, The Omega Center, to keep interested members of the public informed of environmental cleanup progress at the former Hanley Area. Representatives from the Army and regulatory agencies attended the meeting.

The Army has coordinated with the neighborhood's alderman and Job Corps training center staff on an ongoing basis.

4.0 Site Characteristics

4.1 Soil and Bedrock Characteristics

Soil at the site and offsite (that is, areas outside the boundaries of the former Hanley Area) is made up of primarily clay and is relatively consistent. Gravel, concrete rubble, brick debris, and sand were observed above the clay soil in some onsite portions of the site. **Weathered shale bedrock** was encountered beneath the clay where deep wells were installed.

4.2 Groundwater Characteristics

Groundwater is present within more porous pockets of soil within the clay soil at the site. The weathered shale bedrock underlying the clay soil was dry and did not contain groundwater during the 2008 RI (CH2M HILL 2009). The depth to groundwater within the clay was encountered at less than 1 foot below ground at monitoring well MW-110 to more than 25 feet below ground at monitoring well MW-115.

Shallow groundwater generally flows from the southwest to the northeast. Some shallow groundwater also flows from the north (at wells located north of Stratford Avenue) to the south (at wells located near the intersection of Goodfellow Boulevard and Stratford Avenue). Based on groundwater measurements, shallow groundwater may intercept the basement floor slabs of several residences located along Stratford Avenue (CH2M 2016). However, groundwater was not observed to be seeping into the basements and no sumps were

observed where VI assessments were conducted.

4.3 Nature and Extent of Contamination

As described in Table 2, the 2008 RI identified VOCs, metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons in various media at concentrations exceeding conservative screening levels. For this Proposed Plan, VOCs in groundwater are of importance when looking at the VI pathway, as described in the inset on Page 1.

VOCs are generally present in three areas of contamination referred to as Plumes A, B, and C, further discussed below.

Plume A. Before the OU-1 site cleanup in 2012, Plume A was located within the footprint and offsite to the northeast of former Building 220. The plume consisted of the VOCs PCE, TCE, and *cis*-1,2-dichloroethene (DCE) in groundwater at concentrations that exceeded their respective groundwater screening levels. Plume A contamination has been observed from just below ground surface to the weathered shale interface. Figure 2 shows the lateral extent of PCE, TCE, or *cis*-1,2-DCE in groundwater at concentrations above the federal maximum contaminant levels (MCLs), as observed during the April 2016 OU-1 groundwater sampling event and after the OU-1 site cleanup at Plume A in 2012.

Plume B. Plume B has historically been observed to the northeast of former Building 220 and was largely mixed with Plume A before the OU-1 site cleanup in 2012. The plume consists of the VOC 1,2-DCA at concentrations exceeding the groundwater screening level. Plume B contamination has been observed from just below ground surface to the weathered shale interface. Figure 2 shows the extent of 1,2-DCA in groundwater at concentrations above the MCL, as observed during the April 2016 OU-1 groundwater sampling event. Plume B does not appear to be mixed with Plume A following the OU-1 site cleanup in 2012.

Plume C. Plume C has historically been located south of the former Building 220 footprint. The plume consists of CT, chloroform, and TCE at concentrations detected above their respective groundwater screening levels. Chloroform may be present as a breakdown product of CT. CT and TCE appear to be the original chemicals of the plume. Plume C contamination has been observed at greater than 10 feet below ground (the depth of groundwater in that area) to the weathered shale interface. Figure 2 shows the extent of CT or TCE in groundwater at concentrations above the MCLs, as observed during the April 2016 OU-1 groundwater sampling event.

As described in Table 2, VOCs detected in groundwater at concentrations greater than VISLs during the 2010 predesign investigation (CH2M HILL 2011b) prompted VI assessments at select offsite residences to the north of the former Hanley Area. Limited data concerning the VI pathway at that time resulted in separating the former Hanley Area into two OUs, as described in Section 1.0.

5.0 Scope and Role of Response Action

The OU-2 FS (CH2M 2017) identified several remedial alternatives and evaluated them to select the preferred alternative for OU-2. The preferred alternative will be the final response action for OU-2. The primary objective of this Proposed Plan for OU-2 is to prevent the potential for future unacceptable risk to onsite and offsite human receptors from VI of COCs. The concentrations considered acceptable to leave in place are called the remediation goals.

These will be identified in the decision document following the public's review of this Proposed Plan. The implementation of the remedy will also comply with ARARs and achieve the RAOs for OU-2.

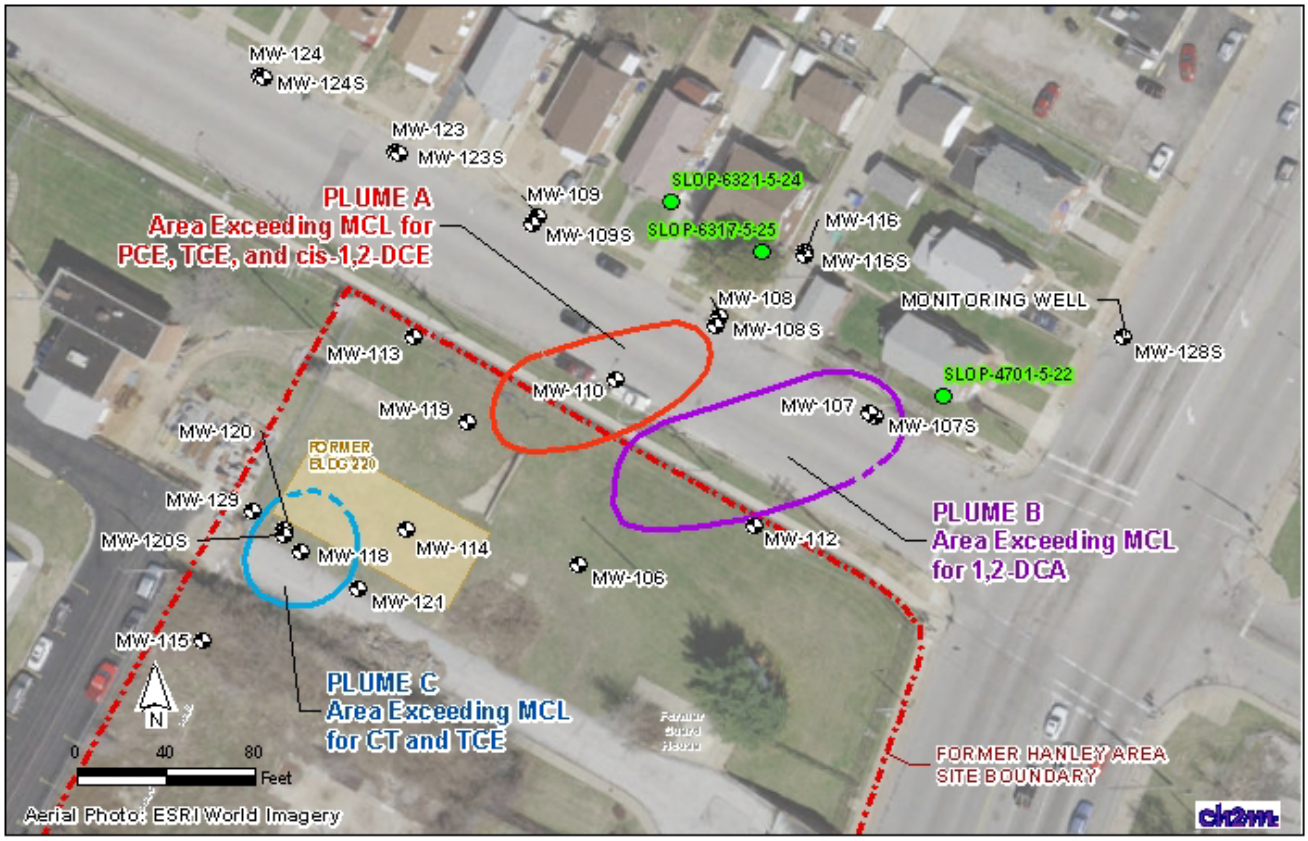

FIGURE 2
GROUNDWATER AT CONCENTRATIONS EXCEEDING MCLS

6.0 Summary of Site Risks

A **human health risk assessment (HHRA)** was performed for OU-2 (refer to Figure 3) to evaluate potential current and future VI risks and hazards to humans on or near the site. This section summarizes the HHRA. Additional details are provided in the OU-2 RI report (CH2M 2016).

It is the Army's current judgment that the preferred alternative identified in this Proposed Plan, or one of the other measures considered in the Proposed Plan, is necessary to protect the future public health or welfare from releases of hazardous substances into the environment and the potential for future VI of site-related COCs.

6.1 Human Health Risk Assessment

The HHRA used the concentrations of contaminants found in onsite groundwater (that is, groundwater beneath the former Hanley Area), subslab soil gas (air collected beneath the lowest level floor slab), and indoor air (air collected in the lowest level of the property) collected during the investigations completed between 2008 and 2015 to assess current and future risk (refer to Table 2 for details of the investigations).

Many everyday consumer products and household activities release chemical vapors into the air and can affect indoor air quality.

Examples include cleaners, solvents, polishes, adhesives, lubricants, aerosols, dry-cleaned clothing, fuels, and insect repellents. Other indoor activities, such as cigarette smoking and home heating, in-home salons, handyman businesses, and craft hobbies can also affect indoor air quality. Outdoor chemical sources, such as automobile exhaust, are another source of chemicals found in air.

Because many factors can affect indoor air quality, the VI evaluation and HHRA considered multiple lines of evidence to determine the source, or sources, of chemicals found in indoor air. The OU-2 VI investigation

evaluated groundwater data within 100 feet of existing buildings (the distance used to identify buildings near a potential vapor source), compared subslab soil gas data and indoor air data, and compared indoor air and outdoor air data. This helped the Army to identify chemicals related to the former Hanley Area (site-related) and those coming from potential indoor air and outdoor air chemical sources.

The HHRA considered the people (that is, **receptors**) who potentially could be exposed to contaminants through VI. It evaluated risks to receptors currently using the site and surrounding properties, as well as those who could use the site and surrounding properties in the future. The following current and potential future human receptors and **exposure** scenarios were identified in the OU-2 HHRA:

- Receptor A: Current and future offsite residents who may inhale site-related vapors in indoor air because of VI.
- Receptor B: Current and future offsite students and instructors at the Job Corps welding shop who may inhale site-related vapors in indoor air because of VI.
- Receptor C: Future onsite residents (assuming that homes are built at the site in the future) who may inhale site-related vapors in indoor air because of VI.
- Receptor D: Future onsite commercial workers who may inhale site-related vapors in indoor air because of VI.
- Receptor E: Current and future onsite trespassers (adolescents and adults) who may inhale site-related vapors in the onsite main tunnel air because of VI.

Indoor air concentrations were used to evaluate current risk, and subslab soil gas concentrations were used to estimate future risk because those concentrations could affect indoor air quality in the future. During the 2008 RI, soil gas samples could not be collected because of the soil characteristics (soils were too tight to allow sufficient soil gas volume to be collected). Therefore, onsite groundwater concentrations were used to determine if off-gassing of VOCs in groundwater could affect indoor air quality in a hypothetical onsite building in the future.

A COC is a chemical substance that potentially poses unacceptable human health or ecological risks. A COC is typically further evaluated for a potential cleanup action. In the HHRA, a chemical was identified as a site-related COC if it contributes significantly to a cancer risk or non-cancer hazard above targets in onsite groundwater, subslab soil gas, and/or indoor air under the current and future exposure scenarios.

WHAT IS RISK AND HOW IS IT CALCULATED?

A CERCLA HHRA estimates "baseline risk." This is an estimate of the potential for unacceptable human health risk if no cleanup action were taken at a site. To estimate baseline risk at a CERCLA site, the following four-step process is used:

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, concentrations of contaminants found at a site, as well as the effects these contaminants may have on people are considered. Comparisons between site-specific concentrations and concentrations are used to determine which contaminants are of potential concern.

In Step 2, the ways (exposure pathways) that people might be exposed to contaminants are determined. The concentrations and the potential frequency and duration of exposure are used to estimate the highest level of human exposure reasonably expected to occur.

In Step 3, the information from Step 2 is combined with information on the toxicity of each chemical to assess potential health risks. Two types of risk are considered: cancer risk and non-cancer effects. The likelihood of any kind of cancer resulting from a CERCLA site is generally expressed as an upper bound probability; for example, a "1 in 10,000 chance." In accordance with CERCLA, cancer risks are determined to be at an "unacceptable" level when the probability is more than 1 in 10,000 (that is, 10^{-4}) and a cleanup action generally is required (USEPA 1991). If cancer risks are less than 10^{-4}, cleanup action generally is not required, but may be warranted. For non-cancer health effects, a "**hazard index**" is calculated. A hazard index is considered acceptable if it is less than 1, and may be considered unacceptable if it is greater than 1.

In Step 4, it is determined whether site risks are high enough that there may be a potential health concern. The results of the three previous steps are combined, evaluated and summarized. The potential risks from the individual chemicals are summed to estimate the total cancer risks and non-cancer hazard index.

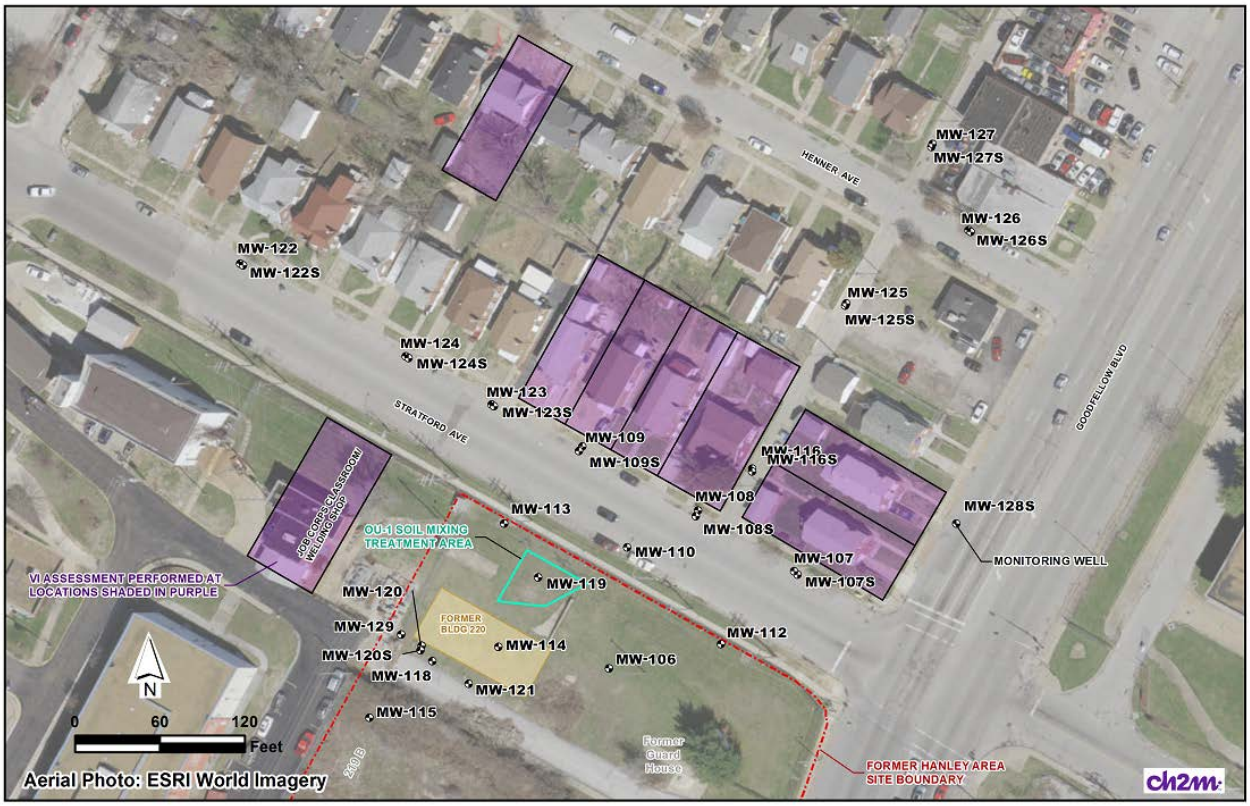

FIGURE 3
OU-2 SITE MAP

The HHRA found no site-related indoor-air COCs for Receptors A and B (current offsite residents, students and instructors). Therefore, no unacceptable offsite risks currently exist, and actions for long-term protection are not required.

TCE was identified as a COC in subslab soil gas because future estimated indoor air concentrations of TCE at one residence north of the former Hanley Area exceeded the target non-cancer hazard index of 1 to Receptor A (future offsite residents). For this reason, actions for long-term protection of residents at that location is required.

Several VOCs in onsite groundwater were identified as COCs based on future estimated indoor air concentrations that may pose potential future unacceptable risk to Receptors C and D (future onsite residents and commercial workers); therefore, actions for long-term protection are required.

No site-related COC tunnel air concentrations due to VI were found for Receptor E (current and future onsite trespassers). Therefore, no current or future risks exist, and actions for long-term protection are not required.

6.1.1 Summary of COCs

The site-related COCs are presented below.

- Subslab soil gas (Receptor A – offsite residents; future offsite exposure): TCE at one residence
- Groundwater (Receptors C and D – onsite residents and commercial workers; future onsite exposure):
  - Residential scenario: benzene, CT, chloroform, and TCE at well MW-118; benzene, CT, PCE, TCE, and vinyl chloride at monitoring well MW-119.
  - Commercial scenario: CT, chloroform, and TCE at monitoring well MW-118; CT, PCE, TCE, and vinyl chloride at monitoring well MW-119.

6.2 Ecological Risks

Risks to ecological receptors were found to be negligible during the 2008 RI (CH2M HILL 2009).

7.0 Remedial Action Objective

RAOs are goals specific to media or OUs for protecting human health and the environment. Typically, RAOs are developed based on the **exposure pathways** (that is, the route by which a person may come into contact with a chemical) and contaminant levels found to pose potentially unacceptable risks according to the results of the HHRA and to satisfy the ARARs.

The RAO for OU-2 is to prevent unacceptable risk to future human receptors (onsite and offsite) from VI of COCs.

7.1 Preliminary Remediation Goals

Preliminary remediation goals (PRGs), as part of the RAO, were identified for COCs in subslab soil gas and onsite groundwater and are based on risk-based concentrations at specific target risk or hazard levels. The PRGs will be considered the final remediation goals in the OU-2 Decision Document once a remedy and target risk levels are selected for the site by the Army. The OU-2 PRGs for onsite groundwater (based on a conservative hypothetical future residential scenario) and subslab soil gas, are presented in Tables 3 and 4, respectively. Additional information on OU-2 PRG development is provided in the OU-2 FS (CH2M 2017).

Figure 4 depicts the locations of onsite groundwater concentrations exceeding the OU-2 PRGs. The HHRA was completed before additional groundwater data collected at monitoring well MW-119 indicated that groundwater concentrations are below the OU-2 PRGs. Groundwater samples were collected at MW-119 during post-remedial action performance monitoring and long-term management groundwater monitoring between July 2012 and April 2017. Results indicate that groundwater concentrations have remained below OU-2 PRGs at MW-119 since July 2014 (samples collected on July 2014, April 2015, April 2016, and April 2017).

Table 3. Preliminary Remediation Goals for Chemicals of Concern in Onsite Groundwater

COC	PRG (µg/L)
Benzene	23
CT	6
Chloroform	12
1,2-Dichloroethane	33
PCE	45
TCE	4
Vinyl Chloride	2

µg/L = microgram(s) per liter

Table 4. Preliminary Remediation Goals for Chemicals of Concern in Subslab Soil Gas

COC	PRG (µg/m^3)
Trichloroethene	70

µg/m^3 = microgram(s) per cubic meter

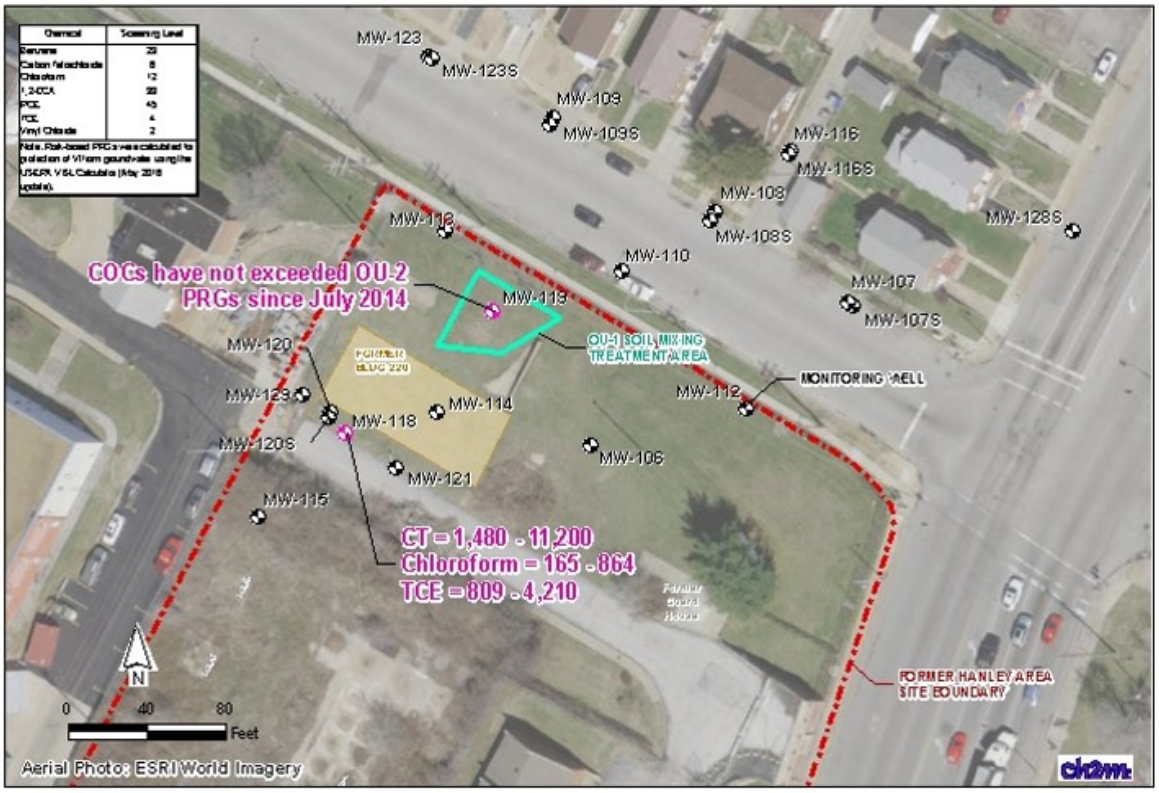

FIGURE 4
COCS IN ONSITE GROUNDWATER EXCEEDING OU-2 PRELIMINARY REMEDIATION GOALS

8.0 Summary of Remedial Alternatives

The preferred alternative for OU-2 of the former Hanley Area addresses the RAO identified in Section 7.0, and it consists of the following components:

- In situ groundwater treatment through chemical oxidation or chemical reduction at Plume C
- Vapor mitigation
- LUCs

The preferred alternative was identified among four remedial alternatives that were developed during the FS phase and is listed as Alternative 4 below. The considered alternatives are discussed briefly below. Additional details can be found in the OU-2 FS (CH2M 2017), as part of the administrative record:

- Alternative 1: No Action (must be retained, per NCP)
- Alternative 2: Sealing Cracks/Openings and Monitoring
- Alternative 3: Vapor Mitigation
- Alternative 4: In Situ Groundwater Treatment through Chemical Oxidation or Chemical Reduction at Plume C and Vapor Mitigation
- Alternative 5: Groundwater Source Removal by Excavation at Plume C and Vapor Mitigation

8.1 Alternative 1: No Action

Alternative 1 is required under CERCLA to provide a baseline for comparing remedial alternatives. Under this alternative, site cleanup would not be conducted and no LUCs would be implemented.

- **Capital Cost: $0**
- **Operation and Maintenance (O&M) Present Value Cost: $0**
- **Total Present Value Cost: $0**

8.2 Common Elements Among Remedial Alternatives

With the exception of the required No Action alternative, the Army has included the following elements that are common among Alternatives 2, 3, 4, and 5:

- LUCs
- Onsite and offsite groundwater monitoring to evaluate the VI pathway
- Monitoring well abandonment

Each of the common elements and the costs incorporated into each remedial alternative are described below. They have been included as part of the remedy and cost estimates for each of the four alternatives. For cost estimating purposes, the estimated duration of Alternatives 2, 3, 4, and 5 was chosen as 30 years. Although the actual monitoring period may be longer, cost estimating periods beyond 30 years have little effect on the **present worth** estimate.

8.2.1 Land Use Controls

LUCs are restrictions placed on the site that help minimize the potential for human exposure to contamination. For instance, no construction activities may be performed within the LUC boundaries without prior written approval from the 88th RSC.

LUCs at the former Hanley Area would restrict land use in areas where onsite groundwater concentrations exceed OU-2 remediation goals. The LUCs would require either (1) VI mitigation technology to be applied to new building construction to address the potential VI pathway if groundwater concentrations have not fallen below remediation goals near the construction site or (2) a location-specific VI evaluation at the building construction site to determine if risk thresholds are exceeded (and if thresholds are exceeded, implementation of building mitigation technology for VI).

Because OU-2 monitoring activities are expected to overlap with ongoing OU-1 monitoring activities, the Army is making plans to combine OU-1 monitoring and implementation of LUCs for both OUs. The LUC implementation plan will provide further details regarding the specific LUC boundaries and how they would be implemented, monitored, and enforced.

Upon transfer of property ownership, the Army will include restrictions in the property deed to memorialize the LUCs, as appropriate. For property sold or to be otherwise transferred from the United States, the Army will prepare required deed covenants to comply with CERCLA Section 120(h)(3), as appropriate.

Figure 5 presents the proposed OU-2 LUC boundaries at the former Hanley Area.

8.2.2 Onsite and Offsite Groundwater Monitoring to Evaluate the VI Pathway

Based on the uncertainty of indoor air risk in the future, onsite and offsite groundwater monitoring would be included in the OU-2 remedy to assess potential future unacceptable risk associated with the VI pathway.

The Army will develop an approach for assessing offsite shallow groundwater sample results that may include, but not be limited to, criteria for increasing or decreasing monitoring, terminating shallow groundwater monitoring activities, VI triggers for additional sampling, VI mitigation, and the type of mitigation. In accordance with the Army VI policy, proper notification would be given to current property owners of potential VI risk.

Details of the OU-2 monitoring program, such as frequency, number, and location of wells to be sampled, will be provided in the site cleanup design once a decision document has been signed.

8.2.4 Monitoring Well Abandonment

Based on the data gathered during the OU-2 RI (CH2M 2016), offsite colocated monitoring well pairs MW-122/122S through MW-127/127S will be abandoned (Figure 5). Multiple rounds of data collected at these monitoring wells do not indicate the presence of site-related contamination in groundwater and they are not located in areas (that is, plume delineation wells, and perimeter wells) that would supplement the current OU-1 LTM program or a future OU-2 LTM program. Additionally, onsite monitoring well MW-118

may be abandoned if an active remedy is implemented at Plume C (refer to Alternatives 4 and 5).

features that could be potential vapor entry points.

Sealing of potential vapor entry points could

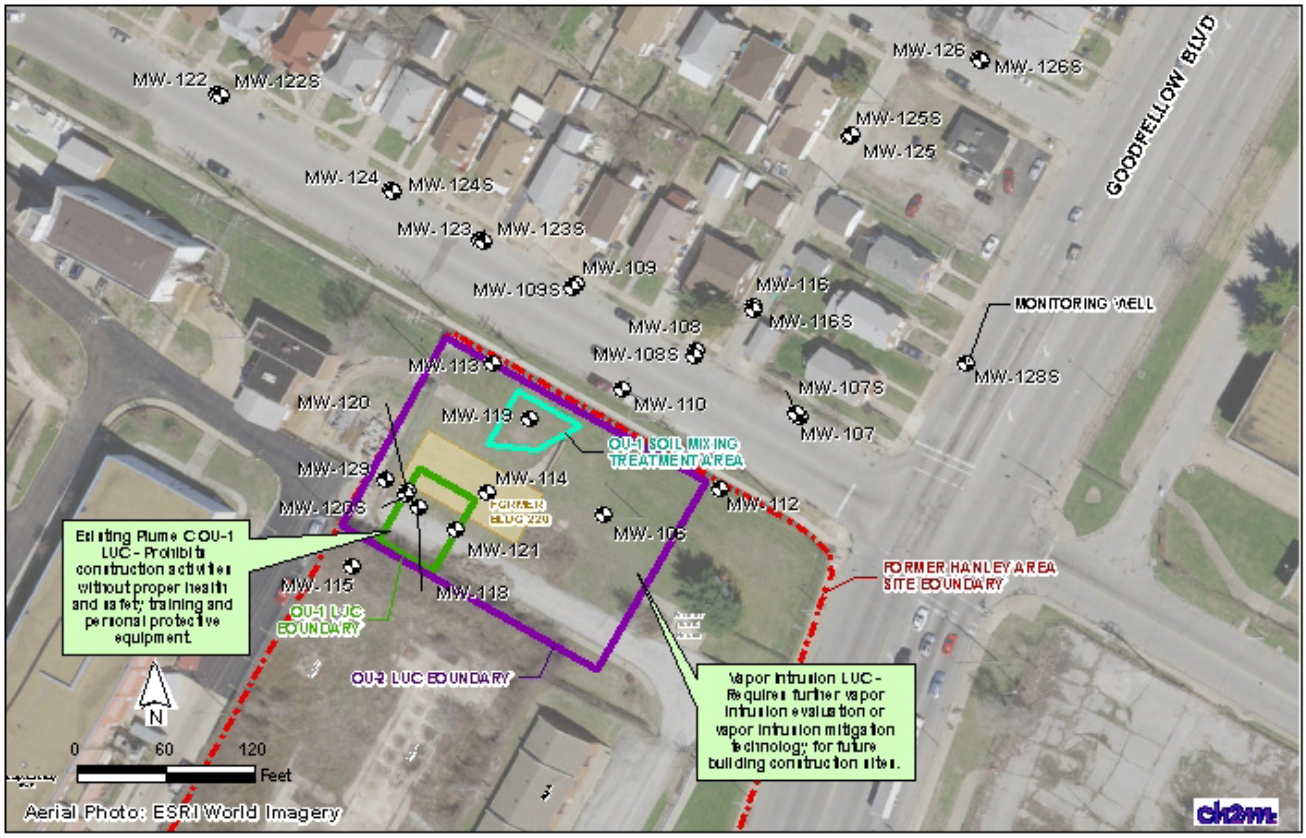

FIGURE 5
OU-2 LAND USE CONTROL

8.3 Alternative 2: Sealing and Monitoring

Alternative 2 was developed to address potential future unacceptable risks to offsite residents associated with exposure to TCE in indoor air since TCE is present in the subslab soil gas at one residence located north of the former Hanley Area. There is no current risk to receptors from VI, based on indoor air concentrations. Alternative 2 consists of sealing potential vapor entry points, if any, and routine collection of subslab soil gas and indoor air and outdoor air samples to evaluate how potential indoor air and subslab soil gas TCE concentrations change over time.

Before monitoring activities begin, potential vapor entry points will be identified for sealing. A visual inspection of the entire structure would be conducted to identify cracks, building joints, and other building

be performed using elastomeric compounds and insulating foam sealants to reduce or prevent TCE vapors from being transported through these vapor entry points. Attempting to identify and seal every potential entry point can be impractical, and long-term monitoring and maintenance of the seals would be required. This approach would address the most obvious and potentially largest points where vapor entry could occur in the future. Note that it has been determined through multiple VI assessments that VI is not significant or occurring currently at the residence.

Alternative 2 is consistent with the current and likely future residential use of the property. This alternative allows normal use of the property with minimal disruption. **Five-year reviews** and monitoring, as necessary, would be conducted until subsurface contamination is below the remediation goals.

The estimated time required to achieve OU-2 remediation goals is 30 years. This timeframe was selected because estimating beyond 30 years is assumed to have a negligible cost impact on the present value analysis. The estimated costs for Alternative 2 are as follows:

- **Capital Cost: $203,000**
- **O&M Present Value Cost: $674,000**
- **Total Present Value Cost: $877,000**

8.4 Alternative 3: Vapor Mitigation

Alternative 3 was developed as an active remedy to address potential future unacceptable risks to offsite residents associated with exposure to TCE in indoor air, since TCE was detected above the OU-2 PRG in the subslab soil gas at one residence located north of the former Hanley Area. There is no current risk to receptors from VI, based on indoor air concentrations. Alternative 3 consists of the actions described in Alternative 2 above and an active subslab depressurization (SSD) system, which would be accomplished using fans or blowers to depressurize the air beneath the slab and prevent any potential for future VI. Subslab air would be piped to an exterior vent located above the building roofline. The extracted air would be discharged to the atmosphere outside the building, either with or without treatment of the offgas, depending on the TCE concentrations in the emissions. It is assumed that treatment would not be required because TCE concentrations beneath the basement floor slab are already relatively low and would be sufficiently diluted.

As part of SSD system installation, a portable gas detector would be used with the goal to identify vapor entry points (such as large cracks or utility penetrations). Sealing may be performed if significant cracks or other openings are identified using sealants, with the goal to further cut off any potential for future vapor entry.

The effectiveness of this alternative would be monitored by measuring field parameters (e.g., vacuum, flow, differential pressure). Subslab soil gas and indoor air samples would be collected to assess fluctuations in concentrations over time.

Alternative 3 is consistent with the current and likely future residential use of the property. This alternative allows current resident activities to be continued; however, there would be short-term disruptions during the SSD system pre-mitigation diagnostic testing and construction. Five-year reviews and monitoring, as necessary, would be conducted until contamination is below regulatory standards. The estimated costs for Alternative 3 are as follows:

- **Capital Cost: $358,000**
- **O&M Present Value Cost: $1,151,000**
- **Total Present Value Cost: $1,509,000**

8.5 Alternative 4: In Situ Treatment through Chemical Oxidation or Chemical Reduction at Plume C and Vapor Mitigation

Alternative 4 consists of active vapor mitigation at one offsite residence, as described in Alternative 3, and includes a remedy to address future onsite hypothetical residential and commercial worker receptors who may inhale site-related constituents in indoor air resulting from groundwater off-gassing and VI. In addition, the onsite remedy would lower the risk of future potential VI at the nearby building located on Job Corps property. Although not associated with the VI pathway, the onsite remedy would also prevent potential future unacceptable risk to onsite construction workers from contacting groundwater contaminated with TCE and CT at Plume C if the depth to groundwater were to rise to depths less than 10 feet below ground (OU-1 objective).

Under the onsite remedy for Alternative 4, the groundwater **target treatment zone (TTZ)**, which is the part of the contaminated groundwater that poses potential future unacceptable risks to human health, would be treated by applying a **chemical reductant** or **oxidant** to in situ soil and groundwater at Plume C (Figure 6). Chemical reduction using soil mixing procedures was selected as the basis of the cost estimate for this alternative.

Due to the heterogeneous, shallow soil, and because soil mixing was successfully applied at Plume A, this option for delivering the

amendment was considered. Mechanical soil mixing involves using an in situ blender (for example, large diameter auger or trenching machine or rotating drum) to effectively distribute chemical amendments throughout the soil medium to treat contaminants through reductive dechlorination. A predesign groundwater investigation would refine the TTZ before applying the amendment.

Groundwater monitoring would be performed at Plume C to evaluate the performance of the selected remedy. Data collected within the Plume C treatment area would be used to evaluate the impact on COC concentrations in groundwater. Additional monitoring wells will likely be installed to conduct adequate performance monitoring of the remedy.

Applying a reductant will lead to rapid treatment, and the remediation goal is likely to be met within 1 year. The onsite remedial alternative allows normal use of the property with minimal disruption. As discussed under Alternative 3, the offsite remedy is consistent with the current and likely future residential use of the property. This alternative allows current resident activities to be continued at the residence; however, there would be short-term disruptions during the SSD system pre-mitigation diagnostic testing and construction. Five-year reviews and monitoring, as necessary, would be conducted until contamination is below regulatory standards. The estimated costs for Alternative 4 are as follows:

- **Capital Cost: $1,626,000**
- **O&M Present Value Cost: $1,157,000**
- **Total Present Value Cost: $2,783,000**

8.6 Alternative 5: Groundwater Source Removal by Excavation at Plume C and Vapor Mitigation

Alternative 5 consists of active vapor mitigation at one offsite residence, as described in Alternative 3, and includes a remedy to reduce future onsite hypothetical residential and commercial worker potential risks from inhalation of site-related constituents in indoor air resulting from groundwater off-gassing and VI. In addition, the onsite remedy would lower the risk of future potential VI at the nearby building located on Job Corps property. Although not associated with the VI pathway, the onsite remedy would also prevent potential future unacceptable risk to onsite construction workers from contacting groundwater contaminated with TCE and CT at Plume C if the groundwater were to rise to depths less than 10 feet below ground (OU-1 objective).

Under the onsite remedy for Alternative 5, soil removal would be completed to decrease COC concentrations in groundwater within the Plume C area. Soil excavation removes the contaminated media, reducing and/or eliminating future risk above target levels associated with the contamination. Alternative 5 combines physical soil removal with disposal at a permitted landfill. The Plume C excavation area size is consistent with Alternative 4 (Figure 6). A predesign groundwater investigation would refine the excavation extents before soil removal.

Contaminated soil would be removed using a backhoe or similar heavy machinery. Contaminated soil at and below the groundwater table would be excavated from Plume C. Some contaminated soil may have to be left in place if it is not safe or practical to be removed (that is, it would require excavation too close to utilities). Excavation near utilities would be conducted in a manner that protects structural integrity, such as the use of sheet piling.

Following excavation, clean imported material would be used to backfill the excavation. The area would be regraded, reseeded, and restored to its original condition.

Groundwater monitoring would be performed at Plume C to evaluate the performance of the selected remedy. Data collected within the Plume C excavation area would be used to evaluate the impact on COC concentrations in groundwater. Additional monitoring wells will likely need to be installed to conduct adequate performance monitoring of the remedy.

The onsite remedial alternative allows normal use of the property with minimal disruption. As discussed under Alternative 3, the offsite

remedy to install a vapor mitigation system is consistent with the current and likely future residential use of the property. This alternative allows current resident activities to be continued at the residence; however, there would be short-term disruptions during the SSD system pre-mitigation diagnostic testing and construction. Five-year reviews and monitoring, as necessary, would be conducted until contamination is below regulatory standards. The estimated costs for Alternative 5 are as follows:

- **Capital Cost: $1,467,000**
- **O&M Present Value Cost: $1,157,000**
- **Total Present Value Cost: $2,624,000**

The nine criteria are divided into three categories: **threshold criteria**, **balancing criteria**, and **modifying criteria**. A cleanup alternative must meet the threshold criteria in order to be considered further. The balancing criteria are used to compare alternatives to one another. State and community acceptance of a proposed remedial action, or modifying criteria, are important elements in selecting a cleanup action and are evaluated during the public review of this Proposed Plan.

ARARs are federal and state remedial standards, standards of control, and other substantive environmental statutes or regulations that are either "applicable" or "relevant and appropriate" to the cleanup actions being considered for the site. A selected remedial alternative must comply with ARARs or provide reasons for a waiver from these requirements. The ARARs are presented in Table 2 of the OU-2 FS (CH2M 2017).

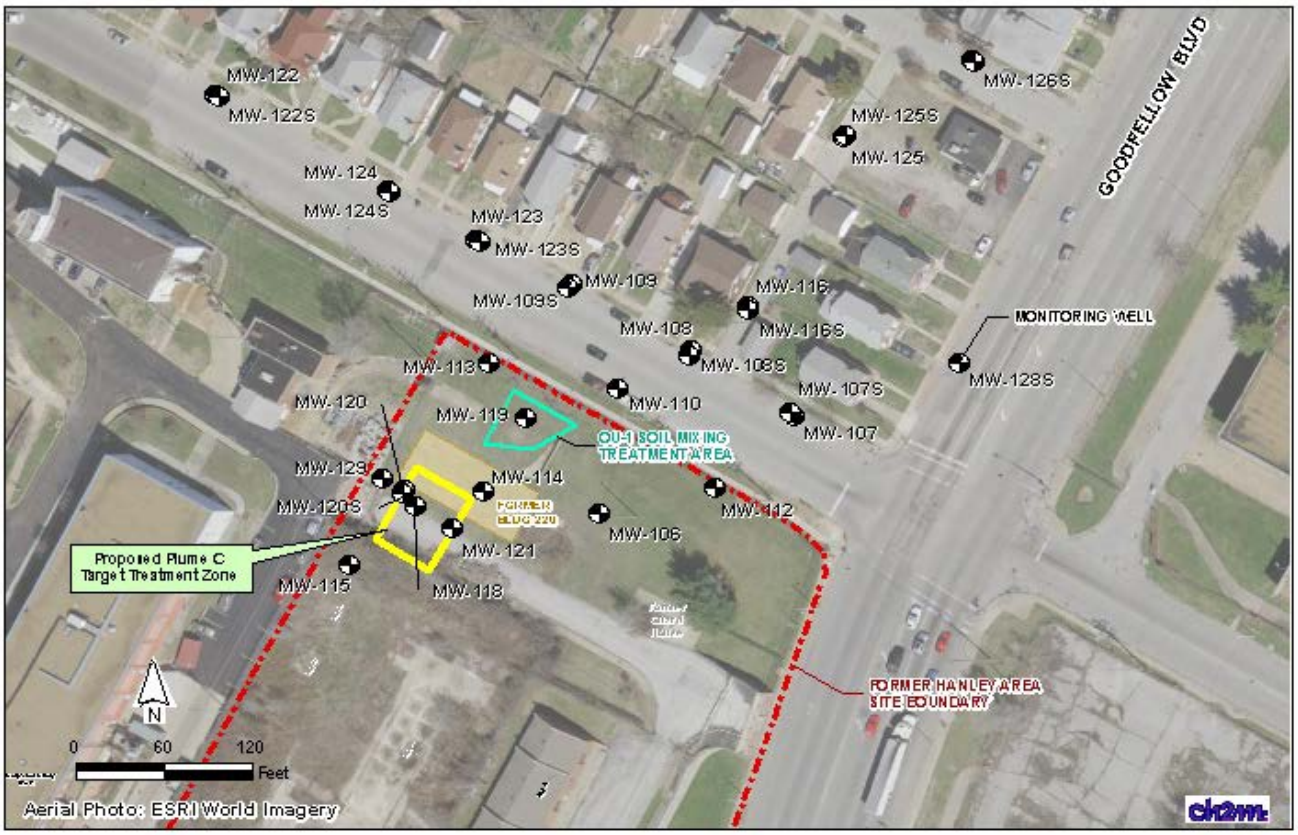

FIGURE 6
PLUME C TARGET TREATMENT ZONE

9.0 Evaluation of Remedial Alternatives

9.1 Evaluation Criteria

Alternatives were evaluated in detail using the nine NCP criteria established by USEPA and described in the inset on Page 19.

9.2 Comparative Analysis

Each remedial alternative for COCs in onsite groundwater and in subslab soil gas was evaluated against the nine criteria established by USEPA and compared to one another, as depicted in Table 5. The final two criteria (state/support agency acceptance and community acceptance) are modifying criteria that are used to modify the selection of the recommended alternative following the public comment period. The purpose was to identify the relative advantages and disadvantages of each alternative.

EVALUATION CRITERIA FOR CLEANUP ALTERNATIVES

Threshold Criteria

Overall Protection of Human Health and Environment requires that a cleanup alternative adequately eliminates, reduces, or controls current and future risk posed by the site.

Compliance with Applicable or Relevant and Appropriate Requirements, which are federal and state cleanup standards, standards of control, and other substantive environmental statutes or regulations that are either "applicable" or "relevant and appropriate" to the cleanup action. A selected cleanup alternative must comply with ARARs or provide reasons for a waiver from these requirements.

Balancing Criteria

Long-term Effectiveness and Permanence addresses the expected residual risk and considers the ability of an alternative to maintain protection of human health and the environment over time, once cleanup goals have been met.

Reduction of Toxicity, Mobility, or Volume through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present. Under CERCLA, the preference is for a cleanup action that uses treatment to reduce the toxicity, mobility, and volume of contamination.

Short-term Effectiveness considers the risks the alternative poses to workers, residents, and the environment during construction and implementation. The length of time needed to implement an alternative is also considered.

Implementability deals with the difficulties of constructing and operating an alternative and the availability of materials and services required.

Cost includes capital costs and O&M costs.

Modifying Criteria

State Acceptance evaluates the issues and concerns that MDNR may have regarding each of the alternatives.

Community Acceptance considers whether the local community agrees with the Army's analyses and preferred alternative. Comments will be assessed after a thorough review of the public comments received on the Proposed Plan.

Based on the comparison, all alternatives except Alternative 1 provide future protection of human health and are expected to comply with ARARs. Alternative 5 is considered to have the greatest short- and long-term effectiveness, permanence, and reduction of toxicity, mobility, and volume because it effectively removes COC concentrations that contribute unacceptable risk to construction workers from contacting groundwater contaminated with TCE and CT at Plume C if groundwater were to rise to depths less than 10 feet below ground (OU-1 objective) and lowers the risk of future potential VI onsite and at the nearby building located on Job Corps property (OU-2 objective). However, it does not satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element.

Alternative 4 satisfies the preference for treatment at Plume C, while Alternatives 2 and 3 do not include a Plume C treatment component. The active remedy for Plume C, as described in Alternative 4, is advantageous for complete and rapid destruction of TCE and CT. It also has the highest short-term effectiveness among Alternatives 3 and 4. However, Alternative 4 is higher in cost because of the Plume C treatment component, but this disadvantage is outweighed by the benefit of short-term effectiveness and the shorter remedial timeframe to achieve the RAO. Although Alternatives 4 and 5 reduce the remedial timeframe to achieve the OU-2 RAO, they are no more protective than LUCs (common element among Alternatives 2 through 5) to address future potential VI onsite. Costs are highest for Alternative 4, followed by Alternative 5, and lastly, by Alternatives 3 and 2.

Table 5 summarizes how each alternative satisfies each criterion and how it compares to

the other alternatives. Active SSD is proposed as a common remedial component for Alternatives 3, 4, and 5, since options for addressing TCE in subslab soil gas at the offsite residence are limited. The ratings associated with the remedy at the offsite residence would be the same among Alternatives (with the exception of Alternative 1); for this reason, a comparative analysis associated with the onsite remedy at Plume C was summarized to determine an overall rating for each alternative.

Alternatives 2, 3, 4, and 5 each require monitoring to confirm that the remedial action proceeds toward achieving RAOs. They are reliable, provided the remedial action is designed and implemented correctly.

10.0 Preferred Alternative

Based on an evaluation of the alternatives and available information, Alternative 4, In Situ Treatment through Chemical Oxidation or Chemical Reduction at Plume C and Vapor Mitigation, is recommended as the preferred alternative because it will most effectively meet the RAOs and satisfy the statutory requirements of CERCLA 121(b). The preferred alternative may change in response to public comment or new information.

Table 5. Comparative Analysis of Alternatives

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Threshold Criteria					
Protection of human health and the environment	Fail	Pass	Pass	Pass	Pass
Compliance with ARARs	Fail	Pass	Pass	Pass	Pass
Balancing Criteria					
Long-term effectiveness and permanence	⊘	◐	◎	●	●
Reduction in toxicity, mobility, or volume through treatment	⊘ [a]	⊘ [a]	◐	●	●
Short-term effectiveness	⊘	◎	◎	◎	◎
Implementability	●	●	◎	◎	●
Cost	$0	$877,000 [b]	$1,509,000 [b]	$2,783,000 [b]	$2,624,000 [b]
Modifying Criteria					
State/support agency acceptance	⊘	To Be Determined[c]			
Community acceptance	To Be Determined				

The two threshold criteria are evaluated with pass/fail.
The primary balancing criteria are rated as qualitative descriptions of the relative compliance of each alternative with the criteria
Ratings:

● Satisfies criterion ◎ Moderately satisfies criterion ◐ Poorly satisfies criterion ⊘ Does not meet criterion

- Alternative 1: No Action
- Alternative 2: Sealing and Monitoring
- Alternative 3: Vapor Mitigation
- Alternative 4: In Situ Treatment through Chemical Oxidation or Chemical Reduction at Plume C and Vapor Mitigation
- Alternative 5: Groundwater Source Removal by Excavation at Plume C and Vapor Mitigation

[a] Alternative does not include active treatment.
[b] Cost is the total present-worth value; cost accuracy ranges from +50 to -30 percent.
[c] MDNR was engaged during development of the remedial alternatives, and their acceptance of the preferred alternative will be evaluated at the end of the public comment period.

11.0 Community Participation

Public participation is an important component of remedy selection. The Army is soliciting input from the community on the Proposed Plan and Preferred Alternative. The public comment period for this Proposed Plan is January 10 through February 10, 2018.

Public comments will be considered before the Army makes a final decision and selects the remedy. The public is encouraged to review and comment on the Proposed Plan. During the comment period, the public is encouraged to review documents (such as the OU-2 RI report) pertinent to the former Hanley Area. Administrative record documents are available at the St. Louis Central Public Library at 1301 Olive Street, St. Louis, MO 63103 (see Page 1).

Comments on the Proposed Plan or other relevant issues can be submitted by e-mail or mail (postmarked no later than February 10, 2018) to the address given on page 1. During the comment period, the Army will hold a public meeting at The Omega Center in St. Louis at 6:00 pm on January 24, 2018. This meeting will provide another opportunity for the public to comment on the Proposed Plan.

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Acronyms

µg/L	microgram(s) per liter
µg/m^3	microgram(s) per cubic meter
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPC	chemical of potential concern
CT	carbon tetrachloride
DCE	dichloroethene
DCA	dichloroethane
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
FS	Feasibility Study
HHRA	human health risk assessment
LTM	long-term management
LUC	land use control
MCL	maximum contaminant level
MDHSS	Missouri Department of Health and Senior Services
MDNR	Missouri Department of Natural Resources
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
OU	operable unit
PCE	tetrachloroethene
PRG	preliminary remediation goal
RACR	remediation action completion report
RAO	remedial action objective
RI	remedial investigation
ROE	right-of-entry
RSC	Regional Support Command
SARA	Superfund Amendments and Reauthorization Act

SSD	subslab depressurization
TCE	trichloroethene
TTZ	target treatment zone
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USEPA	U.S. Environmental Protection Agency
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
ZVI	zero-valent iron

Glossary of Terms

Applicable or Relevant and Appropriate Requirements (ARARs)—*Applicable* requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only state standards identified in a timely manner and more stringent than federal requirements may be relevant and appropriate. 40 *Code of Federal Regulations* 300.

balancing criteria: Five of the nine CERCLA criteria used to further evaluate remedial alternatives. They are long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

bedrock: The native consolidated rock underlying the ground surface.

capital cost: The actual costs related to the labor, equipment, and material costs of construction.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (together, commonly known as Superfund) is the environmental program to address abandoned hazardous waste sites and releases of hazardous substances to the environment.

chemical of concern (COC): Site-specific chemical substance that potentially poses unacceptable human health or ecological risks. A COC is typically further evaluated for remedial action.

chemical of potential concern (COPC): Site-specific chemical substance with a maximum detected concentration exceeding the conservative screening level.

chemical oxidant: A chemical agent that causes the loss of electrons or an increase in oxidation state by a molecule, atom, or ion.

chemical reductant: A chemical agent that causes the gain of electrons or a decrease in oxidation state by a molecule, atom, or ion.

chlorinated volatile organic compound: A volatile organic compound containing one or more chlorine atoms in its chemical structure.

decision document: A legal document issued following the Proposed Plan that sets forth the selected remedy for remedial action at a site as decided by the lead federal agency.

exposure: Chemical contact by a receptor.

exposure pathway: The route by which a receptor may come into contact with a chemical. An exposure model identifies pathways and routes by which a receptor group may be exposed to chemicals based on a hypothetical "complete" exposure pathway.

The following five elements are needed to form a complete exposure pathway:

- Chemical source
- Mechanism of chemical release to the environment
- Environmental transport medium (air, groundwater) for the released chemical
- An exposure point (point of contact between the impacted medium and the receptor)
- Exposure route (for example, ingestion of groundwater) at the exposure point

If any element is missing, the exposure pathway is incomplete, and no intake (or subsequent health risk) associated with the pathway may exist.

feasibility study (FS): A comprehensive evaluation of potential alternatives for remediating contamination. It identifies general response actions, screens potentially applicable technologies and process options, assembles alternatives, and evaluates alternatives in detail.

five-year review: The regular checkup on a CERCLA site where a hazardous substance was left behind after a remedial action, to make sure that the site is still safe and that the remedial action is continuing to protect people and the environment. Public notices announce the beginning and end of the review and availability of the report. The public has a chance to provide information about any changes or problems they may have noticed at the site.

groundwater: Water in the ground surface that fills spaces between sand, soil, and rock. In aquifers, groundwater occurs in sufficient quantities that can be used as a source of water for drinking, irrigation and other purposes.

hazard index: The term for the measuring adverse health effects to humans associated with exposure to noncancer causing contaminants. Noncancer hazards are expressed as a ratio and when these hazards are summed for each chemical and this hazard index is equal to or less than the USEPA acceptable hazard index threshold of 1, no adverse health effects are anticipated. However, if it exceeds 1, the potential for noncancer effects exists.

human health risk assessment (HHRA): Uses analytical sampling data to evaluate the potential risks posed to human health by specific contaminants, based on site-specific exposure scenarios. Exposure scenarios ask these questions: *Who could be exposed to chemicals at a site (potential receptors)? How could people be exposed (for example, by skin contact or ingestion)? How often and for how long?* Using these scenarios and toxicity values for the chemicals present at a site, provided by USEPA and based on independent scientific studies, the risks are calculated and added up for all chemicals across all exposure pathways. The overall risk for each potential receptor is then compared to acceptable levels defined by USEPA.

in situ: In the original position, not having been moved or transferred to another location.

land use control (LUC): A physical, legal, or administrative mechanism that restricts the use of, or limit access to, contaminated property to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers to limit access to property, such as fences or signs. The legal mechanisms are generally the same as those used for institutional controls as discussed in the National Contingency Plan. Institutional controls are a subset of LUCs and are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions.

Missouri Department of Natural Resources (MDNR): The state agency responsible for enforcement of state laws protecting the environment.

modifying criteria: Two of nine CERCLA criteria used to evaluate remedial alternatives: namely state and community acceptance.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): Commonly called the National Contingency Plan, the NCP is the federal government's blueprint for responding to both oil spills and hazardous substance releases. The NCP is the result of efforts to develop a national response capability and promote coordination among the hierarchy of responders and contingency plans.

No Action: No remedial action necessary per the CERCLA process.

operation and maintenance (O&M): Measures required to maintain the effectiveness of response actions. 40 *Code of Federal Regulations* 300.

operable unit: A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site. Operable units will not impede implementation of subsequent actions, including final action at the site.

plume: A volume of groundwater affected by a contaminant source. Typically, an elongated, mobile volume representing the extent of contaminated groundwater.

powder well: Sediment catch basin designed to catch gunpowder washed down from buildings before discharge of the wastewater to the sewer.

Preferred Alternative: The cleanup approach proposed by the lead agency based on the information contained in the OU-2 FS. The Preferred Alternative, as presented in this Proposed Plan, is subject to change or revision based on public comment.

present worth: The amount of money that would need to be invested today to fund a stream of expenditures at given points in time. O&M expenses are often calculated for their present worth, in order to compare different alternatives. Present worth is not just an addition of the yearly costs; it takes into account interest rates.

Proposed Plan: A plan for a site remedial action or other action that is available to the public for comment.

public comment period: A reasonable time period, of at least 30 days, for the public to review and comment on various documents and actions.

receptor: Human being or nonhuman organism that might be exposed to a contaminant, by coming in contact with air, water, soil, or other material containing the contaminant.

remedy [or remedial action]: An action taken to address a release or threatened release of hazardous substances that could affect public health or the environment.

remedial action objective (RAO): Medium-specific objective for protecting human health and the environment (for example, groundwater and soil).

remedial investigation (RI): Extensive and detailed studies of the nature and extent of the contamination at the site, including field testing and sampling, site characterization, and conducting formal risk assessments. This phase in the CERCLA process occurs after a site inspection reveals a real or potential threat to human health and the environment exists. The remedial investigation is used to determine whether or not remedial action is required and provides data for a feasibility study of remedial alternatives.

remediation goal: Specific cleanup concentration or level based upon federal and state environmental laws and regulations or the health risk on a given site.

screening level: The values or standards against which the significance of the identified hazard or effect can be judged. They should be based on sound scientific and technical information and may be developed by the company and industry bodies, or provided by the regulators.

Superfund Amendments and Reauthorization Act of 1986 (SARA): In addition to certain free-standing provisions of law, it includes amendments to CERCLA, the Solid Waste Disposal Act, and the Internal Revenue Code. Among the free-standing provisions of law is Title III of SARA, also known as the "Emergency Planning and Community Right-to-Know Act of 1986" and Title IV of SARA, also known as the "Radon Gas and Indoor Air Quality Research Act of 1986." Title V of SARA amending the Internal Revenue Code is also known as the "Superfund Revenue Act of 1986." 40 *Code of Federal Regulations* 300.

target treatment zone (TTZ): Area where groundwater requires further action.

threshold criteria: The first two of the nine CERCLA criteria: overall protection of human health and the environment, and compliance with ARARs.

Trichloroethene (TCE): TCE is a chemical solvent used in dry-cleaning operations, in metal degreasing, and as a solvent for household cleaners for walls, clothing, and rugs. It also has been used as a refrigerant, a cleaner and drying agent for electronic parts and as a component in paints and adhesives.

vapor intrusion (VI): The movement of volatile chemicals in soil and groundwater into indoor air.

vapor intrusion screening level (VISL): A screening level associated with VOCs (see definition provided below) that was developed by USEPA.

volatile organic compound (VOC): A contaminant that evaporates into the air easily, such as paint thinner or an industrial solvent.

weathered shale: Shale that has reacted with air and/or water near the Earth's surface.

zero-valent iron (ZVI): A strong chemical reductant that is used to chemically degrade chlorinated VOCs in groundwater.