DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

REPLY TO
ATTENTION OF

September 29, 2011

Project Management
Environmental Branch

RECEIVED
SEP 30 2011
SUPERFUND DIVISION

Mr. Andrew Rackers
Missouri Department of Natural Resources
Federal Facilities Section, HWP
1730 East Elm Street
Jefferson City, MO 65101

Dear Mr. Rackers,

The U.S. Army Corps of Engineers, Kansas City District is pleased to submit two hard copies and one electronic copy of the Final Decision Document for Operable Unit 1 (OU-1) at the St. Louis Ordnance Plant, Former Hanley Area, in St. Louis, Missouri. The enclosed copies have been signed by the U.S. Army Environmental Command. Additional copies have been distributed as noted below.

The Final OU-1 Decision Document incorporates redline text revisions that were transmitted between the Army and Missouri Department of Natural Resources (MDNR) between August 26 and September 9, 2011. The revisions divided response actions at the Former Hanley Area into two OUs: OU-1 (Actions Addressing Contaminated Soil, Powder Well Sediment, and Groundwater Concerns) and OU-2 (Vapor Intrusion Pathway). OU-1 response actions are presented in the enclosed Decision Document. Response actions associated with OU-2 will be defined at a later date after appropriate vapor intrusion investigation measures are completed. Responses to MDNR and U.S. Environmental Protection Agency, Region VII comments received prior to August 26, 2011 are provided with the enclosed documents.

If you have any questions regarding this submittal, please do not hesitate to contact me at (816) 389-3912.

Sincerely,

Jo Newton-Lund

Josephine Newton-Lund
Senior Project Manager

Cc: Ms. Josephine Newton-Lund, U.S. Army Corps of Engineers – 2 hard copies, 2 electronic copies
Mr. Jonathan Harrington, U.S. Army Environmental Command – 3 hard copies, 3 electronic copies
Ms. Lisa Gulbranson, 88th Regional Support Command – 1 electronic copy
Mr. Dave Moore, 88th Regional Support Command – 1 electronic copy
Mr. Barry McFarland, 88th Regional Support Command – 1 hard copy, 1 electronic copy
Mr. Jim Brown, Sverdrup Army Reserve Center – 1 hard copy
Ms. Michelle Hartman, Missouri Department of Health and Senior Services – 1 hard copy, 1 electronic copy
Mr. Matt Jefferson, U.S. Environmental Protection Agency Region VII – 1 hard copy, 1 electronic copy
Mr. Bill Pedicino, U.S. Environmental Protection Agency Region VII – 1 hard copy, 1 electronic copy
Mr. Filippe Cade, Professional Environmental Engineers – 1 electronic copy

Responses to USEPA Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant, Former Hanley Area

July 5, 2011

This document provides Army responses to U.S. Environmental Protection Agency (USEPA) comments on the document referenced above. USEPA comments were submitted to the Army on June 14, 2011.

General Comments

Comment 1

The vapor intrusion description as a common element under each alternative does not provide a clear evaluation and appears that more VI characterization is needed before making a decision. Section 2.9.2.2 states "Based on the uncertainty of indoor air risk, the vapor intrusion pathway will be further evaluated as part evaluated as part of the site remedy" and later states "Data collected as part of the remedial design may be used to adjust the remedial approach if appropriate." This section, along with section 2.12.2.3, does not follow the EPA's Guide to Preparing Superfund Proposed Plans, Records of Decision, other Remedy Selection Decision Documents and National Oil and the Hazardous Substances Pollution Contingency Plan. The NCP Section 300.430(5)(i) states: "To support the selection of a remedial action, all facts, analyses of fact and site specific policy determination considered in the course of carrying out activities in the section shall be document, as appropriate, in a record of decision, in levels of detail appropriate to the site situation..." The fourth bullet in section 6.1.1 of the ROD Guidance "(The ROD serves as:) A key communication tool for the public that explains the contamination problems the remedy seeks to address and the rationale for its selection." Therefore, the VI issue (if one exists) must be evaluated and documented as a decision to public and regulatory agencies. The EPA recommends the following:

a. The VI evaluation discussions should reference the fall 2010 meeting between USACE, MDNR, USEPA and the other project stakeholders regarding further VI activities, including additional indoor air sampling and subslab sampling.

b. Based on the language of the NCP and the ROD guidance, the VI analysis and decision should be documented in separate ROD as another operable unit. Modify sections 2.9.2.2 and 2.12.2.3 to include this language.

c. If action is required, then remedial action objectives, an evaluation of alternatives based on the nine criteria specified in the ROD guidance, public participation and land use controls for VI will need to be discussed the modified ROD. Specifically, LUCs will need to cover the following:

    i. Risk exposure and reasonably anticipated land uses

ii. Risks necessitating the LUCs

iii. The logic behind selecting the LUCs

iv. Add language on the duration of the LUC, such as "Land Use Controls will be maintained until the concentrations of the vapors or groundwater are at the levels to allow for unrestricted use and exposure."

v. Include language that the Army is responsible for implementing, maintaining, reporting on and enforcing LUCs.

vi. Language assuring responsibility of the LUCs, even through transfer, for example as "Although the Army may later transfer, these procedural responsibilities to another party by contact, property transfer agreement, or through other means, the Army shall retain ultimate responsibility for remedy integrity."

vii. Assuring the LUCs are clear and enforcements in the modified ROD, using the following language "A LUC Implementation Plan will be prepared as the land use component of the Remedial Design/Remedial Action Work Plan. Within 90 days of ROD signature, the Army shall prepare and submit to MDNR for review and approval a LUC Implementation Plan that shall contain implementation and maintenance actions, including periodic inspections."

Response

The Army is addressing the vapor intrusion pathway in accordance with its response to MDNR comments on the decision document. Rather than breaking the vapor intrusion pathway into a separate operable unit and decision document, the final remedy for the vapor intrusion pathway will be documented in an appropriate post-DD change document pursuant to the NCP §§ 300.435(c)(2) and 300.825. Please refer to the Army's response to MDNR Comment 3 in the document titled, *Responses to MDNR Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant, Former Hanley Area,* for more details regarding the approach that the Army will follow. Specific text changes to Sections 2.9.2.2 and 2.12.2.3 are provided in Army responses to MDNR Comments 2 and 3.

Regarding land use controls (LUCs), please refer to the Army's response to MDNR Comment 4 in the document titled, *Responses to MDNR Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant, Former Hanley Area.*

Comment 2

The city of St Louis Ordinance 66777 cannot stand alone as means to provide no remedial action objective for the restoring groundwater to drinking water standards. Determination of the groundwater potability must have supporting state regulations or a groundwater system assessment by the EPA. The EPA recommends the following:

a. Include the memorandum enclosed in this letter as a reference to the decision document and include in Section 2.8 and Section 2.13.1 the assessment to classify groundwater as a Class IIIA groundwater system, meaning the groundwater is not a source of drinking water based on insufficient yield.

b. The groundwater classification should be verified by a drawdown and transmissivity tests on steady state monitoring wells and the classification needs to be reevaluated as part of the five-year review process.

Response

The Army will include a reference to USEPA's groundwater classification system, as well as a discussion of groundwater yield, as discussed in the Army's response to MDNR comment 11 in the document titled, *Responses to MDNR Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant, Former Hanley Area.* Per that response, the Army will reference USPEA's memorandum in the decision document.

The Army feels that available information is sufficient to assess groundwater yield and does not intend to perform additional drawdown or transmissivity tests of the aquifer. In addition, groundwater yield is not expected to change appreciably over time because the saturated zone is unlikely to be altered. Therefore, reevaluation of the groundwater classification as part of five-year process is not necessary. Groundwater drawdown observations in August 2010 are consistent with those recorded during previous groundwater monitoring events at the former Hanley Area. Please refer to the remedial investigation (RI) report for additional information.

Comment 3

The discussion of the LUCs needs to be expanded in Sections 1.4, 2.9.2.4 and 2.12.2.5 to address Comments 1.c.i through 1.c.vii for consistency with similar decision documents at the Department of Defense sites.

Response

The Army will expand the discussion of LUCs as described in its response to MDNR Comment 4 in the document titled, *Responses to MDNR Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant, Former Hanley Area.*

Comment 4

It does not appear that this document provides an adequate exit strategy for groundwater monitoring. For example, the text states that five-year reviews will be terminated once contaminants of concern are at or below the remediation goals, but it does not provide information such as the number of consecutive rounds of results less than or equal to the RGs are necessary. Is this an oversight or will these details be provided in a Remedial Action/Remedial Design document? Please clarify.

Response

The exit strategy will be presented in the long-term management (LTM) plan for the former Hanley Area.

Specific Comments

Comment 5

Page 1-2, Section 1.4, Lines 15-20: The "Vapor intrusion evaluation" text needs to reference groundwater sampling per the Feasibility Study and other parts of this Decision Document.

Response

Reference to groundwater sampling will be added to Section 1.4.

Comment 6

Page 1-3, Section 1.6: As presented in other Decision Documents approved by EPA, please include a statement similar to the following: "Additional information about the site can be found in the Administrative Record file."

Response

The text will be added as requested.

Comment 7

Page 1-3, Section 1.6: For each of the bulleted items, identify the applicable section, for example, baseline risk represented by the COCs (Section 2.7).

Response

The section references will be added as requested.

Comment 8

Page 1-4, Section 1.7: As presented in other Decision Documents approved by EPA, including a lead-in sentence to this section as follows: "The undersigned acknowledges approval of the Selected Remedy for the Former Hanley Area, St. Louis Ordnance Plant, St. Louis, Missouri."

Response

The text will be added as requested.

Comment 9

Page 2-5, Section 2.2.2.2, Line 17: The text states that "The 2008 RI filled remaining data gaps and fully delineated the nature and extent of contamination at the site." The description of "fully delineated" is problematic and not entirely true. In fact, text on Page 2-18 admits that PCB-1260 was not completely vertically delineated. Please revise the text accordingly.

Response

The referenced text will rewritten as follows:

> The 2008 RI filled data gaps identified from a review of previous investigation results.

Comment 10

Page 2-5, Section 2.2.2.2, Lines 34-44: In which document/report will the PDI data be formally presented?

Response

The predesign investigation results will be presented in the remedial design / remedial action work plan (RD/RAWP). Text explaining this will be added to Section 2.2.2.2 of the document.

Comment 11

Page 2-6, Section 2.2.3, Paragraph 5: The number of loads of clean fill are referenced but the report does not indicate the volume of soil in cubic yards or other volume measurement.

Response

The decision document presents the information that was provided in the 2007 SCS Engineers *Building 220, Guard House, and Harboad Street Bridge Demolition and Site Restoration Report*. The total soil volume was not provided.

Comment 12

Page 2-6, Section 2.2.3, Paragraph 5: This text is written as if there is uncertainty as to if Building 220 was demolished. Consider revising as follows: "As described in the June 2007 ..., Building 220 was demolished in March 2007."

Response

The text will be revised as requested.

Comment 13

Page 2-7, Section 2.3, last paragraph: Include the street address and zip code for the Julia Davis Branch Library.

Response

The text will be added as requested.

Comment 14

Page 2-12, Section 2.5.3.1, Paragraph 7: On page 2-2, paragraph 1 (line 8), the location of the lead azide reactor was listed as unknown. This paragraph says that it was housed in Buildings 219E and 219F. If the location is known, the paragraph on page 2-2 should be changed.

Response

The fifth sentence in the third paragraph of Section 2.2.1 will be revised as follows:

> Explosives were dried in magazines by leaving cans of explosives exposed to the air, and Buildings 219E and 219F housed Hanley's lead azide reactor.

Comment 15

Page 2-13, Section 2.5.3, Paragraph 2: Elevated chromium concentrations are indicated. Are these total chromium, chromium VI or chromium III?

Response

Chromium concentrations are reported as total chromium. This will be clarified in Section 2.5.3.1.

Comment 16

Page 2-13, Section 2.5.3, Paragraph 6: In the final sentence of the paragraph, the text indicates that" lead concentration was dispersed below the screening level." What mechanism would be responsible for the decreased concentration in the soil? Dispersion would not be a major mechanism for contaminant transport since the medium is soil and not groundwater.

Response

As summarized in Section 2.5.3.1, 54 loads of clean fill were brought in to fill the void at former Building 220, and grading was completed to match the surrounding topography. Based on several pictures included in the Demolition and Site Restoration Report (SCS 2007), extensive reworking and regrading of the area is evident. Movement of heavy equipment, backfilling activities, and grading activities likely resulted in lead concentration below the screening level, as observed in the surface soil sample collected during the RI at HA-22.

Comment 17

Page 2-13, Section 2.5.3. Paragraph 7: In the third line of the paragraph, consider adding "exceeding the screening level" after "selenium concentration.

Response

The text will be revised as requested.

Comment 18

Page 2-15, Section 2.5.3.2, Paragraph 1: Please add "collected at depths of" before "more than 2 feet ...." in line 1.

Response

The text will be revised as requested.

Comment 19

Page 2-15, Section 2.5.3, Paragraph 1: In line 6 and 7, the text states that the metals in the subsurface were determined to be naturally occurring. Please state the basis for this statement.

Response

The referenced text will be revised as follows:

> The metals in the subsurface were comparable to naturally occurring concentrations in Missouri soils (Tidball 1984). For this reason, no further action is needed to address them.

Comment 20

Page 2-15, Section 2.5.3, Paragraph 2: Were the arsenic, cadmium and lead detected in the groundwater measured as total or dissolved metals?

Response

Based on available information, it appears that groundwater samples collected were analyzed for total metals.

Comment 21

Page 2-16, Section 2.5.3, Paragraph 5: It is unclear why the model would not predict the plume length over time. This would be a crucial portion of the fate and transport of the contaminant plume.

Response

The third and fourth paragraphs in the Plume A discussion in Section 2.5.3.3 present possible contaminant migration scenarios using various release dates. Based on the REMChlor model predictions of a 1959 release (averaged known period of industrial operations at the site), the leading edge of Plume A is either already near its maximum extent or will be within the next 5 years, if left untreated. Assuming a possible release date of 1979 (year when Hanley operations ceased), the plume is expected to migrate for another five years before decreasing. Using a release date of 1941 (year when St. Louis Ordnance Plant operations began), the plume is possibly decreasing.

Comment 22

Page 2-17, Section 2.5.3, Paragraph 2: Why were three release dates (1941, 1959 and 1979) modeled? Is there physical/chemical evidence or information about site history that suggest that the release could have occurred in one or more of these years?

Response

As discussed in the RI report, because of simplifying assumptions, specific results should be considered order-of-magnitude and useful for basic understanding of plume stability. Using the 2008 data and considering the known period of industrial operations at the site (1941 through 1979), the model estimates a possible date of release around 1959, which is 49 years before the calibration year (2008) of the model.

Comment 23

Page 2-18, Section 2.5.3, Paragraph 1: Is there a map of the aquifer showing where the fine sediments are located? If so, does this coincide with the CT plume?

Response

A map of the aquifer showing the fine sediments is not available. During the August 2010 predesign investigation, groundwater within monitoring well MW-118 was encountered at a depth greater than 26 feet below ground. Based on the boring log for this monitoring well, which will be presented in the RD/RAWP, lean clay and clay were observed between 12.5 feet and 36 feet below ground. During the 2008 RI, similar lithology was observed in boring CB-01, located within 18 inches of MW-118. Groundwater samples were collected from MW-118 and CB-01 within the lean clay and clay soils, indicating that the carbon tetrachloride resides within these-fine grained materials.

Comment 24

Page 2-18, Section 2.5.3.5: Please elaborate on the screening levels (or lack thereof) for the metals and explosives in the powder well sediment.

Response

This information is provided in Table 2-19, which is referenced in Section 2.5.3.5. No further discussion of screening levels is necessary in the text.

Comment 25

Page 2-21, Section 2.7.1.1, Paragraph 6: Lines 32 and 33 state that the HHRA was performed out of order from that presented in the RI work plan. Please explain why it was not performed in the order specified in the work plan.

Response

The HHRA was performed out of order due to a miscommunication within the risk assessment team during preparation of the HHRA. As noted in the decision document, the HHRA conclusions were unaffected by the sequence that was followed. For this reason, no further revision to Section 2.7.1.1 is necessary.

Comment 26

Page 2-22, Section 2.7.1.1, Paragraph 2: In the third bullet point under "Groundwater," the third bullet states that on-site groundwater samples were collected within 100 feet of Building 219G. In the next sentence, it states that one groundwater sample collected from MW-104 in 2006 was used in the evaluation. How many total samples were used to evaluate the groundwater exposure for on-site groundwater near Building 219G?

Response

One groundwater sample collected at monitoring well MW-104 in 2006 was used to assess potential risk for onsite groundwater near Building 219G. MW-104 is the only well located within 100 feet of Building 219G. The referenced text will be rewritten as follows:

- **Onsite Groundwater (Within 100 feet of Building 219G)**—Groundwater sampled within 100 feet of Building 219G was used to evaluate the potential current indoor air pathway for industrial workers. A groundwater sample collected from MW-104 in 2006 was used for this evaluation. No volatile chemicals were detected in the groundwater sample, so the indoor air pathway for current industrial workers (who are only present at Building 219G) is not a concern.

Comment 27

Page 2-23, Section 2.7.1.2, Paragraph 6: In the Soil and Groundwater Exposures in Deep Excavations bullet, it states that future maintenance and repairs would be conducted over a few days' time duration only so exposures are not expected to be significant and were not quantified. Is this assumption enough to close the exposure pathway? What happens if people are impacted during the time maintenance is conducted, which may, for weather or other reasons, take longer than the few days assumed.

Response

Project stakeholders representing the Army, MDNR, and USEPA agreed upon the exclusion of this exposure pathway during a teleconference held on August 27, 2008. The stakeholders agreed that the low likelihood of a deep-excavation exposure was sufficient to close the exposure pathway.

Comment 28

Page 2-24, Section 2.7.1.2 Paragraph 2: Under the Soil Exposures by Future Trespassers scenario it is stated that the groundwater is too shallow to use the Johnson and Ettinger Model. What alternative method will be used to quantify the exposure if groundwater is less than five feet below ground surface?

Response

Please note that the text referenced by the comment does not fall under "Soil Exposures by Future Trespassers", but instead applies to current and future offsite residences and future onsite residences.

An alternative method for quantifying the exposure is not proposed. To address this pathway, LUCs will be placed in potentially-impacted areas of the former Hanley Area (described in Sections 2.9.2.4 and 2.12.2.5), and a vapor intrusion evaluation (described in Sections 2.9.2.2 and 2.12.2.3) will be performed along Stratford Avenue to address possible exposures to offsite residences.

Comment 29

Page 2-26, Section 2.7.1.5, Paragraph 6: In evaluating the VOCs in groundwater downgradient of former Building 230, it is stated that the groundwater is too shallow to use the Johnson and Ettinger Model. What alternative method will be used to quantify the exposure if groundwater is less than five feet below ground surface?

Response

Please refer to the response to Comment 28.

Comment 30

Page 2-27, Section 2.7.2, Paragraph 2: A study for chromium and vanadium in the eastern United States was used to determine a background concentration for the site. Was Missouri considered a part of the eastern United States in this study?

Response

Eastern United States background concentrations were incorrectly used for comparison. Samples for chromium and vanadium were collected in Missouri and incorporated into the western United States dataset. To avoid confusion, Missouri-only data from the Eco-SSL will be used in the comparison. The text on Page 2-27, Section 2.7.2, Paragraph 2 will be changed to the following:

> Although site-specific background data are unavailable, Missouri data used in the calculation of background levels in the Eco-SSLs for chromium and vanadium (averages of 50 mg/kg and 72.4 mg/kg, respectively) are higher than the average concentrations at the site.

Comment 31

Page 2-27, Section 2.7.3, Paragraph 3: Lines 19 and 20 state that bioavailable forms of selenium are expected to be present. Is there data to show that these are present?

Response

Bioavailable forms of selenium were not analyzed directly. Selenate (4+) and selenide (6+) are oxidized forms of selenium that occur more often in well-aerated and alkaline soils, and these forms are associated with increased availability and toxicity. Bioavailable forms of selenium, such as selenate and selenide, may be present at the Site, but exact levels are not known. The text will be revised to the following to more appropriately indicate that, although present, low levels of bioavailable forms are expected:

> Furthermore, the soils at the site are expected to be slightly acidic and less oxidized, and, although not measured, more bioavailable forms of selenium, such as selenate (4+) and selenide (6+) are not expected to be the dominant forms of selenium present at the site.

Comment 32

Page 2-27, Section 2.7.3, Paragraph 3: The final sentence of this paragraph states that average concentrations of lead, manganese and zinc exceeded Eco-SSLs only slightly. Can this exceedance be quantified?

Response

The text will be changed to the following:

> Average concentrations of lead, manganese, and zinc exceeded Eco-SSLs only slightly, with Hazard Quotients of 1.2, 3.1, and 1.4, respectively.

Comment 33

Page 2-27, Section 2.7.3, Paragraph 4: The fact that the soil is disturbed does not necessarily imply that the risk to flora and fauna is negligible. The contaminants could be present in the disturbed soil and may be available to these organisms.

Response

The Army assumes the reviewer is referring to Section 2.7.2, third paragraph, which states the following:

> Available habitat is limited to enclosed and maintained grassy areas. Although plant and invertebrate receptors are present at the site, the habitat does not represent a natural ecosystem, as it is controlled by human activity. The potential for adverse effects to terrestrial plants and soil invertebrates exists, but the nature of the habitat in the regularly disturbed area is likely to limit the diversity and abundance of terrestrial plants and soil invertebrates and the overall potential for adverse effects to receptor communities. The conditions suggest that risks are negligible, and no further investigation is warranted.

The paragraph is not stating that contaminants are not available to plants and invertebrate receptors because of site disturbance. Instead, the text notes that the diversity and abundance of species is limited because of human activity and site disturbance. The Army maintains that no further investigation of ecological impacts is warranted.

Comment 34

Page 2-28, Section 2.8, Paragraph 2: The third bullet point mentions the concentrations of various COCs in soil, but does not give a cleanup level for comparison with these concentrations. What are the risk-based cleanup levels for arsenic and Aroclor 1260?

Response

The following text will be included after the fifth bullet in Section 2.8:

> PRGs developed in the feasibility study (CH2M HILL 2010) are risk-based or applicable or relevant and appropriate requirement-based chemical-specific concentrations that help refine the RAOs and define the extent of contaminated media requiring remedial action. The following soil PRGs were selected as remediation goals for the selected remedy:
>
> - Thallium 7 mg/kg
> - Antimony 31 mg/kg
> - Lead 400 mg/kg
> - Arsenic 13.2 mg/kg
> - Aroclor 1260 1 mg/kg
>
> Groundwater PRGs developed during the feasibility were chosen as remediation goals for the selected remedy. The remediation goals to prevent unacceptable risk to onsite construction workers for dermal contact with COCs in groundwater consist of the following:
>
> - CT: 3,200 μg/L

- PCE: 21,000 μg/L

Comment 35

Page 2-32, Section 2.9.3, Paragraph 2: How many years of O&M are used to estimate the cost?

Response

For cost estimating purposes, the estimated duration of Alternatives 2, 3, and 4 was chosen as 50 years. Although the actual monitoring period may be more than 50 years, cost estimating periods beyond 50 years have little effect on the present worth estimate. The O&M period of 50 years is shown in the cost estimate provided in Table 2-23.

Comment 36

Page 2-32, Section 2.9.4, Paragraph 1: In line 23, it states that the TTZ will be treated with a chemical reductant or oxidant. Consider changing this to state that it will be treated with a reductant since the next sentence states that chemical reduction was selected.

Response

The word "oxidant" will be removed from the second sentence of the first paragraph of Section 2.9.4.

Comment 37

Page 2-32, Section 2.9.4, Paragraph 3: In the final sentence on this page, it states that two samples will be collected each day at various depths. How many depths will be sampled? Are there two samples per depth or two samples per day only with the depth of each sample varying?

Response

The reference to two samples per day will be replaced with more general text noting that soil samples will be collected during mixing operations to verify proper mixing and usage of the amendment. The quality control sampling approach will be further detailed in the remedial design/remedial action work plan.

Comment 38

Page 2-33, Section 2.9.4, Paragraph 1: Groundwater samples will be collected from the soil mixing area. How will groundwater monitoring wells be protected during the trenching operation?

Response

The fourth paragraph in Section 2.9.4 states that groundwater samples will be collected from within the treatment zone <u>after</u> soil mixing activities have been completed. Prior to soil mixing, monitoring wells within the treatment zone will be abandoned. Monitoring well(s) will be installed within the treatment zone to facilitate collection of groundwater samples. The remedial design/remedial action work plan will present fieldwork activities before and after soil mixing activities.

Comment 39

Page 2-33, Section 2.9.4, Paragraph 2: How many years of O&M are used to estimate the cost?

Response

Refer to response to Comment 35.

Comment 40

Page 2-33, Section 2.9.5, Paragraph 1: In lines 13 and 14, it states that contaminated soil above and below the groundwater table will be excavated from the TTZ. How far below the water table will soil sample be collected? Are the soil conditions at the site amenable to collecting soil samples below the water table?

Response

Soil would be excavated to the top of the weathered shale within the treatment zone. Text will be added to the paragraph to clarify this depth of the excavation. Contaminated soil would therefore not be left in place. Sampling post-excavation would focus on groundwater, and not saturated soil.

Comment 41

Page 2-33, Section 2.9.5, Paragraph 3: How many years of O&M are used to estimate the cost?

Response

Refer to response to Comment 35.

Comment 42

Page 2-36, Section 2.12.1, Paragraph 2: The final sentence indicates that Alternative 3 would move the contaminated media and Alternative 4 would reduce the toxicity, mobility and volume. If the proper reductant is used, the toxicity and mobility and volume of contaminated media should also be reduced since the chemical reduction technique should decrease the volume of groundwater with COC concentrations above the action levels.

Response

The last sentence in paragraph 2 of Section 2.12.1 is provided below:

> Alternative 4 would move the contaminated media from Plume A from one location to another, while Alternative 3 would reduce contaminant toxicity, mobility, and volume in place, without requiring offsite transport and disposal.

The Army believes that the reviewer misread the text above.

Comment 43

Page 2-37, Section 2.12.2.2, Paragraph 1: What are the action levels for thallium, arsenic, lead and Aroclor 1260?

Response

Refer to response to Comment 34.

Comment 44

Page 2-38, Section 2.12.2.3, Paragraph 3: Who developed the screening levels for chloroform; naphthalene; 1,1,1,2-TeCA; and 1,1,2,2-TeCA?

Response

The screening levels for chloroform, naphthalene, 1,1,1,2-TeCA, and 1,1,2,2-TeCA were established by the Army during development of the feasibility study. This information will be added to Section 2.12.2.3.

Comment 45

Page 2-39, Section 2.12.2.4: How many groundwater monitoring wells were to be sampled for estimating the cost of the Plume C monitoring? How many years of monitoring were assumed to estimate the cost?

Response

The second sentence in Section 2.12.2.4 will be revised, as follows:

> Details of the monitoring program, such as number and location of wells to be sampled, will be provided in a LTM plan.

For cost-estimating purposes, 10 monitoring wells will be sampled. This information will be added to Section 2.12.2.4.

Refer to response to Comment 35 for the O&M and monitoring period.

Comment 46

Table 2-1: The units for this table of mg/kg appear to be incorrect for the TCLP Threshold values that are presented. Please verify.

Response

The units will be revised to milligrams per liter (mg/L).

Comment 47

Table 2-2: Are the MSSLs at the EPA Region 6 screening levels? What about arsenic? Please identify the source of the screening values.

Response

The basis and procedure for selecting the appropriate screening levels are presented in the

RI report.

Comment 48

Table 2-2: Is the "certified" reporting limit listed in the Notes the same as the reporting limit provided in the table? If so, add "certified" to the Reporting Limits column to avoid confusion.

Response

Exhibit 5-2 of the November 1991 Status Report (USATHAMA 1991) presents the certified laboratory reporting limits that are presented in Table 2-2 of the decision document. The Exhibit indicates that the laboratory reporting limit is certified; however, the Army does not have additional information to make the claim that the reporting limits are certified. Therefore, the word "certified" will be removed from the footnote.

Comment 49

Data Tables (2-1 through 2-19): The data are collected over many years. Does comingling nonsynoptic data present a problem in the risk analysis? Some compounds may have changed concentration over time.

Response

The RI report presents the risk assessment approach and the samples used to evaluate risk to human health and the environment. The inclusion of recent and historical concentrations was approved by project stakeholders during the RI phase.

Comment 50

Data Tables (2-1 through 2-19): Some analytes are listed as "Not Reported." Were the samples analyzed for these compounds? If they were analyzed but not reported, please include an explanation.

Response

The 1991 Status Report (USATHAMA 1991) did not provide an explanation regarding the meaning of "NR" in the data tables. Based on a review of the 2005 Phase I RI report, it remains unclear if the dashes (---) in the Phase I tables represent constituents that were not analyzed, or if it means that the constituents were analyzed, but did not meet validation requirements. The 2007 Final Supplemental Soil and Groundwater Phase II Remedial Investigation Technical Memorandum did not report various analytes (i.e. 1,2-DCA not reported in Table 5).

Comment 51

Data Tables (2-1 through 2-19): There are inconsistencies in the notation for chemicals not detected (ND, U, <). Consider making all the notations for nondetect uniform in all tables. In some notations, the criterion for listing a compound as nondetect (below MDL, below RL) is not stated.

Response

The data tables provided in the decision document are presented in the same manner as those presented in previous documents (e.g., RI report, feasibility study). Non-detected results are presented as such based on available information provided in previous documents.

Comment 52

Table 2-15: There are no notes for this table explaining U and J, the "a" superscript and the meaning of shaded values.

Response

The footnotes are provided on the second page of Table 2-15.

Comment 53

Figure 2-4: Please add an explanation of the USCS classifications to the legend. Please include a notation for the screened intervals in the groundwater monitoring wells.

Response

Figure 2-4 will be revised to include the meaning of the USCS terms "CL" (lean clay), "CH" (fat clay), and "ML" (silt). In addition, the symbol for typical monitoring well screens will be provided in the Legend.

Administrative Comments

Comment 54

Page vii - The term O&M is not defined before it is first used as abbreviation on page 2-29.

Response

The term "O&M" is defined in Section 1.6 of the decision document.

Comment 55

Page 2-4, Section 2.2.2.2, Line 9: Add "aforementioned" between fill and data gaps.

Response

The text will be revised accordingly.

Comment 56

Page 2-6, Section 2.2.4, Paragraph 2: The state (Illinois) should be placed after "Chicago" in line 23.

Response

The Army believes the reviewer is referring to the second sentence in the second paragraph of Section 2.2.3. The text will be revised accordingly.

Comment 57

Page 2-8, Section 2.4, Paragraph 3: The city of St. Louis is referred to as "the City" later in this section. Consider adding it in Line 24 as "limits of the city of St. Louis (City)."

Response

The sixth sentence in the sixth paragraph of Section 2.4 will be revised as follows:

> The MOU was signed on October 25, 2006. It specifies the City of St. Louis's and MDNR's responsibilities in satisfying the ordinance requirements.

Comment 58

Page 2-9, Section 2.5, Paragraph 1: Consider changing line 2, first full sentence to "A significant elevation."

Response

The text will be revised accordingly.

Comment 59

Page 2-15, Section 2.5.3.3, Paragraph 5: Change the word "registered a" in line 42 to "was analyzed to have a... "

Response

The text will be revised accordingly.

Comment 60

Page 2-16, Section 2.5.3.3, Paragraph 4: Under "Plume A," reword the first sentence to read "Contaminants of concern in Plume A consist of PCE, TCE and cis-1,2-DCE."

Response

The text will be revised as follows:

> Contaminants in Plume A consist primarily of PCE, TCE, and *cis*-1,2-DCE.

Comment 61

Page 2-17, Section 2.5.3, Paragraph 1: Line 4 mentions that year 52 is 2011, which will be "another 3 years." The date of this document is 2011. Consider rephrasing this sentence.

Response

The text in the third paragraph of the Plume A discussion in Section 2.5.3.3 will be revised as follows:

> The model output suggests that the TCE plume may migrate towards Stratford Avenue until year 52, which is 2011, before the plume will begin to shrink because of destructive and/or nondestructive fate and transport processes.

Comment 62

Page 2-17, Section 2.5.3, Paragraph 3: In lines 16 and 17, it is unclear what the "industrial industry" is. Please clarify.

Response

The text will be revised as follows:

> 1,2-DCA was used as a degreaser, paint remover, and as a constituent in scouring compounds (Agency for Toxic Substances and Disease Registry 2005).

Comment 63

Page 2-17, Section 2.5.3, Paragraph 3: In line 21, consider changing it to "contributed to the vertical and lateral migration of the contaminant, but the leaks in the sewer system have not been..."

Response

The text will be revised accordingly.

Comment 64

Page 2-20, Section 2.6, Paragraph 2: In line 16, consider changing "Zoning Department" to "City of St. Louis Zoning Department."

Response

The text will be revised accordingly.

Comment 65

Page 2-27, Section 2.7.3, Paragraph 2: Line 14 should read "and vanadium in the eastern United States ..."

Response

Please refer to the response to Comment 30.

Comment 66

Page 2-30, Section 2.9.2, Paragraph 1: Change the first bullet point to "Soil and powder well sediment excavation and off-site disposal."

Response

The feasibility study refers to the remedy as "soil and powder well sediment removal and offsite disposal". Therefore, the bullet point will remain unchanged.

Comment 67

Page 2-32, Section 2.9.4, Paragraph 3: Reword the first sentence to read "In this alternative, a one-pass trenching machine method for soil mixing was assumed for cost estimating purposes."

Response

The text will be revised accordingly.

Comment 68

Page 2-34, Section 2.10.3, Paragraph 1: Modify line 39 to read "of exposure. Under Alternative 1, the COCs would naturally attenuate, slowly decreasing COC mass, but the..."

Response

The text will be revised accordingly.

Comment 69

Page 2-35, Section 2.10.4, Paragraph 1: Change the words "contaminated area" to COCs since these are what are being destroyed or removed.

Response

The text will be revised accordingly.

Comment 70

Page 2-35, Section 2.10.8, Paragraph 1: Substitute "MDNR" for "The State" since this is the agency involved.

Response

The text will be revised accordingly.

Comment 71

Page 2-37, Section 2.12.2.2, Paragraph 2: Change the second sentence to "Excavation will be performed using a backhoe."

Response

The text will be revised accordingly.

Comment 72

Table 2-14: All compounds were analyzed. There is no need for the Not Analyzed note.

Response

Table 2-14 will be revised accordingly.

Comment 73

Table 2-16: There are no E qualified values. These notations should be removed from the notes section.

Response

Table 2-16 will be revised accordingly.

Comment 74

Table 2-17: There are no D or R qualified values. This notation should be removed from the notes section.

Response

Various results in Table 2-17 are D and R-qualified (i.e., MW-111 results). Therefore, Table 2-17 will remain unchanged.

Comment 75

Table 2-19: There are no B qualified values. This notation should be removed from the notes section. For the SED-PW-22 sample, the 2,4,5-trinitrotoluene sample has a J notation but no value.

Response

The Army believes the reviewer is referring to 2,4,6-trinitrotoluene in Table 2-19. The column in Table 2-19 was not expanded enough to show the result. Table 2-19 will be revised to show the result for 2,4,6-trinitrotoluene of 0.154186 J mg/kg.

Responses to MDNR Comments on the Draft Final Decision Document for the St. Louis Ordnance Plant/Former Hanley Area

July 5, 2011

This document provides Army responses to the Missouri Department of Natural Resources (MDNR) comments on the document referenced above. MDNR comments were submitted to the Army on April 15, 2010.

Hazardous Waste Program General Comments

Comment 1

When outlining the parameters under which five-year reviews may be subject to termination please use language similar to that which was used in *Section 3.8.2.5 Five-Year Reviews* of the Feasibility Study Report.

Response

Five-year termination criteria are presented in Section 1.4 (Description of Selected Remedy), Section 2.12.2.6 (Five Year Reviews), and Section 2.13.6 (Five-Year Review Requirements). The language in each section matches that used in Section 3.8.2.5 of the Feasibility Study Report, with the exception of the following underlined text:

- Chemicals of concern (COCs) are at or below the remediation goals.
- The vapor intrusion pathway is determined not to cause unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels).
- Monitoring confirms that no unacceptable risks are posed by Plume C. Confirmation will consist of demonstrating that groundwater in Plume C remains deeper than 10 feet below the ground surface or that concentrations within the plume have fallen below remediation goals.

To address the comment, the underlined text will be added to Sections 2.12.2.6 and 2.13.6 of the decision document.

Follow up Comment: The language to which the department was referring as it appears in the FS is underlined below:

Five-year site reviews will be performed as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure, per the NCP. The 5-year reviews will take place until the following occur:

- COCs are at or below the remediation goals.
- The vapor intrusion pathway is determined not to cause unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels).
- Monitoring confirms that no unacceptable risks are posed by Plume C. Confirmation will consist of demonstrating that groundwater in Plume C remains deeper than 10 feet

below the ground surface or that concentrations within the plume have fallen below remediation goals.

Once these conditions are confirmed at the former Hanley Area, the 5-year reviews will be recommended for termination. The basis for the recommendation will be documented in a final 5-year Review Report that will be submitted for regulator approval.

Please refer to Follow Up Comment 25 for further guidance on how to satisfy this concern.

Army Follow up Response: The underlined text in the first and last paragraphs of MDNR's follow up response already appears in Section 2.13.6 (Five-Year Review Requirements) and will be added to Section 2.12.2.6 (Land Use Controls) as noted in the Army's follow up response to Comment 20.

Regarding MDNR's concerns expressed in Follow up Comment 25, the text in the last underlined paragraph above will be rewritten as follows in Sections 2.12.2.6 and 2.13.6:

> Once these conditions are confirmed at the former Hanley Area, the U.S. Army will recommend terminating the 5-year reviews, in consultation with MDNR and subject to their approval. Once MDNR approves of terminating the 5-year reviews, the basis for termination will be documented in a final 5-year review report.

Comment 2

When referring to the "Vapor Intrusion Evaluation," it is recommended that the word investigation is used in place of evaluation. Evaluation implies that current data will simply be assessed or considered, where as an investigation implies that further research into the topic matter will be done, including the analysis of new data.

Response

The Army feels that "evaluation" is a proper term to describe vapor intrusion component of the remedy. Evaluation includes investigation, the interpretation of investigation findings, and the decision to implement a mitigation measure based on the findings. Each step is part of the vapor intrusion evaluation for the former Hanley Area.

The Army agrees that investigation measures associated with the vapor intrusion pathway need to be more clearly stated in the decision document. As discussed in a stakeholder meeting on November 4, 2010, the Army will perform quarterly groundwater monitoring for two years using passive diffusion bags (PDBs), followed by annual monitoring. In addition, the Army will attempt to collect subslab soil gas samples beneath the residence adjacent to MW-107 (4701 Goodfellow). Indoor and outdoor air samples will also be collected. If subslab soil gas samples can be collected at this residence, the Army will request access to three additional residences located to the west along Stratford Avenue to repeat the investigation scope.

To more clearly explain the investigation component of the vapor intrusion evaluation, Sections 2.9.2.2 and 2.12.2.3 will be revised as presented below. Section 2.9.2.2 presents the vapor intrusion evaluation as a common element among Alternatives 2, 3, and 4. Section 2.12.2.3 provides additional details on the vapor intrusion evaluation as a component of the selected remedy (Alternative 3). Please note that some revisions in the following text were made in response to comments discussed later in this response-to-comment document. In addition, the text was revised to note that details regarding the vapor intrusion groundwater monitoring program will be provided in the long-term management plan for the site.

2.9.2.2 Vapor Intrusion Evaluation

Based on the uncertainty of indoor air risk, the vapor intrusion pathway will be further evaluated as part of the site remedy. Several components may be included in the evaluation, such as:

- Vapor migration information collected from similar sites
- Site-specific VOC data
- Data collection methods developed by the industry
- Vapor intrusion modeling
- Potential risk based on current or future structures

The vapor intrusion evaluation will include monitoring the VOCs in groundwater that were observed above screening levels developed in the FS and discussed further in Section 2.12.2.3. Groundwater COC concentrations above the screening levels will be used as a trigger for determining whether additional sampling and/or mitigation actions are necessary. If groundwater concentrations along Stratford Avenue exceed screening levels and show increasing concentration trends, subslab soil gas beneath nearby residences (located within 50 feet of the exceeding concentrations) will be investigated. Indoor and outdoor air samples at the residences will also be collected. If subslab soil gas samples cannot be collected because of saturated conditions beneath the floor slab, then the U.S. Army will evaluate indoor and outdoor air samples to determine whether mitigation actions, such as vapor mitigation measures, are necessary.

If the evaluation reveals that indoor vapor concentrations in offsite residences pose an unacceptable risk to the residents and are related to the former Hanley Area, then mitigation actions, such as vapor barriers or in-home mitigation systems that vent indoor air to the atmosphere, will be implemented as part of the remedy.

Because the study and mitigation of vapor intrusion is an evolving field, the use of groundwater analytical results as a vapor intrusion indicator may be replaced with modeling or other vapor sampling methods as new technologies become available during the remedial design, remedial action, or long-term management of the site. Data collected as part of the remedial design may be used to adjust the remedial approach if appropriate.

2.12.2.3 Vapor Intrusion Evaluation

Based on the uncertainty of indoor air risk, the vapor intrusion pathway will be further evaluated as part of the site remedy. Several components may be included in the evaluation, such as:

□ Vapor migration information collected from similar sites
□ Site-specific VOC data
□ Data collection methods developed by the industry
□ Vapor intrusion modeling
□ Potential risk based on current or future structures

The vapor intrusion evaluation will include monitoring the VOCs in groundwater that were observed above the screening levels listed below.

Benzene: 5 □g/L	Naphthalene: 6.2 □g/L
CT: 5 □g/L	1,1,1,2-TeCA: 5.2 □g/L

Chloroform: 1.9 µg/L
1,2-DCA: 5 □g/L
cis-1,2-DCE: 70 □g/L
trans-1,2-DCE: 100 □g/L
Methylene chloride: 5 µg/L

1,1,2,2-TeCA: 0.67 □g/L
1,1,2-TCA: 5 □g/L
PCE: 5 □g/L
TCE: 5 µg/L
Vinyl chloride: 2 µg/L

Except for chloroform, naphthalene, 1,1,1,2-TeCA, and 1,1,2,2-TeCA, the screening levels are the MCLs. For these other four chemicals, resident risk-based screening levels for potable groundwater use were developed.

Groundwater COC concentrations above the screening levels will be used as a trigger for determining whether additional sampling and/or mitigation actions are necessary. If groundwater concentrations along Stratford Avenue exceed screening levels and show increasing concentration trends, subslab soil gas beneath nearby residences (located within 50 feet of the exceeding concentrations) will be investigated. Indoor and outdoor air samples at the residence will also be considered. If subslab soil gas samples cannot be collected because of saturated conditions beneath the floor slab, then the U.S. Army will evaluate indoor and outdoor air samples to determine whether vapor mitigation measures are necessary.

If the evaluation reveals that indoor vapor concentrations in offsite residences pose an unacceptable risk to the residents and are related to the former Hanley Area, then mitigation actions, such as vapor barriers or in-home mitigation systems that vent indoor air to the atmosphere, will be implemented as part of the remedy. In accordance with the U.S. Army vapor intrusion policy, proper notification will be given to current property owners (onsite and offsite) of potential vapor intrusion risk.

The details of the vapor intrusion groundwater monitoring program, such as the number and location of wells to be sampled and the frequency, will be provided in the long-term management plan for the site. For cost estimating, it is assumed that groundwater sampling will be conducted quarterly for the first 2 years to establish groundwater trends and to identify areas that may be susceptible to indoor air risk. Following year 2, groundwater samples will be collected annually to monitor the above VOCs at the site to identify changes in the plume that might affect the protectiveness of the selected remedy. Because the study and mitigation of vapor intrusion is an evolving field, the use of groundwater analytical results as a vapor intrusion indicator may be replaced with modeling or other vapor sampling methods as new technologies become available during the remedial design, remedial action, or long-term management of the site. Data collected as part of the remedial design may be used to adjust the remedial approach if appropriate. If an alternative vapor intrusion evaluation approach emerges in the future, the U.S. Army will seek MDNR's concurrence on following the alternative approach, if a change in approach is warranted.

Follow up Comment: The statement "located within 50 feet of the exceeding concentrations" in section 2.12.23 should be 100 feet instead of 50 feet.

MDHSS Follow up comment: The revised text now states that subslab soil gas will be investigated for residences located within 50 feet of groundwater concentrations that exceed screening levels. Given uncertainties with the vapor intrusion pathway, MDHSS feels that the distance noted is too restrictive and recommends that a distance not be specifically stated in the decision document.

Army Follow up Response: During a teleconference held on June 2, 2011, representatives of the Army, MDNR, MDHSS, and USEPA agreed that the sentence:

> If groundwater concentrations along Stratford Avenue exceed screening levels and show increasing concentration trends, subslab soil gas beneath nearby residences (located within 50 feet of the exceeding concentrations) will be investigated.

would be replaced with text that does not specify a distance, in order to provide flexibility in decision document. In accordance with the June 2, 2011 teleconference, the sentence above will be replaced with the following text.

> If groundwater concentrations along Stratford Avenue exceed screening levels and show increasing concentration trends, subslab soil gas will be investigated beneath potentially-impacted residences that are selected in consultation with MDNR.

Comment 3

After the VI pathway has been properly addressed and investigated how will the decision of a path forward with VI be documented?

Response

Quarterly groundwater monitoring results will be summarized in annual long-term management reports. If future groundwater results reveal the need for subslab soil gas, indoor air, and outdoor air sampling, the Army will notify MDNR before the residential sampling is performed. Results from subslab soil gas, indoor air, and outdoor air sampling will be reported in a technical memorandum for each residence. Recommendations for mitigation measures, if warranted, will be presented in the technical memorandum.

Follow up Comment: What I meant was, what milestone/stand alone document will be used to solidify the decision on VI and the agreed path forward for evaluating it? Since the decision will not be included in the ROD due to lack of data to support a definite path forward, will it be in an addendum to the ROD or an LTM Plan?

Army Follow up Response: As discussed on June 2, 2011, the Army and MDNR have different perspectives on the definition of the term, "decision on VI". The Army views the VI evaluation *process* as the selected remedy, while MDNR views the final step of the process as the remedy. The Army maintains its position because the endpoint of the process cannot be predicted (that is, when the VI evaluation is no longer needed because human health risks are longer unacceptable, or when a mitigation action is implemented, should one be warranted based on analytical results). This uncertainty stems from the fact that 1) it is not known how quickly soil mixing in the contaminant source area will lower groundwater concentrations downgradient from the source area; and 2) it is not known whether the groundwater concentrations and possibly vapor concentrations along the downgradient edge of the plume will expand in the future, before the source area treatment yields remedial benefit downgradient from the source area.

The Army maintains that the text presented in the response to Comment 2 (including the revised text in the Army's follow up response) adequately describes the decision on VI and the agreed path forward for evaluating it. This position is consistent with examples of remedial components presented in *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents* (EPA 540-R-98-031). Highlight 6-22, Examples of Remedy Components for Each Alternative, notes that "contingency actions" and "remedy refinements" can be included in the remedy presented in the decision document. The Army considers the installation of mitigation systems as a possible contingency action in the event that groundwater VOC concentrations exceed risk-based screening levels and demonstrate an increasing trend along Stratford Avenue.

Additional Follow up Comment: It is the States understanding that the soil mixing remedy for the source area is not intended to treat the contamination downgradient. Its purpose is to treat the source area. Treatment of the downgradient contamination under Stratford Ave is not expected since the chemicals used in the treatment are not intended to be mobile in groundwater. Under current site conditions, we expect the contaminated plume to continue its downgradient migration toward homes along Stratford Ave, and while some natural attenuation is expected this is unpredictable since it is unknown when the contamination occurred.

Contingency actions per *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents (EPA 540-R-98-031)* are appropriate in order to allow for the use of innovative or comparative technologies, not as a mechanism to allow a Decision Document to be finalized before a pathway is satisfactorily characterized. This approach is not consistent with *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents (EPA 540-R-98-031)* or the NCP Section 300.430(5), which requires that all facts and analyses of facts be included in remedy selection.

Several options have been identified to address the disagreement between the document and the NCP, as outlined above:

a. The vapor intrusion pathway may be broken out as a separate operable unit. This would allow the current Decision Document, minus vapor intrusion to proceed expeditiously. Meanwhile, the additional vapor intrusion evaluation may proceed and a second Decision Document would be completed at the conclusion of the assessment, with the decisions clearly defined and based on the measured data and risk analysis.
b. The current Decision Document may be re-classified as an Interim Decision Document, and a final Decision Document would be completed following completion of the vapor intrusion investigation.
c. The current Decision Document may proceed with an uncertainty discussion related to ongoing vapor intrusion investigations, followed at a later date by an Explanation of Significant Differences following completion of the vapor intrusion investigation.

Army Response to Follow up Comment: To address the follow up comment above, the following text (shown in bold underlined font) will be made to the revised Section 2.12.2.3 provided in the Army's response to Comment 2. Text changes to Section 2.9.2.2 are not necessary because this section introduces the vapor intrusion evaluation as a common element among Alternatives 2, 3, and 4 before a remedy is selected in Section 2.12. Mentioning a post-DD change document in Section 2.9.2.2 would be premature before the selected remedy is identified.

> Groundwater COC concentrations above the screening levels will be used as a trigger for determining whether additional sampling and/or mitigation actions are necessary. If groundwater concentrations along Stratford Avenue exceed screening levels and show

increasing concentration trends, subslab soil gas will be investigated beneath potentially-impacted residences that are selected in consultation with MDNR. Indoor and outdoor air samples at the residence will also be considered. If subslab soil gas samples cannot be collected because of saturated conditions beneath the floor slab, then the U.S. Army will evaluate indoor and outdoor air samples to determine whether vapor mitigation measures are necessary. **The collection of subslab soil gas, indoor air, and outdoor air samples, as new information generated that may affect the implemented remedy under the DD, will be documented in the appropriate post-DD change document that will be prepared and issued pursuant to the NCP §§ 300.435(c)(2) and 300.825. Notice will be sent to the public upon issuance of the appropriate post-DD change document in compliance with the NCP §§ 300.435(c)(2) and 300.825 . The Army will prepare the selected post-DD change document in consultation with MDNR.**

If the evaluation reveals that indoor vapor concentrations in offsite residences pose an unacceptable risk to the residents and are related to the former Hanley Area, then mitigation actions, such as vapor barriers or in-home mitigation systems that vent indoor air to the atmosphere, will be implemented as part of the remedy. In accordance with the U.S. Army vapor intrusion policy, proper notification will be given to current property owners (onsite and offsite) of potential vapor intrusion risk. **If mitigation actions are deemed necessary based on a finding of unacceptable risk related to the former Hanley Area, they will be documented in an appropriate post-DD change document, in consultation with MDNR, at a later date.**

The details of the vapor intrusion groundwater monitoring program, such as the number and location of wells to be sampled and the frequency, will be provided in the long-term management plan for the site. For cost estimating, it is assumed that groundwater sampling will be conducted quarterly for the first 2 years to establish groundwater trends and to identify areas that may be susceptible to indoor air risk. Following year 2, groundwater samples will be collected annually to monitor the above VOCs at the site to identify changes in the plume that might affect the protectiveness of the selected remedy. Because the study and mitigation of vapor intrusion is an evolving field, the use of groundwater analytical results as a vapor intrusion indicator may be replaced with modeling or other vapor sampling methods as new technologies become available during the remedial design, remedial action, or long-term management of the site. Data collected as part of the remedial design may be used to adjust the remedial approach if appropriate. If an alternative vapor intrusion evaluation approach emerges in the future, the U.S. Army will seek MDNR's concurrence on following the alternative approach, if a change in approach is warranted. **If an alternative approach is selected in the future, it will be documented in an appropriate post-DD change document, in consultation with MDNR, at a later date.**

Comment 4

This document generally lacks sufficient detail on land use controls (LUCs) that will be implemented in order to manage risk. The U.S. EPA has a checklist for all Federal Facilities Decision Documents containing land use controls. It is recommended that this checklist be used as a basis to develop an acceptable LUC plan for this site. The referenced checklist can be found as an attachment to this letter.

Response

Details regarding LUCs will be provided in a forthcoming LUC implementation plan (LUCIP). The Army appreciates the checklist provided by MDNR and will consult it when preparing the LUCIP for the former Hanley Area.

Follow up Comment: This response does not satisfy the department's concern. In order for a remedy to be protective, land use controls must be enforceable, durable and run with the land. Without a description of what land use controls are planned, this remedy cannot be demonstrated to be protective and comply with the NCP.

Army Follow up Response: Additional information on LUCs will be added to the decision document. Specifically, the first 9 items on the October 2006 USEPA checklist titled, *Sample Federal Facility Land Use Control ROD Checklist with Suggested Language,* will be added to the decision document, unless the information is already presented. Decision document revisions pertaining to LUCs are described below, according to each of the nine items presented in USEPA's checklist.

1. Map/Figure showing boundaries of the land use controls.

   LUCs are shown in Figure 2-14, titled Land Use Control Boundaries.

2. Document risk exposure assumptions and reasonably anticipated land uses, as well as any known prohibited uses which might not be obvious based on the reasonably anticipated land uses.

   Risk exposure assumptions are described in Section 2.7.1 (Summary of Human Health Risk Assessment) which includes subsections pertaining to selection of chemicals of potential concern, exposure assessment, toxicity assessment, risk characterization, and identification of chemicals of concern. Known prohibited uses consist of the following:

   - Vapor Intrusion LUC: Prohibited uses consist of those that expose building occupants, whether industrial workers or residents, to vapor concentrations posing unacceptable risk to the occupants.
   - Plume C LUC: In addition to the prohibited land uses noted above for the Vapor Intrusion LUC, prohibited land uses consist of those that expose construction workers to contaminated groundwater without proper health and safety training and personal protective equipment.

   The bullets above will be added to Section 2.12.2.5 of the decision document.

3. Describe the risks necessitating the LUCs.

   The following text will be added to the beginning of Section 2.12.2.5:

   LUCs will be implemented to address the following potential risks that are not being immediately mitigated by other components of the selected remedy:

   - Resident or industrial worker inhalation of contaminated vapors stemming from VOC concentrations in groundwater above risk-based screening levels.
   - Construction worker direct contact with groundwater CT concentrations exceeding the remediation goal in excavations within the Plume C footprint.

4. State the LUC performance objectives.

   LUC performance objectives are already presented in Section 2.12.2.5 of the decision document.

5. Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications.

   This information is already presented in Section 2.12.2.5 of the decision document.

6. Duration language: "Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure."

   The following language will be added to Section 2.12.2.5:

   > LUCs will be maintained until the concentration of hazardous substances in the soil, soil vapors, and groundwater are at such levels to allow for unrestricted use and exposure.

7. Include language that the [federal agency] is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. This may be modified to include another party should the site-specific circumstances warrant it.

   The following sentence will be added at the beginning of the final paragraph of Section 2.12.2.5:

   > The U.S. Army will be responsible for implementing, maintaining, reporting on, and enforcing the LUCs.

8. Where someone else will or the federal agency plans that someone else will ultimately be implementing, maintaining, reporting on, and enforcing land use controls, the following language should be included:

   "Although the [federal agency] may later transfer [has transferred] these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the [federal agency] shall retain ultimate responsibility for remedy integrity."

   To address this item, the final paragraph of Section 2.12.2.5 will be rewritten as shown below. The following information that was also presented in the FS and PP:

   > The U.S. Army will be responsible for implementing, maintaining, reporting on, and enforcing the LUCs. The U.S. Army will prepare a Land Use Control Implementation Plan (LUCIP) to define restrictions within the LUCs, establish LUC boundaries, and explain how they will be implemented, monitored, and enforced. Upon transfer of property ownership, the U.S. Army will include restrictions in the property deed to document the LUCs defined in the LUCIP. The *Army Defense Restoration Program Management Guidance for Active Installations* (Department of the Army 2004) provides guidelines for conveying LUCs during a property transfer from the Army to a nonfederal entity. At sites where a CERCLA hazardous substance has been stored, released or disposed on federal property where the United States sells or otherwise transfers the impacted property, CERCLA Section 120(h)(3) specifically dictates deed covenant language. For property sold or to be otherwise transferred from the United

States, the Army will prepare all required deed covenants to comply with CERCLA Section 120(h)(3).

9. [ONLY INCLUDE IN NON-AF RODS] Refer to the remedial design (RD) or remedial action work plan (RAWP) for the implementation actions.

   This information is already presented in Section 2.12.2.5. The implementation actions will be presented in the LUCIP.

Comment 5

Performance measures are a required component of a decision document per the NCP 300.430 (5)(iii)(A). What are the performance objectives for each component of the remedy, and how will performance be measured? The document should provide the Army with the ability to utilize objective data to support a conclusion that LUCs can be terminated at the point remedial action completion goals are achieved.

Response

40 CFR 300.430 (f)(5)(iii) states the following:

> (iii) The ROD also shall:
>
> (A) Indicate, as appropriate, the remediation goals, discussed in paragraph (e)(2)(i) of this section, that the remedy is expected to achieve. Performance shall be measured at appropriate locations in the ground water, surface water, soils, air, and other affected environmental media. Measurement relating to the performance of the treatment processes and the engineering controls may also be identified, as appropriate;

Remediation goals for the project are presented in Table 2-23 of the draft final decision document.

Performance measures for each remedial component are described in Section 2.12.4 (Expected Outcomes of the Selected Remedy). Additional details regarding performance measures will be presented in the forthcoming remedial design / remedial action work plan (RD/RAWP), long-term management (LTM) plan, and land-use control implementation plan (LUCIP). The performance measures are as follows:

- **Soil removal and offsite disposal.** Soil remediation goals (Table 2-23) for arsenic, lead, thallium, and Aroclor 1260 will serve as cleanup levels for the soil removal action. Pre-excavation soil samples will be collected in areas of arsenic, lead, and thallium contamination. Pre- and post-excavation samples will be collected in the area of Aroclor 1260 contamination. These details are provided in the April 8, 2011 technical memorandum, *Delineation of Soil Removal Areas at the St. Louis Ordnance Plant, Former Hanley Area.*

- **Removal and offsite disposal of sediment.** Sediment will be removed from powder wells, and the powder wells will be backfilled with clean fill. Remediation goals were not established for powder well sediment because the material will be removed from the powder wells prior to backfilling.

- **In-situ groundwater treatment using chemical processes and soil mixing.** The groundwater remediation goals for tetrachloroethene (PCE; Table 2-23) will serve as the cleanup level for in-situ groundwater treatment. Groundwater concentrations within the target treatment zone (MW-111, which will be removed prior to soil mixing and replaced after mixing is complete, as discussed in the forthcoming remedial design report) and downgradient of the treatment zone (e.g., MW-108, 109, and 110) will be monitored to confirm that groundwater concentrations remain below remediation goals.

- **Groundwater monitoring within Plume C.** The groundwater remediation goal for carbon tetrachloride (Table 2-23) will serve as the cleanup level. In addition, monitoring will confirm that the exposure pathway between construction workers and contaminated groundwater remains incomplete because of the depth of the groundwater table (greater than 10 feet below ground surface, the maximum depth for which the construction worker exposure pathway is considered complete). Monitoring well MW-118 was installed in August 2010 and will serve as the monitoring point within Plume C.
- **Vapor intrusion evaluation.** Groundwater screening levels based on MCLs or resident risk-based screening levels for potable groundwater use (for chemicals without MCLs) will be used to assess the need for further investigation (e.g., subslab soil gas sampling) or mitigation measures. Groundwater screening levels are listed in Section 2.12.2.3 (Vapor Intrusion Evaluation) of the decision document.
- **Land use controls.** LUCs will remain in place until future vapor intrusion evaluations confirm that risk thresholds have not been exceeded (or onsite groundwater concentrations fall below screening levels) and until carbon tetrachloride concentrations in Plume C fall below the groundwater remediation goal. If LUCs are implemented around concrete or asphalt paved areas, they will remain in place until the underlying soils are remediated to achieve remediation goals presented in Table 2-23.
- **Five-year site reviews.** Five-year reviews will be performed as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. The five-year reviews would be terminated once chemicals of concern (COCs) are at or below the remediation goals, the vapor intrusion pathway is determined not to cause unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels), and monitoring confirms that no unacceptable risks are posed by Plume C.

Comment 6

Throughout the document, discussion of the vapor intrusion pathway is described as an uncertainty, and the narrative indicates that further characterization is needed before a decision can be made regarding whether a remedy is needed or how it will be addressed. This approach is not consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Section 300.430(5), which requires that all facts and analyses of facts be included in remedy selection, which is not possible given that the vapor intrusion investigation is ongoing. Furthermore, the same section also requires an explanation of how the remedy is protective, which the Decision Document is not able to satisfy given that a definitive plan for how vapor intrusion risk will be addressed is not included. It is recommended that the VI language of the document be revised to be definitive about a clear path forward to describing remedy implementation.

Response

The Army acknowledges that uncertainties exist regarding future exposures through vapor intrusion. However, the Army does not agree with the statement that "further characterization is needed before a decision can be made regarding whether a remedy is needed or how it will be addressed". The vapor intrusion evaluation is the remedy, and as noted in the response to Comment 2, the evaluation will include groundwater monitoring, subslab and indoor / air sampling (as needed), and mitigation measures (as needed). Although the vapor intrusion pathway was adequately characterized during the RI, ongoing evaluation of the pathway is warranted in the event that the groundwater concentrations near the residences along Stratford Avenue exceed screening levels and show increasing trends. Evaluation of the pathway will continue until it can be demonstrated that the pathway does not pose unacceptable risk to offsite residences. This evaluation will be made as part of the five-year review process as described in Section 2.12.2.6 of the decision document.

More definitive language describing the vapor intrusion evaluation will be added to the decision document as described in the Army's response to Comment 2.

Follow up Comment: This is a path forward, not a remedy or solution to the VI threat. A remedy would be a mitigation system or vapor barrier which removes the threat of VI thus remedying the problem. Please revise the language accordingly so that it is clear that a remedy has not been chosen for VI in this ROD.

The department is not in agreement with the statement that the vapor intrusion pathway was characterized during the RI, which is why the department and the EPA has advocated the further investigation that the U.S. Army Corps of Engineers is currently conducting.

Army Follow up Response: As discussed during the teleconference on June 2, 2011, the Army and MDNR have different opinions regarding the adequacy of the vapor intrusion characterization effort during the RI. Regardless of those differences, both parties agreed that the selected remedy must be protective of human health and the environment. Please refer to the Army's follow up response to Comment 2 above regarding the revised text in Section 2.12.2.3. The text presented in the revised response was endorsed by the project stakeholders from the Army, MDNR, MDHSS, and USEPA.

Additional Follow up Comment: Please see the Additional Follow up Comment to Comment 3.

Army Response to Follow up Comment: Please refer to the Army's response to Follow up Comment 3.

Hazardous Waste Program Specific Comments

Comment 7

Page 1-2, Line 19-20: Please include language to the affect that appropriate response measures will be implemented with regulator approval.

Response

The sentence referenced in the comment will be revised as follows:

> If the evaluation reveals that indoor vapor concentrations in offsite residences pose an unacceptable risk to the residents and are related to the former Hanley Area, appropriate response measures will be implemented by the U.S. Army with concurrence from MDNR.

Comment 8

Page 2-8, Lines 33-36: The strategy outlined specifies developing alternatives to protect current and future residents from consuming groundwater in the event that City Ordinance 66777 is repealed. This approach will result in a "lag" period between the repeal of the Ordinance and initiation of the new alternative, during which residents will not be protected and exposure may occur. Having an alternative ready for such an occurrence, so that exposure during development of alternatives does not occur, would address this issue and form a more complete means of ensuring the remedy is protective.

Response

It is highly unlikely that City Ordinance 66777 will be repealed because groundwater is not a viable drinking water resource in St. Louis, and a repeal would significantly affect redevelopment efforts at sites across the City. As noted in the ordinance, rationale behind the potable use restrictions includes the following:

- Due to limited quantity and low quality, groundwater beneath the City of St. Louis is not valued as a potable water source.
- It is often technologically impossible and financially unfeasible to restore groundwater to drinking water standards.
- The City does not use groundwater as a source for public drinking water.
- The City desires to limit potential threats to human health from groundwater contamination while facilitating the redevelopment and productive use of properties that may be affected by such chemical constituents.

To address the comment, the following text will be added to the end of Section 2.4:

> In accordance with the MOU, the City must notify MDNR at least 30 days before a proposed change to Ordinance 66777 goes into effect. During that period, MDNR will notify the Army of the proposed changes. The Army, in turn, will issue a letter explaining the changes in the Ordinance and warning residents against installing a potable water supply well in or near an area of groundwater contamination. The letter will provide a point of contact at MDNR for further information while an alternative measure to protect against residential groundwater consumption is developed.

Follow up Comment: Placing the responsibility on the department to notify the Army ***during the*** 30 day period that the City has to notify a change to the city ordinance is not acceptable. This is the U.S. Army Corps of Engineers' remedy, and the Army must bear the responsibility for handling contingencies related to any mechanism considered as part of this Decision Document.

Army Follow up Response: As discussed on June 2, 2011, the Army will confirm that St. Louis Ordinance 66777 remains in effect during annual inspections that the Army will performed as part of LUC monitoring at the site.

Instead of inserting the text presented in the Army's original response, the last paragraph of Section 2.4 will be replaced by the following text:

> The City will allow MDNR access to information necessary to monitor adherence to the terms of the MOU or the ordinance. The U.S. Army will confirm that the ordinance remains in place during annual inspections that the U.S. Army will perform as part of LUC monitoring. In the unlikely event that City Ordinance 66777 is repealed, the U.S. Army will issue a letter explaining the changes in the Ordinance and warning residents

against installing a potable water supply well in or near an area of groundwater contamination. The letter will provide a point of contact at the U.S. Army for further information while an alternative measure to protect against residential groundwater consumption is developed.

Comment 9

Page 2-12, Line 22: Please correct the word "Uutside" to read "Outside".

Response

The change will be made as requested.

Comment 10

Page 2-26, Lines 29-30: Plea se explain how the exposure scenario for a construction worker along Stratford Ave does not exceed risk triggers assuming the level of PCE beneath Stratford Ave is above 13,000 µg/L.

Response

In MW-110, located along Stratford Avenue, PCE concentrations have ranged from 7,700 to 13,400 µg/L. These concentrations fall below the PCE remediation goal of 21,000 µg/L, which is based on construction worker dermal contact with excavation water at an individual excess lifetime cancer risk of 1×10^{-5} and a non-cancer hazard index of 1.0. No unacceptable risks associated with offsite construction worker inhalation of PCE were identified during the human health risk assessment. Because the maximum concentration of 13,400 µg/L does not exceed the PCE remediation goal of 21,000 µg/L, risk triggers for a construction worker along Stratford Avenue are not exceeded.

Comment 11

Page 2-8, Lines 26-33: The hypothetical future potable use of onsite and offsite groundwater exposure scenario exceeded risk triggers, as documented in Section 2.7.1.5. The NCP 300.430 (e)(2)(i) states that remedial action objectives (RAOs) will include potential exposure pathways. How does this decision document satisfy this NCP requirement without a RAO for the groundwater ingestion pathway?

Response

The pathways referenced in the comment are not complete because of City Ordinance 66777. This is stated in Section 2.5.4 (Page 2-19, Lines 22 through 27):

- Under current and future land use, hypothetical potable use of groundwater was evaluated at the request of MDNR and MDHSS even though the current and future exposure pathways for potable groundwater are incomplete (due to City Ordinance 66777).

RAOs are not required for exposure pathways that are not complete. Therefore, an RAO prohibiting potable consumption of groundwater is not warranted. The role of the groundwater ordinance in blocking the groundwater ingestion pathway is provided in the last paragraph of Section 2.8 (Remedial Action Objectives).

Follow up Comment: As stated on page 2-8 of the DD there is a potential that city ordinance 66777 could be lifted. That means this pathway could be complete in a future use scenario. How does this decision document satisfy the NCP requirement without an RAO for the groundwater ingestion pathway? Response to comment 8 is not sufficient to satisfy this requirement. This DD needs to remain consistent in regard to its assumptions of city ordinance 66777. Since it is acknowledged that there is a possibility of the ordinance being lifted in the future all future scenarios for the site must also consider that the ordinance could no longer be in effect.

<u>Army Follow up Response:</u> The Army does not agree that an RAO is warranted for the groundwater ingestion pathway because it would remain incomplete even if the ordinance was lifted. This is because groundwater yield in the formation where onsite and offsite monitoring wells are screened is too low to adequately supply a potable well in the area. Please note the Army's follow up response to Comment 8 regarding an approach to confirm that the ordinance remains in effect and a contingency plan to address the unlikely scenario of the ordinance being repealed.

Additional Follow up Comment: Please provide with your response any yield calculations that have been used to rule out the groundwater as a possible pathway and include these calculations as an Appendix to the Decision Document.

<u>Army Response to Follow up Comment</u>: To address the follow up comment above, text will be revised in the seventh bullet of Section 2.5.4 (Conceptual Site Model), which describes exposure pathways evaluated in the human health risk assessment:

- Under current and future land use, hypothetical potable use of groundwater was evaluated at the request of MDNR and MDHSS even though the current and future exposure pathways for potable groundwater are incomplete. **<u>The exposure pathways are incomplete because of insufficient groundwater yield in the contaminated zone, as discussed in Appendix A, and because of City Ordinance 66777 which prohibits the installation of potable water supply wells.</u>** The hypothetical exposure scenarios for onsite and offsite residential use of potable groundwater are ingestion, dermal, and inhalation exposures to chemicals in bathroom air from volatilization of tap water during showering.

Appendix A will be added to the decision document to present groundwater yield estimates derived from low-flow groundwater purging that was performed in August 2010. It will include the attached Tables 1 and 2. The text of Appendix A will be as follows:

Groundwater Yield Estimates at the Former Hanley Area

Groundwater yield beneath the former Hanley Area was assessed using groundwater drawdown and pumping data collected in August 2010. Low-flow purging preceded groundwater sampling at monitoring wells located within the contaminated zone at the former Hanley Area and in offsite, downgradient wells north of the site along Stratford Avenue. Figure 2-10 in the decision document shows the locations of monitoring wells that were purged and sampled in August 2010. Table 1 of Appendix A presents well construction details for the onsite and offsite monitoring wells.

To perform low-flow purging, the system volume (that is, the volume of water within the entire length of sample tubing and the flow-through cell) was calculated before sampling each monitoring well. On five-minute intervals, the field parameters temperature, specific conductance, dissolved oxygen, pH, oxidation reduction potential, and turbidity were measured and recorded during the low-flow purge cycle. Groundwater depth in the monitoring well was also measured every five minutes. Each monitoring well was purged until groundwater parameters stabilized over three consecutive 5-minute intervals and after a minimum of two system volumes were removed.

Table 2 of Appendix A displays water quality parameters measured during the purge cycles described above. Pumping rates ranged from 0.033 to 0.056 gallons per minute (gpm), or 48 to 76 gallons per day (gpd). With the exception of MW-114 (purged at a rate of 48 gpm), groundwater drawdowns did not stabilize and reach a steady-state condition during the purge cycle.

Based on the information above, groundwater yield beneath the former Hanley Area and in downgradient offsite areas is on the order of 48 to 76 gpd. This range may be an overstatement of actual yield, because steady-state drawdowns were not observed in most monitoring wells, meaning that the cited yields may not be sustainable.

Groundwater yields of 48 to 76 gpd fall below 150 gpd, which the U.S. Environmental Protection Agency (USEPA) considers as the minimum yield required to supply the needs of an average-size household (USEPA 1988). In their review of data presented in Table 2, USEPA classified groundwater within and downgradient of the former Hanley Area as Class IIIA – not a source of drinking water due to insufficient yield (USEPA 2011).

References

USEPA. 1988. Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy. Office of Ground-Water Protection (WH-550G). June.

USEPA. 2011. Groundwater Classification for the Hanley Area, St. Louis Ordnance Plant – Former Hanley Area Operable Unit. Memorandum from USEPA Region VII to Superfund Site File. June 13.

Comment 12

Page 2-26, Line 31: The indoor air pathway has yet to be fully investigated. This scenario should not be included in the list of pathways not exceeding risk triggers, as currently there is not sufficient data to support this conclusion.

Response

During the RI, the indoor air pathway was adequately characterized and found to fall within acceptable risk thresholds. The uncertainty associated with the vapor intrusion pathway lies with <u>future</u> exposures caused by contaminant migration through groundwater. The text in line 31 will be revised as follows, with the underlined text added:

- <u>Current</u> indoor air concentrations at offsite residences (via vapor intrusion) along Stratford Avenue

This text change was also recommended by the Missouri Department of Health and Senior Services (see Comment 34).

Comment 13

Page 2-37, Section 2.12.2.2: It should be mentioned in this section and in Section 2.12.2.5 that any inaccessible areas suspected to contain levels of COCs above screening values will require a LUC.

Response

The following text will be added after the second paragraph of Section 2.12.2.2 (after Line 29 on Page 2-37):

> If contaminant concentrations exceed remediation goals along areas covered with concrete and asphalt (i.e., former building foundations, concrete bunkers, barrier walls, and sidewalks), then the Army will implement LUCs that prohibit removal of the surface materials (concrete or asphalt) without proper health and safety training and personal protective equipment.

The following text will be added at the end of the third paragraph of Section 2.12.2.5 (Page 2-39, Line 22):

> As noted in Section 2.12.2.2, additional LUCs will be implemented if contaminant concentrations in surface soil exceed remediation goals along areas covered with concrete and asphalt. The LUCs will prohibit removal of the surface materials (concrete or asphalt) without proper health and safety training and personal protective equipment.

Comment 14

Page 2-38, Lines 1-2: Will only the sediments residing in the powder wells be removed? What about the potentially contaminated concrete making up the well, or if the well has been compromised the potentially contaminated soils around and under the well? How will these areas be addressed?

Response

Sediment and debris will be removed from inside the powder wells. Direct contact exposures to residual contamination, if present, on the concrete will be prevented by backfilling the powder wells with clean fill material.

Based on the tight clays beneath the site and the low mobility of metals, the potential for contaminant migration from the powder wells into underlying soil is low. Subsurface soil samples were collected in 2001 near two powder wells (PW-12 and PW-13) from 7 to 8 feet below ground surface and analyzed for metals, including the contaminants of concern (arsenic, lead, and thallium). Results from these samples are provided in Table 2-7 of the decision document. None of metal concentrations exceeded remediation goals. Based on this information, further investigation or action associated with subsurface soil adjacent to powder wells is not warranted.

Follow up Comment: This comment does not refer to residual contamination; we refer to contaminants and contaminated sediments/soils that have undoubtedly seeped through cracks in the concrete to the spaces beyond the powder well walls. Is the Army proposing that this contamination be left in place? An LUC will need to be placed on all potential areas if this is the case.

Army Follow up Response: The Army maintains that the potential for release from powder wells was adequately addressed during the RI, and the likelihood of release is very low because of the tight clays underlying the site. The clays would mitigate the migration of sediments/soil that could have leaked through cracks in the powder well walls. The samples referenced in the Army's original response were collected only a few feet below the bottom of the powder wells.

Had a release from the powder wells occurred, those samples should have revealed evidence of such a release. Based on that information, the Army proposed the removal of sediment from the powder wells and not the removal of the entire powder well. This approach was agreed upon by the project stakeholders during the RI phase. The removal of sediment from the powder wells will not require the implementation of LUCs on the powder wells themselves.

Comment 15

Page 2-38, Lines 4-10: This description of the approach to vapor intrusion investigations is too open-ended. Use of the EPA's vapor intrusion guidance is preferred. Alternately, if flexibility in future investigation approaches is desired, consider declaring a minimum standard with several optional methods or combinations of lines of evidence that may be used.

Response

The text referenced by the comment will be updated as shown in response to Comment 2 to provide more specifics regarding the investigation component of the vapor intrusion evaluation.

Comment 16

Page 2-38, Lines 16-24: Groundwater monitoring is not the preferred method of VI investigation or monitoring, and this has been discussed among the stakeholders and an agreement was reached. Please list and discuss the quarterly sub-slab sampling, indoor air sampling and groundwater sampling currently planned to assess the VI threat at the residences within 100 feet of the edge of the plume.

Response

The Army would like to clarify that quarterly subslab sampling was not agreed upon during the November 4, 2010 meeting, nor was there an agreement on a distance from the edge of the groundwater plume. Details regarding the November 4, 2010 meeting are provided in a meeting summary that the Army provided to the project stakeholders on November 24, 2010. The Army agreed to perform quarterly <u>groundwater</u> monitoring and to attempt collection of sub-slab soil samples at 4701 Goodfellow Boulevard, located near MW-107, where 1,2-dichloroethene was measured above the MCL in August 2010. The Army agreed to attempt subslab sampling at three additional residences along Stratford, to the west of 4701 Goodfellow, if subslab samples could be collected from 4701 Goodfellow.

The text referenced in this comment will be revised as shown in the response to Comment 2.

Follow up Comment: We have not maintained that an agreement was not reached on a distance from the edge of the plume. The distance of 100 feet is the 100 feet widely acknowledged standard for VI evaluation.

MDHSS Follow up Comment: Please see MDHSS Follow up Comment to Comment 2.

<u>Army Follow up Response</u>: Please see the follow up response to Comment 2.

Comment 17

Page 2-38, Line 28: Recommend inserting the word "identify" to revise "and areas" to "and identify areas."

Response

The change will be made as requested. Please refer to the response to Comment 2.

Comment 18

Page 2-38, Lines 31-34: Decisions on changing the approach to the study and mitigation of vapor intrusion should be made by consensus. Please include a statement to this effect.

Response

The change will be made as requested. Please refer to the response to Comment 2.

Comment 19

Page 2-39, Lines 25-26: Any restrictive covenant used to manage risk for this site needs to comply with the Missouri Uniform Environmental Covenant Act.

Response

The Army acknowledges the comment. Additional information regarding LUC implementation, including compliance with the Missouri Uniform Environmental Covenant Act, will be provided in the forthcoming LUCIP.

Follow up comment: Please refer to the follow up comment on the Response to Comment 4.

Army Follow up Response: Please see the Army's follow up response to Comment 4. The Army maintains that the LUCIP is the appropriate document to discuss compliance with the Missouri Uniform Environmental Covenant Act.

Comment 20

Page 2-39, Section 2.12.2.6: Five-year reviews should focus on *all* pathways and COCs that remain above unrestricted use concentrations in order to meet the statutory requirement. For example, five year reviews will summarize groundwater monitoring, allowing systematic, periodic evaluation of groundwater quality to help ensure that the established LUC boundaries fully encompass the contaminant plumes, and remain protective of human health and the environment. Use of the long term monitoring program to allow systematic, periodic evaluation of site groundwater quality to help ensure that the LUC boundaries fully encompass the contaminant plumes, and ensure the remedy remains protective of human health and the environment should be explicitly stated.

Response

The referenced paragraph will be rewritten as follows:

> Five-year site will be conducted as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. The five-year reviews will be terminated once COCs are at or below the remediation goals, the vapor intrusion pathway is determined not to pose unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels), and monitoring confirms that no unacceptable risks are posed by Plume C. Once these conditions are confirmed at the former Hanley Area, the U.S. Army will recommend that the five-year reviews be terminated. The basis for the recommendation will be documented in a final five-year review report that will be submitted for regulatory approval.

The five-year review will consider all complete exposure pathways and COCs that remain above unrestricted use concentrations. The primary pathways of interest will be future offsite residential exposures to indoor air COCs through vapor intrusion. The five-year review will also assess the effectiveness of LUCs in protecting against onsite residential and industrial worker exposure to indoor air, groundwater, and surface soil COCs. The time that natural attenuation takes to return groundwater to the potable use levels is estimated to be more than 84 years for Alternatives 2, 3, and 4 – this duration is considered comparable to the time required to remove risk associated with vapor intrusion.

Comment 21

Page 2-40, Line 9: Table 2-22 referenced here is not attached to this document.

Response

The table, which provides a cost estimate for selected remedy, was included in the decision document but mislabeled as Table 2-23. The table number will be corrected in the final decision document, along with associated references in the text.

Comment 22

Page 2-40, Line 29: The term "vicinity" here should be defined or replaced with a specific distance required, at the time of construction, for a VI investigation to be done.

Response

The phrase "in the vicinity of the construction site" will be replaced with "within LUC boundaries".

Follow up Comment: This response does not satisfy the Department's concern. Groundwater is mobile and is moving off-site toward property that is not controlled by the Army. Therefore, there needs to be a clearly defined distance for which investigations must be conducted in order for the new construction to be protective. For example the current practice accepted distance is 100 feet.

Army Follow-up Response: The phrase "within LUC boundaries" provides adequate protection because the vapor intrusion LUC boundaries will be expanded as necessary to encompass the area where chemical concentrations in groundwater exceed screening levels. Details regarding expansion of the LUC boundaries, if warranted based on an expansion of the VOC plume, will be included in the LUCIP.

Comment 23

Page 2-41, Lines 6-10: Include language similar to this in Section 2.12.2.3. The Department notes that if unacceptable risk is identified, in order to be consistent with CERCLA a ROD Amendment or Explanation of Significant Differences will likely be necessary in order to document response measures selected.

Response

The Army disagrees with the comment. An Explanation of Significant Differences (ESD) would not be needed if a response measure, such as installation of a vapor mitigation system, were deemed necessary. The Army has included flexibility in the vapor intrusion evaluation for the specific purpose of avoiding an ESD in the event that such measures are warranted.

Follow up comment: Pressing forward with a Decision Document on a site that has an exposure pathway still being investigated by crafting the Decision Document with a short list of types of potential remedies that may be implemented should the pathway be determined to be complete post-DD does not seem to meet the intent of CERCLA and the NCP.

Army Follow up Response: Please refer to the Army's follow up response to Comment 2.

Additional Follow up Comment: Please see Additional Follow up Comment to Comment 3.

Army Response to Follow up Comment: Please refer to the Army's response to Follow up Comment 3.

Comment 24

Page 2-41, Lines 31-36: ROD protectiveness statements are expected to clearly define the means by which the selected remedy will attain the statutory mandate. Please revise so that the protectiveness statement for the vapor intrusion pathway is definitive rather than vague and speculative.

Response

To address this comment, the referenced text will be rewritten as follows:

> Potential indoor air risks to future offsite residents will be assessed through further evaluation of the vapor intrusion pathway. Human health will be protected by implementing appropriate response measures if the evaluation reveals that indoor vapor concentrations in offsite residences pose an unacceptable risk to the residents and are related to the former Hanley Area.

Comment 25

Page 2-42, Line 26: Please revise to reflect that the five-year reviews may only be terminated with regulatory concurrence. See Comment 1 of this letter under HWP General Comments.

Response

Regulatory approval is mentioned in the underlined text of Section 2.13.6 (Five-Year Review Requirements) referenced by the comment:

> As required by the NCP, five-year reviews will be conducted as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. The five-year reviews will be terminated once COCs are at or below the remediation goals, the vapor intrusion pathway is determined not to pose unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels), and monitoring confirms that no unacceptable risks are posed by Plume C. Once these conditions are confirmed at the former Hanley Area, the U.S. Army will recommend that the five-year reviews be terminated. The basis for the recommendation will be documented in a final five-year review report that will be submitted for regulatory approval.

Follow up Comment: Language such as "will be terminated" makes this entire paragraph seem contradictory. The language needs to reflect the fact that five year reviews will be conducted as required by the statute and will not be terminated without prior regulatory approval. The current language indicates that reviews will be terminated, then documented, and finally submitted for approval. Please revise.

Army Follow up Response: Please refer to the Army's follow-up response to Comment 1.

Hazardous Waste Program Community Involvement Comments

Comment 26

The Department suggests attaching copies of the public notices, letters (template), and flyers as supporting documentation of public outreach.

Response

The Army feels that text references to the public notices, letters, and flyers in Section 2.3 (Community Participation) are sufficient for the decision document. The level of detail provided in the decision document is consistent with USEPA's July 1999 guidance titled, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Documents.*

Comment 27

Please consider including the public comment period dates in 2010 in both the Community Participation and the Community Acceptance sections.

Response

The public comment period dates (November 29 through December 29, 2010) will be added to Section 2.3 (Community Participation). It is already provided in Section 2.10.9 (Community Acceptance).

Comment 28

Page 2-7, Lines 6-7: When the Administrative Record file was moved in 2010, was a public notice published in the local newspapers of record?

Response

Yes – the new location of the administrative record was noted in the public notice that ran on November 25, 2010.

Comment 29

Page 2-7, Lines 17-18: Please consider including the name(s) of the alderman with whom the U.S. Army coordinated.

Response

The referenced text will be replaced with the following text:

> The U.S. Army has coordinated community involvement/input with Ward 22 Alderman Jeffrey Boyd, who represents the neighborhood and Job Corps training center.

Comment 30

Page 2-36, Line 8: There are two periods in this sentence.

Response

The extra period will be deleted.

Comment 31

Page 2-36, Line 8: It is suggested that last sentence be modified to show facts not assumptions. For example, "USACE worked through various outlets to inform the community of the Proposed Plan and the various alternatives (e.g. flyers, letters, public meetings, public comment periods, etc.). No comments were submitted and no concerns were raised regarding the Proposed Plan. Based on these community outreach efforts, USACE is confident that that community acceptance has been reached."

Response

The last sentence of the paragraph will be replaced with the following text:

> The U.S. Army has worked through various outlets (e.g., fact sheets, letters, a public meeting, and a public comment period) to inform the community of the Proposed Plan and the remedial alternatives. No comments were submitted and no concerns were raised regarding the Proposed Plan. Based on these community outreach efforts, the U.S. Army is confident that that community acceptance of Alternative 3 has been reached.

Comment 32

If the Army would like, the State is willing to post the Final Decision Document on the MDNR website for viewing by the public.

Response

The Army appreciates MDNR's offer to post the decision document on their website. The Army would be happy to post the decision document once it has been signed by the Army and received MDNR's concurrence.

Missouri Department of Health and Senior Services Comments

Comment 33

Page 2-24, Section 2.7.1.3: This section notes the hierarchy used to obtain toxicity values. The following is listed under Tier 3 Sources: "Minimal Risk Levels identified by the Agency for Toxic Substances and Disease Registry for intermediate inhalation exposures". The latter part of the sentence, "for intermediate inhalation exposures" should be removed from the sentence.

Response

The phrase should remain in the text to provide the specific source used in the Tier 3 hierarchy. This is consistent with the hierarchy provided in the RI report.

MDHSS Follow up Comment: MDHSS previously commented on Section 2.7.1.3 requesting to remove the phrase "for intermediate inhalation exposures" from the toxicity hierarchy listing for the Agency for Toxic Substances and Disease Registry (ATSDR). The Army responded that the phrase should remain in the text to provide the specific source used in the hierarchy and that this is consistent with what was stated in the RI report. MDHSS is unclear why this phrase was included in the RI report - the toxicity values used in the RI from ATSDR were actually chronic values; therefore, MDHSS again requests the phrase be removed.

<u>Army Follow up Response</u>: The Army agrees with the MDHSS comment that the toxicity values used in the RI from ATSDR were chronic values. Therefore, the phrase "for intermediate inhalation exposures" will be removed from the sentence, as requested.

Comment 34

Page 2-24, Section 2.7.1.4: The last sentence states, "An HI of 1.0 or less is considered highly unlikely to cause noncancer adverse effects even if exposure continues for a lifetime." This should be changed to read, "An HI of 1.0 or less is considered unlikely to cause noncancer adverse effects."

Response

The change will be made as requested.

Comment 35

Page 2-25, Section 2.7.1.5: This section contains a bulleted list of exposure scenarios that do not exceed risk triggers. The last bullet should indicate that Current indoor air concentrations at offsite residences along Stratford Avenue do not exceed risk triggers.

Response

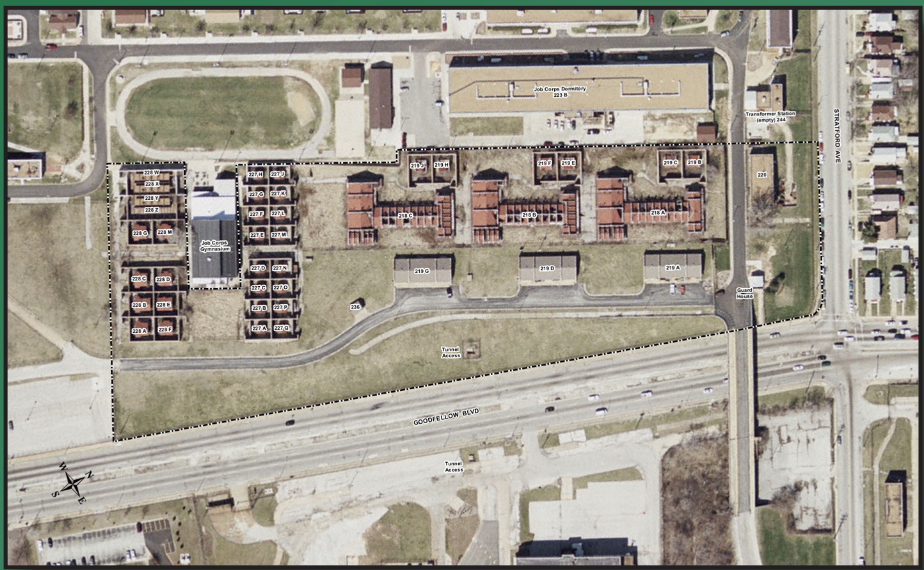
The change will be made as requested. Also note the response to Comment 12.

Performance Based Contract

Final Remedial Design/Remedial Action Work Plan – Operable Unit 1

St. Louis Ordnance Plant Former Hanley Area

St. Louis, Missouri



Submitted to:

US Army Corps of Engineers
Kansas City District

88th Regional Support Command

US Army Environmental Command

Prepared by: Conti and CH2MHILL

September 2011

Final Decision Document – Operable Unit 1

St. Louis Ordnance Plant Former Hanley Area

St. Louis, Missouri

Prepared for
U.S. Army Corps of Engineers,
Kansas City District
Contract No. W912DQ-05-D-0002
Task Order No. 0007

September 2011

Prepared by

Conti

and

CH2MHILL

Contents

Appendix

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Tables

Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
COC	chemical of concern
COPC	chemical of potential concern
CPT	cone penetrometer test
CT	carbon tetrachloride
cVOC	chlorinated volatile organic compound
1,2-DCA	1,2-dichloroethane
cis-1,2-DCE	*cis*-1,2-dichloroethene
trans-1,2-DCE	*trans*-1,2-dichloroethene
DAF	dilution-attenuation factor
DD	decision document
DNAPL	dense nonaqueous phase liquid
Eco-SSL	ecological soil screening level
ELCR	excess lifetime cancer risk
FS	feasibility study
HHRA	human health risk assessment
HI	hazard index
ID	identification
LUC	land use control
LUCIP	land use control implementation plan
MCL	maximum contaminant level
MDHSS	Missouri Department of Health and Senior Services
MDNR	Missouri Department of Natural Resources
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
MIP	membrane interface probe
MOU	Memorandum of Understanding
MSSL	medium-specific screening level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
OU-1	Operable Unit 1
OU-2	Operable Unit 2
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act

REMChlor	Remediation Evaluation Model for Chlorinated Solvents
RI	remedial investigation
RRC	Regional Readiness Command
RSC	Regional Support Command
SLAAP	St. Louis Army Ammunition Plant
SSL	soil screening level
SVOC	semivolatile organic compound
TAL	target analyte list
TCE	trichloroethene
TCH	thermal conductive heating
TeCA	tetrachloroethane
TTZ	target treatment zone
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1. Declaration

1.1 Site Name and Location

St. Louis Ordnance Plant, former Hanley Area
Army Reserve Facility identification number (ID) MO030
6400 Stratford Avenue
St. Louis, Missouri
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID MO3210090038

1.2 Statement of Basis and Purpose

This decision document (DD) presents the selected final remedial action for Operable Unit 1 (OU-1)—Actions Addressing Contaminated Soil, Powder Well Sediment, and Groundwater Concerns—at the former Hanley Area of the St. Louis Ordnance Plant in St. Louis, Missouri. The U.S. Army chose the remedy with input and concurrence from the Missouri Department of Natural Resources (MDNR) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The DD is based on the administrative record file for the former Hanley Area, which is maintained at the Julia Davis Branch Library, 4415 Natural Bridge Avenue, St. Louis, and available for public review. The U.S. Army will fulfill its responsibility and obligation under CERCLA and the NCP as it implements, maintains, and reviews the selected remedy.

Further investigation and potential mitigation of contamination associated with the vapor intrusion pathway will be conducted under Operable Unit 2 (OU-2).

1.3 Assessment of the Site

The response action selected in this DD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 Description of Selected Remedy

The selected remedy for OU-1 will address areas of soil and groundwater contamination that potentially pose unacceptable risks to human health. It consists of the following components:

- **Soil removal and offsite disposal**. During the remedial investigation phase, MDNR, Missouri Department of Health and Senior Services (MDHSS), U.S. Environmental

Protection Agency (USEPA), and the U.S. Army agreed that certain areas of surface soil with elevated arsenic, lead, and Aroclor 1260 concentrations would be removed during the remedial action. Additional areas of surface soil contaminated with thallium were identified during the feasibility study (FS) phase and will also be removed during the remedial action.

- **Removal and offsite disposal of sediment, if present, at 22 powder well locations**. The sediment will be transported to an offsite licensed disposal facility based on characterization sampling, and the wells will be backfilled with clean imported fill.
- **In situ groundwater treatment using chemical processes and soil mixing—Plume A**. The area of groundwater contamination posing an unacceptable risk to construction workers will be treated by applying a chemical reductant to soil and groundwater in place. Mechanical mixing of the soil will be performed to distribute the chemical amendment through the soil column within the treatment zone.
- **Groundwater monitoring within Plume C, an area contaminated with carbon tetrachloride (CT)**. Data from groundwater monitoring will confirm that the exposure pathway between construction workers and contaminated groundwater remains incomplete because of the depth to the groundwater table.
- **Land use controls (LUCs)**. LUCs will be established over Plume C as long as CT concentrations remain above the groundwater preliminary remediation goal (PRG) established in the FS. The LUC will prohibit construction activities below the groundwater table without proper health and safety training and personal protective equipment.
- **Five-year site reviews.** Five-year reviews will be performed as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. The five-year reviews would be terminated once chemicals of concern (COCs) are at or below the remediation goals and monitoring confirms that no unacceptable risks are posed by Plume C.

The potential migration of contaminated vapors from groundwater to indoor air will be further assessed through a vapor intrusion investigation under OU-2 addressing responses related to the vapor intrusion pathway.

Although it is not part of the selected remedy, City of St. Louis Ordinance 66777 provides protection against exposure to contaminated groundwater. The ordinance prohibits the use or attempted use of groundwater as a potable water supply and the drilling or installation of wells for a potable water supply within the corporate limits of the City of St. Louis.

1.5 Statutory Determinations

The selected remedy for OU-1 meets the statutory requirements of CERCLA. It is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy.

Because the selected remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action. The reviews will continue at a minimum frequency of once every 5 years thereafter to ensure that the remedy remains protective of human health and the environment.

1.6 Decision Document Data Certification Checklist

The following information is included in the Decision Summary sections of this report:

- COCs and their respective concentrations (Section 2.5.3)
- Baseline risk represented by the COCs (Section 2.7)
- Cleanup levels established for COCs and the basis for these levels (Section 2.8)
- How source materials constituting principal threats are addressed (Sections 2.9 and 2.11)
- Current and reasonably anticipated future land use assumptions, and current and hypothetical future beneficial uses of groundwater used in the baseline risk assessment and DD (Section 2.5.4)
- Potential land and groundwater uses resulting from the selected remedy (Section 2.6)
- Estimated capital costs, annual operation and maintenance (O&M) costs, and total present worth; discount rate; and the number of years over which the remedy cost estimates are projected (Section 2.9)
- Key factors that led to remedy selection (Sections 2.10 and 2.12)

Additional information about the site can be found in the administrative record file.

1.7 Authorizing Signature

The undersigned acknowledges approval of the selected remedy for OU-1—Actions Addressing Contaminated Soil, Powder Well Sediment, and Groundwater Concerns—at the former Hanley Area, St. Louis Ordnance Plant, St. Louis, Missouri.

for Deborah L. Potter
Scott D. Kimmell/Colonel, U.S. Army

26 Sept 2011
Date

2. Decision Summary for Operable Unit 1

2.1 Site Name, Location, and Description

The former Hanley Area (Army Reserve Facility ID MO030, CERCLIS ID MO3210090038) is an industrial site that consists of 14.68 acres and is located at 6400 Stratford Avenue 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 2-1). The site is north of the Sverdrup U.S. Army Reserve Center (Facility ID MO028), located at 4301 Goodfellow Boulevard in St. Louis. The 89th Regional Readiness Command (RRC) owned the former Hanley Area until it was disestablished in June 2009. The 88th Regional Support Command (RSC) owns the former Hanley Area and occupies the Center.

The U.S. Army is the lead agency for the former Hanley Area. The U.S. Army Environmental Command (USAEC) is the Army agency responsible for cleanup activities at the site. The U.S. Army Corps of Engineers (USACE)–Kansas City District provides environmental technical assistance to the USAEC in support of their cleanup activities at this site. Through a U.S. Department of Defense State Memorandum of Agreement, USAEC works with the Federal Facilities section of MDNR on Defense Environmental Restoration Program properties in Missouri. USEPA Region 7 provides regulatory assistance to MDNR. Although the former Hanley Area is not on the National Priorities List, USACE follows the CERCLA process for responses to hazardous substances, pollutants, and contaminants as set forth in 10 United States Code 2701.

2.2 Site History and Enforcement Activities

2.2.1 Site History

The St. Louis Ordnance Plant operated from 1941 to 1945 as a small arms ammunition production facility, producing primarily .30- and .50-caliber ammunition. The plant was divided into two areas designated No. 1 (east of Goodfellow Boulevard) and No. 2 (west of Goodfellow Boulevard). Plant Area No. 2 encompassed 27.68 acres. The former Hanley Area consists of the 14.68 acres at the northeastern end of Plant Area No. 2 at the intersection of Stratford Avenue and Goodfellow Boulevard (Figure 2-2). Production at the latter plant consisted of blending primary explosives, incendiary compounds, and tracer charging .30- and .50-caliber projectiles as part of the assembly of the final product. Powder wells installed in 1941 received wastewater from buildings and magazines until 1945. The powder wells provided sediment collection before the wastewater was discharged to the sanitary sewer.

From 1945 through 1959, some buildings within Plant Area No. 2 were used by the U.S. Army Adjutant General's Office for maintaining service records. Other buildings within Plant Area No. 2 were used as classrooms by the U.S. Department of Defense Finance Center.

The Hanley Area takes its name from Hanley Industries, Inc., which leased 14.68 acres at the northeastern end of Plant Area No. 2 in 1959 and conducted operations there through 1979.

Hanley used the site for research, development, manufacture, and testing of explosives. Over that time, Hanley produced specialty ordnance and nonordnance devices for the U.S. military and the National Aeronautics and Space Administration. Hanley used most of the buildings to load detonators and primers and to mix explosives. Explosives were dried in magazines by leaving cans of explosives exposed to the air, and Buildings 219E and 219F housed Hanley's lead azide reactor. Hanley reportedly did not use the powder wells or sumps on the property for wastewater disposal.

The Goodfellow U.S. Army Reserve Center (now the Sverdrup U.S. Army Reserve Center) was established on the remaining 13 acres of Plant Area No. 2. Some of the western parts of the 13 acres subsequently were transferred to the U.S. Department of Labor, and the land is currently occupied by the Job Corps. Most of the Hanley Area housed a series of warehouse buildings, bunkers, and related buildings. Between 2004 and 2007, buildings and bunkers, with the exception of Buildings 219A, 219D, 219G, and 236, were demolished by an 89th RRC contractor.

Soil and groundwater contamination observed at the former Hanley Area is suspected to be related to previous waste handling, generation, and disposal processes. The explosives manufacturing process may have resulted in metal contamination in soil, and laboratory and maintenance activities at former Building 220 may have released polycyclic aromatic hydrocarbons (PAHs) in soil and volatile organic compounds (VOCs) in soil and groundwater. A leaking transformer resulted in polychlorinated biphenyl (PCB) Aroclor 1260 contamination in surface soil.

The June 1981 U.S. Army Toxic and Hazardous Materials Agency *Survey of Hazardous Chemical Area No. 2 of the Former St. Louis Ordnance Plant* states that Hanley Industries, Inc., disposed of explosives-contaminated material by burning it in the basement of Building 218C between 1959 and 1979. Open burning of explosives was also conducted in magazines 219F and 219J.

2.2.2 Site Investigations

Environmental investigations at the former Hanley Area have been conducted since 1979. The investigation history and findings are summarized below.

2.2.2.1 Preliminary Assessments / Site Inspections

1979 and 1980—Site Investigation by Battelle Columbus Laboratories. The Battelle study was performed at the current site of the Job Corps Training Center and former Hanley Area. Existing buildings, magazines, sewer pipe locations, and powder wells were sampled and analyzed for explosives and metals to assess whether explosive and metal residues remained after previous decontamination efforts. Results indicated the presence of potential explosives and metals residues on building surfaces, in powder wells, and on other structures associated with munitions production, packing, or storage activities (U.S. Army Toxic and Hazardous Materials Agency [USATHAMA] 1981).

1991—Environmental Study by USATHAMA. Surface and shallow soil samples and tunnel water samples were collected. Lead concentrations in surface soil exceeded site-specific and regional background values. No explosives were detected in the soil samples. Semivolatile organic compounds (SVOCs) were detected at five locations. The PCB Aroclor 1260 was detected in one soil sample at a concentration of 18,200 milligrams per kilogram (mg/kg) at the location of a former leaking transformer (USATHAMA 1991).

1998—Site Investigation by HARZA Environmental Services, Inc. The investigation assessed the presence of chemicals in soil and sediment. Surface and shallow soil samples were collected and analyzed for VOCs, SVOCs, explosives, and Resource Conservation and Recovery Act (RCRA) metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Subsurface soil, sewer sediment, and powder well sediment samples were collected and analyzed for explosives and RCRA metals. Explosives and elevated lead concentrations were detected in surface and shallow soil samples at one location. Arsenic concentrations ranging between 5.0 mg/kg and 67.7 mg/kg were also identified. Silver was found at a maximum concentration of 82.6 mg/kg in a shallow soil sample at one location (HARZA 1998).

2001—Draft Preliminary Assessment / Site Inspection by TapanAm Associates, Inc. The preliminary assessment/site inspection evaluated the extent of surface soil contamination, the potential for contaminant migration by surface routes through underground utility tunnels, and the potential for groundwater contamination. Surface soil, subsurface soil, sediment, and groundwater samples were analyzed for one or more of the following parameters: VOCs, explosives, and target analyte list (TAL) metals. Surface soil samples were collected in the northern part of the site around the Building 219 series. Subsurface soil samples were collected near sewer line breaks and two near powder wells. Direct-push probes/temporary piezometers were installed and groundwater samples were collected for chemical analysis. Five monitoring wells (MW-101 through MW-105) were installed and sampled. Sediment samples were also collected from powder wells, sewers, and tunnels. Water samples were collected from sewer locations.

Arsenic, lead, and thallium were found in soil samples at concentrations exceeding USEPA Region 9 PRGs for residential soil. No explosives were detected in surface soil, and no explosives or VOCs were detected in subsurface soil. Lead concentrations exceeding the PRG, as well as low concentrations of explosives, were found in powder well sediment. The VOC *cis*-1,2-dichloroethene (*cis*-1,2-DCE) was detected at a concentration slightly above the maximum contaminant level (MCL) in groundwater at one well, upgradient of the former Hanley Area. No other VOCs were detected at concentrations above the MCL, and no explosives were detected in groundwater (TapanAm 2001).

2003—Limited Phase II Environmental Site Assessment by Shaw Environmental, Inc. The environmental site assessment further assessed offsite upgradient VOC contamination found during the preliminary assessment/site inspection. Samples were collected from direct-push borings near the monitoring well to assess the presence of VOCs in soil. The borings were then converted to temporary monitoring wells to sample groundwater for VOCs. No VOCs were detected in subsurface soil. Concentrations of *cis*-1,2-DCE, *trans*-1,2-dichloroethene (*trans*-1,2-DCE), and vinyl chloride were detected in groundwater at direct-push sample location GP-4 (Shaw 2003).

2003—Phase I Environmental Site Assessment by Pangea, Inc. Asbestos samples were collected from onsite buildings during the Phase I environmental site assessment (Pangea 2003).

2.2.2.2 Remedial Investigations

2004—Sampling, Asbestos Abatement, and Building Demolition by SCS Engineers. Sediment samples and building materials were collected and analyzed for explosives and metals. Asbestos abatement was performed in the buildings, which were then demolished (SCS Engineers 2004).

2004—Environmental Data Compilation by USACE. USACE compiled environmental data from the previous investigations and identified data gaps (USACE 2005).

2005—Phase I Remedial Investigation by USACE. USACE performed a Phase I remedial investigation (RI) to fill aforementioned data gaps. Composite and discrete surface soil samples were collected in areas where metals previously had been identified in surface soil. The samples were analyzed for TAL metals. Some of the samples were also analyzed for PAHs. Surface soil samples were collected for PCB analysis from the area of the former transformer, located near the southern site boundary. Subsurface soil samples were collected from soil borings advanced adjacent to powder wells, sewer lines, and foundations. One monitoring well was installed downgradient from former Building 220. The new well and five existing wells were sampled and analyzed for explosives, VOCs, and TAL metals.

Investigation results identified an area of localized PCB contamination near the former leaking transformer along the southern site boundary. Site-related metals were found to be localized and limited to surface and near-surface soil. Subsurface soil was not contaminated. Groundwater in the upgradient well, MW-101, was contaminated with benzene and the chlorinated VOCs (cVOCs) *cis*-1,2-DCE, *trans*-1,2-DCE, and trichloroethene (TCE). The newly installed well, MW-106, on the northern part of the site, exhibited detections of tetrachloroethene (PCE) and 1,2-dichloroethane (1,2-DCA). Various metals were also detected in groundwater (USACE 2005).

2005 and 2006—Supplemental Groundwater RI by USACE. In 2005, direct-push borings/temporary piezometers were installed and sampled near former Building 220 to assess the origin and extent of 1,2-DCA in groundwater in MW-106. Results indicated that groundwater was contaminated with PCE, TCE, CT, and chloroform. Based on these results, activities were conducted in February 2006 to assess the extent of groundwater contamination. Temporary piezometers were installed, and groundwater samples were collected. Existing monitoring wells were also sampled. Results from the temporary piezometers indicated the presence of PCE, TCE, *cis*-1,2-DCE, 1,2-DCA, and CT in groundwater. Benzene, *cis*-1,2-DCE, *trans*-1,2-DCE, TCE, and vinyl chloride were detected at upgradient well MW-101. PCE and 1,2-DCA were detected at MW-106. Various metals were detected in each monitoring well, but no explosives were detected.

Based on the February 2006 findings, additional field activities were implemented in July 2006. Direct-push borings were advanced and groundwater samples collected around former Building 220. Samples were analyzed using field gas chromatography for VOCs and submitted for laboratory analysis. PCE, TCE, *cis*-1,2-DCE, chloroform, and 1,2-DCA were detected in the direct-push samples. The gas chromatography confirmed the presence of cVOCs. Sediment samples were collected from the two sewer inlets that drain water from the concrete pad north of former Building 220. PCE was the only VOC detected in sediment (USACE 2006a, USACE 2006b).

2007—Supplemental Groundwater Phase II RI by USACE. Additional groundwater investigations were undertaken in January 2007. Membrane interface probes (MIPs) were advanced to top of bedrock, north and northeast of former Building 220 where previous direct-push probes showed high PCE and 1,2-DCA concentrations. Direct-push soil borings were advanced adjacent to and stepped out from the MIP locations for confirmation samples and to determine the extent of VOC contamination in the surface and subsurface soil. Eight monitoring wells (MW-107 through MW-114) were installed in the area northeast of Building 220 and along Stratford Avenue to monitor the interior and boundaries of the VOC contamination observed during the direct-push groundwater investigations.

Additional work was completed in March and April 2007. Soil borings were advanced in the affected area northeast of former Building 220. One monitoring well was installed upgradient of the affected area within the footprint of former Building 220. Groundwater samples were also collected from the eight new wells and one existing well, MW-106, and analyzed for VOCs. PCE and its breakdown products TCE, *cis*-1,2-DCE, and *trans*-1,2-DCE were present in each soil boring. PCE and its associated breakdown products were also detected beneath Stratford Avenue (USACE 2007).

2008—RI by CH2M HILL. The 2008 RI filled data gaps identified from a review of previous investigation results. Surface soil samples were collected to characterize lead and arsenic contamination and the surface soil. A MIP/cone penetrometer test (CPT) was used to characterize the nature and extent of VOC contamination in soil, soil gas, and groundwater in the area around former Building 220. Following the MIP/CPT investigation, confirmation soil and groundwater samples were collected based on the MIP/CPT data. Groundwater grab samples were collected from soil borings using results from the MIP investigation. To further define the nature and extent of cVOC groundwater contamination near and downgradient of former Building 220, one deep and two shallow groundwater monitoring wells were installed. Groundwater samples were collected from new and existing wells in the area of former Building 220 to confirm the extent of cVOC impact on groundwater at the northern part of the site. Indoor air sampling was also performed in a residence along Stratford Avenue to assess the potential for vapor intrusion in residences north of the St. Louis Ordnance Plant (CH2M HILL 2009).

Results from the 2008 RI and previous investigations were presented and discussed in the RI report (CH2M HILL 2009). Human health and ecological risk assessments were performed and are presented in the RI report.

2010—Groundwater Predesign Investigation by CH2M HILL. A groundwater predesign investigation was performed to refine the groundwater target treatment zone (TTZ) in the northern part of the former Hanley Area. The information will be used to develop the remedial design and will be presented in the remedial design/remedial action work plan. Groundwater grab samples were collected from four soil borings to delineate the groundwater treatment area that will be addressed during the remedial design. One new monitoring well, MW-118, was installed in an area where CT contamination was observed in groundwater during the 2008 RI. Groundwater samples were collected from MW-106 through MW-118. 1,2-DCA was found in MW-106 and MW-107 at concentrations exceeding screening levels. The results will be further evaluated as part of a vapor intrusion investigation under OU-2.

2.2.2.3 Feasibility Study

2010—FS by CH2M HILL. The FS developed and evaluated remedial alternatives that address potential unacceptable risks to human health and the environment identified in the RI, and meet applicable or relevant and appropriate requirements (ARARs). Remedial action objectives (RAOs) were established based on regulatory requirements, standards, and guidance. PRGs were developed based on regulatory requirements, standards, and guidance to meet the site-specific RAOs. 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, In Situ Groundwater Treatment using Thermal Technologies, Soil and Powder Well Sediment Removal, and Offsite Disposal; Alternative 3, In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal; and Alternative 4, Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal, and Offsite Disposal. The alternatives were evaluated against seven feasibility evaluation criteria as defined in the NCP and CERCLA (CH2M HILL 2010).

2.2.3 Site Removal and Remedial Actions

No remedial actions at the St. Louis Ordnance Plant have occurred to date. However, decontamination efforts and demolition of buildings, bunkers, and magazines have been completed throughout the operational history of the site.

According to the 1991 *Environmental Study* by USATHAMA (1991), following deactivation of the St. Louis Ordnance Plant in 1945, buildings having explosives contamination were decontaminated by USACE. This was reportedly conducted in accordance with regulations of the Safety and Security Branch Office, Chief of Ordnance, Chicago, Illinois. Although no records are available describing the procedures employed or the results obtained in the decontamination project, many of the buildings were marked with “XXX,” signifying 99.9 percent clean. The mark was typically used to indicate decontamination and inspection following decontamination to verify safety and absence of explosives contamination. With the exception of the powder wells, magazines and buildings throughout the former Hanley Area were marked “XXX.”

The U.S. Army required Hanley Industries, Inc., to conduct decontamination of buildings following lease termination in 1979. Decontamination procedures reportedly consisted of spray washing of the walls in the buildings to a height of 8 feet above the floor. None of the magazines were spray washed. Washdown wastewater from decontamination activities was discharged onto the ground surface outside the buildings (USATHAMA 1991).

According to the May 2005 USACE *Technical Memorandum – Final Hanley Area Phase I Remedial Investigation* (USACE 2005), Buildings 218A, 218B, and 218C were demolished by the 89th RRC in the summer of 2004. Building 219B was demolished in 2005.

As described in the June 2007 USACE *Final Supplemental Soil and Groundwater Phase II Remedial Investigation Technical Memorandum* (USACE 2007), Building 220 was demolished in March 2007. According to the 2007 SCS Engineers *Building 220, Guard House, and Harboad Street Bridge Demolition and Site Restoration Report* (SCS 2007), 54 loads of clean fill were brought in to fill the void at former Building 220, and finish grading was completed to match the surrounding topography.

2.2.4 Summary of Enforcement Actions

No enforcement actions have been taken at the former Hanley Area to date.

2.3 Community Participation

In April 2004, the U.S. Army began community involvement efforts for environmental activities at the former Hanley Area, and the administrative record file was established at the St. Louis Central Public Library (the administrative record file was subsequently moved to the Julia Davis Branch Library, located at 4415 Natural Bridge, St. Louis, Missouri 63115, in 2010). A notice announcing the availability of the file and points of contact for the USAEC and USACE–Kansas City District was published in the *St. Louis Post-Dispatch* and *St. Louis American* in January 2005.

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

On March 28, 2008, the U.S. Army mailed questionnaires to seven community members. The affected community is defined as the five homes immediately across Stratford Avenue from the site and the first two homes along Goodfellow Boulevard immediately north of the site.

The U.S. Army has coordinated community involvement/input with Ward 22 Alderman Jeffrey Boyd, who represents the neighborhood and Job Corps training center.

The notice of availability of the Proposed Plan and date of the public meeting was published on November 25, 2010, in *The St. Louis American* and on November 26, 2010, in the *St. Louis Post-Dispatch*. The public comment period extended from November 29 through December 29, 2010. The public meeting was held on December 13, 2010, at the Julia Davis Branch Library in St. Louis, Missouri. Information regarding the site and the remedy was available at the public meeting, and representatives from the U.S. Army were present to answer questions from the public. MDNR distributed general environmental information for the State of Missouri. A transcript of the meeting is available in the Administrative Record. Responses to substantive comments received at the meeting and during the comment period are provided in the Responsiveness Summary in Section 3.

The Proposed Plan and other supporting site documents, including the RI, FS, and other investigation reports, are available in the administrative record file at Julia Davis Branch Library in St. Louis, Missouri.

2.4 Scope and Role of Response Action

The FS identified remedial alternatives and evaluated them to select a preferred remedy for the former Hanley Area. In consultation with MDNR, the U.S. Army has divided the remedy at the former Hanley Area into two operable units:

- OU-1: Actions Addressing Contaminated Soil, Powder Well Sediment, and Groundwater Concerns
- OU-2: Vapor Intrusion Pathway

As defined in the NCP §§ 300.5, *operable unit* means 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 a 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.

The selected remedy presented in this DD will be the final response action for OU-1.

The response action for OU-1 addresses soil and groundwater impacted by releases of materials that occurred at the former Hanley Area. The releases have resulted in several localized areas of surface soil contamination across the former Hanley Area and plumes of contaminated groundwater in the northern part of the site that have migrated offsite under Stratford Avenue.

Areas of surface soil contamination will be excavated and properly disposed of offsite to prevent future human exposures to these contaminants. Although powder well sediment was not evaluated in a human health risk assessment (HHRA) in the RI, it will be removed and disposed of offsite to prevent future human exposure to the material.

Potential construction worker exposures to groundwater will be addressed by a combination of in situ groundwater treatment using chemical processes and soil mixing, groundwater monitoring, and land use controls.

Although not part of the response action, City of St. Louis Ordinance 66777 provides protection to future onsite residents and current offsite residents from groundwater as a potable water supply. On August 1, 2005, the City of St. Louis approved Ordinance 66777. The ordinance prohibits the use or attempted use of groundwater as a potable water supply and the drilling or installation of wells for a potable water supply within the corporate limits of the City of St. Louis. Further, the ordinance authorizes the Mayor of the City of St. Louis to enter into a Memorandum of Understanding (MOU) with MDNR. The MOU was signed on October 25, 2006. It specifies the City of St. Louis's and MDNR's responsibilities in satisfying the ordinance requirements. Under the MOU, the City's responsibilities include the following:

- The City will notify MDNR of proposed changes to Ordinance 66777 or requests for variance at least 30 days before the date that the local government is scheduled to take action on the proposed change or request.
- The City will enforce the ordinance and notify MDNR when the ordinance is violated.

The City will allow MDNR access to information necessary to monitor adherence to the terms of the MOU or the ordinance. The U.S. Army will confirm that the ordinance remains in place during annual inspections that the U.S. Army will perform as part of LUC monitoring. In the unlikely event that City Ordinance 66777 is repealed, the U.S. Army will issue a letter explaining the changes in the ordinance and warning residents against installing a potable water supply well in or near an area of groundwater contamination. The letter will provide a point of contact at the U.S. Army for further information while an alternative measure to protect against residential groundwater consumption is developed.

2.5 Site Characteristics

The former Hanley Area is 14.68 acres in size and consists of a relatively flat terrace, which slopes steeply down to Goodfellow Boulevard to the east and Stratford Avenue on the north. There is evidence of grading, with high points cut and low areas filled to generally level the site. Based on survey data collected at the site, the elevations of the site range from 532 to more than 558 feet above mean sea level. A significant elevation change (greater than 18 feet) occurs between the northern portion of the site and Stratford Avenue. Current site features are shown in Figure 2-2.

As discussed in Section 2.2.1, most of the former buildings and bunkers at the former Hanley Area have been demolished, with the exception of Buildings 219A, 219D, 219G, and 236. According to the 88^{th} RSC, Buildings 219A, 219D, and 236 are used for storage only. Building 219G is occupied during business hours, and the site is completely fenced (partially with iron fencing, the balance with a 6-foot-tall chain-link fence).

The site contains former powder wells, underground rooms (former basements and bunkers), tunnels for service utilities, and a combined underground wastewater and stormwater collection system. The underground structures are still intact. The tunnels are located 10 to 12 feet below ground (USATHAMA 1991).

2.5.1 Geology and Hydrogeology

Overburden soils at the former Hanley Area consist primarily of lean clay. The soil lithology is relatively consistent across the site. Residuum exists from the ground surface up to 25 feet below ground. Residuum is derived from complete weathering of the parent bedrock, in this case, shale. Fill material including gravel, concrete rubble, brick debris, and sand, were also observed in the northern portion of the site as deep as 11 feet, likely the result of demolition of former Building 220, backfilling, and grading activities. Figure 2-3 shows the location of the geologic cross section depicted in Figure 2-4.

Discontinuous lenses of silt are present within the native lean clay. A fat clay layer with discontinuous lenses of lean clay exists beneath the lean clay, decreasing in thickness offsite to the north until pinching out near monitoring well MW-108 (Figure 2-4). Weathered shale with discontinuous lenses of silt and clay underlies the clay. The discontinuous lenses of silt and clay within the weathered shale are likely the result of differential weathering along bedding planes. The thickness of the weathered shale ranges from 6 to 12 feet in boreholes advanced to depths at which the competent bedrock was encountered (monitoring wells MW-116 and MW-117). Competent shale was encountered at monitoring well MW-116 at 34.0 feet below ground and at monitoring well MW-117 at 38.3 feet below ground. When the soil boring at monitoring well MW-117 was advanced, a coal layer roughly 6 inches thick was observed at 45 feet below ground.

Groundwater is present within more permeable silt and clay lenses that are locally discontinuous within the upper lean clay unit.

Saturated conditions were not observed within the weathered shale underlying the clay unit. Groundwater was encountered in a 6-inch saturated coal layer within the competent shale zone. Groundwater within the coal does not appear to be hydraulically connected to groundwater observed in the discontinuous silt and clay lenses. In June 2008, the groundwater level measured in MW-117, screened within competent shale, was roughly 8.5 feet lower than the groundwater level measured in MW-111, located 4 feet west of MW-117 and screened in the overburden clay.

As shown in Figure 2-5, groundwater generally flows from the south and west to the northeast. The depth to groundwater within the lean clay is less than 1 foot below ground at monitoring well MW-110 to more than 24 feet below ground upgradient of former Building 220.

2.5.2 Risk-Based Screening Levels

The first step in the nature and extent evaluation was to select conservative risk-based screening levels for the chemicals detected at the former Hanley Area. Screening levels are used both to identify chemicals that might pose a risk to human health or the environment and to provide concentrations to guide the delineation of the extent of contamination. The screening levels were developed for preliminary human health risk evaluations. The ecological risk assessment evaluated risk to the environment. The human health screening levels are based on the residential scenario. The risk-based screening levels used for this site are summarized below, and additional information on the screening levels is provided in the RI report (CH2M HILL 2009).

2.5.2.1 Soil

Soil screening levels were derived from the following sources:

- USEPA Region 6 medium-specific screening levels (MSSLs) for residential and industrial land use. MSSLs based on noncarcinogenic effects were adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ. The selection of residential or industrial land use MSSLs was based on sample depth, as described below.
- USEPA soil screening levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20. The DAF of 20 was selected as appropriate for the site based on the clay soil present, which results in a low hydraulic conductivity and slow infiltration rate. Other factors influencing the use of DAF 20 as appropriate are the thickness of the unsaturated zone (about 15 feet) and the size of the contaminant source areas (less than 30 acres) (USEPA 1996).
- Soil background values established during the Environmental Baseline Survey for the adjacent former St. Louis Army Ammunition Plant (SLAAP). The background study included the collection of 10 surface (0 to 0.5 foot below ground) soil samples at 2 municipal parks to establish regional background concentrations for metals and PAHs in the vicinity of SLAAP. Five surface soil samples were collected from Penrose Park, just

south of I-70 on both sides of North Kingshighway Boulevard, 1.3 miles southeast of SLAAP. Five surface soil samples were collected from Dwight Davis Park, located north of I-70 and east of Riverview Boulevard between Lillian and Theodore avenues, 0.4 mile east-northeast of SLAAP. During their review of the RI report, MDNR and USEPA expressed concerns over using SLAAP background concentrations as screening levels for the former Hanley Area. The concerns focused primarily on PAHs because the SLAAP background PAH levels exceeded PAH concentrations measured at the former Hanley Area. As discussed in Section 2.7.1.1, the use of the SLAAP background concentrations did not affect HHRA findings or RI conclusions.

From the sources cited above, screening levels were assigned as follows:

Soil between 0 and 10 feet below ground. The screening levels are the lower of (1) the USEPA MSSLs for residential land use (adjusted downward by a factor of 10 if based on noncarcinogenic effects) and (2) the USEPA SSLs for protection of migration to groundwater using a DAF of 20. Soil background values established for SLAAP were used in place of the MSSL or SSL when the background value was higher.

Soil greater than 10 feet below ground (to the depth of the site sewer lines). The screening levels were USEPA Region 6 MSSLs for industrial soil, since only utility workers may contact soil at this depth. Per the RI work plan (CH2M HILL 2008), the screening levels were to be used to discuss the nature and extent of site contaminants and to provide preliminary human health risk evaluations. However, during the August 27, 2008, meeting MDNR, USEPA Region 7, USACE, 89th RRC, MDHSS, and CH2M HILL agreed that utility worker exposure to deep soil (greater than 10 feet below ground) did not need to be quantified in the HHRA because of the infrequency of exposure (CH2M HILL 2009).

2.5.2.2 Groundwater

Groundwater screening levels are the lower of (1) the USEPA Region 6 MSSLs for tap water (adjusted downward for noncarcinogens by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ), and (2) the USEPA screening level for protection of indoor air based on a target risk of 1×10^{-6} (USEPA 2002). The screening levels provide a conservative evaluation of the potential risks associated with chemicals in groundwater. The screening levels are conservative because groundwater at the site is not used for potable purposes, and offsite residents do not use groundwater as a potable water supply. Effective August 1, 2005, St. Louis City Ordinance 66777 prohibits the installation of potable water supply wells.

2.5.3 Nature and Extent of Site Contaminants

Previous investigations performed at the former Hanley Area have sufficiently delineated the nature and extent of chemicals above screening levels for the purpose of developing a remedy for OU-1. The RI report (CH2M HILL 2009) presents a comprehensive understanding of site conditions and potential risk associated with site contaminants. The nature and extent of contamination is summarized in the following subsections.

2.5.3.1 Surface Soil

Contamination in surface soil (0 to 2 feet below ground) consists of metals, VOCs, PCBs, and PAHs. Surface soil analytical results from previous investigations are presented in Tables 2-1 through 2-14.

Metals

The following metals exceeded screening levels in one or more surface samples from the former Hanley Area:

- Aluminum
- Antimony
- Arsenic
- Chromium (total)
- Copper
- Iron
- Lead
- Manganese
- Selenium
- Silver
- Thallium
- Vanadium

As discussed in the RI report, aluminum, iron, manganese, and vanadium were determined to be naturally occurring and not attributable to site activities (CH2M HILL 2009). The conclusion is based on the relatively uniform distribution of the metals across the site (and offsite) and their concentrations falling within the range of published metal concentrations in Missouri soil (Tidball 1984).

Figure 2-6 presents the concentrations of the remaining metals (antimony, arsenic, chromium, copper, lead, selenium, silver, and thallium) that exceed their screening levels. The metals were delineated during previous investigations, with the exception of arsenic at the western property boundary adjoining Job Corps property. To fill that data gap, the U.S. Department of Labor collected six soil samples on the property in the area adjoining the elevated arsenic concentrations. On September 28, 2009, USEPA collected two split surface soil samples and analyzed them for metals. Arsenic concentrations of 7.4 and 7.2 mg/kg were measured in these samples.

The metals described in the RI as exceeding their respective screening levels and the locations of the exceedances are listed below.

Antimony. Antimony concentrations observed above the screening level at the former Hanley Area occur at the following locations:

- Within the bunker walls at Building 219B
- Outside the east bunker wall at Building 219J
- Outside the south bunker wall at Building 227B
- Near Building 227O, outside the south bunker wall at Building 228B
- Outside the north bunker wall at Building 228M

Arsenic. Arsenic concentrations observed above the screening level at the former Hanley Area occur at the following locations:

- West of the bunker wall at Building 219C
- Near and within the east bunker wall at Building 219C
- Within the bunker walls at Building 219B
- Near the north bunker walls at Buildings 227O and 228E
- Near the south bunker walls at Buildings 228A, 228B, and 228C
- Surrounding the north, south, and west sides of Building 236

The source of arsenic found in surface soil around the Building 219 bunker series is potentially attributed to previous site activities. Buildings 219E and 219F housed Hanley's lead azide reactor, and Buildings 219B, 219C, and 219J were used for open-air drying of explosives. During initial operations between 1941 and 1945, blended pyrotechnic chemicals were transferred to the Building 228 bunker series for final drying operations. Upon completion of the drying, the finished primers were moved to the Building 227 series for temporary storage.

Chromium. Elevated total chromium was isolated to one location near Building 227M.

Copper. Copper concentrations exceeding the screening level in surface soil appear confined to the north and west sides of Building 218A. The elevated copper concentrations are bounded laterally to the east and south.

Lead. Lead concentrations exceeding the screening level in surface soil occur at the following locations:

- South of Building 228Z along the southern site boundary of the former Hanley Area
- Within the confines of the bunker walls at Building 219F
- North of Building 218A, where subsequent composite sampling showed the lead in this area was of limited areal extent
- Within the confines of the bunker walls at Building 219 F, where subsequent samples showed the lead in this area was of limited areal extent
- North of Building 219 G, which was bound by samples to the south and east
- West of Building 218C, where subsequent samples showed the lead in this area was of limited areal extent
- East of Building 219J, where subsequent samples showed the lead in this area was of limited areal extent

The former source of lead in surface soil south of Building 228Z along the southern site boundary, north of Building 218A, within the confines of the bunker walls at Building 219F, near Building 220, north of Building 219G, west of Building 218C, east of Building 219J, and south of Building 228B is likely related to primer material containing lead azide that was used during previous site activities.

An elevated lead concentration was detected at historic soil boring SB-020 (near former Building 220 located on the north part of the site) in 2005. During the field investigation, effort was made to place surface soil sample boring HA-22 as close as possible to previous soil boring SB-020. According to the 2004 SCS Engineers *Building 220, Guard House, and Harboad Street Bridge Demolition and Site Restoration Report* (SCS 2007), 54 loads of clean fill were brought in to fill the void at former Building 220, and grading was completed to match the surrounding topography. Since SB-020 was collected immediately adjacent to the east wall of former Building 220, and, based on several pictures included in the Demolition and Site Restoration Report (SCS 2007), extensive reworking and regrading of the area is evident. The lead concentration was likely dispersed below the screening level, as observed in the surface soil sample collected during the RI at HA-22.

Selenium. Selenium concentrations that exceed the screening level in surface soil were observed south of Building 220 and downgradient to the northeast of Building 220, where subsequent samples showed the selenium concentration was of limited areal extent. Selenium concentrations in excess of the screening level in surface soil were observed south of Buildings 228Y and 228Z. Selenium concentrations exceeding the screening level are bounded laterally by samples with concentrations below the screening level near the southern site boundary.

Silver. Elevated silver was isolated to one location within the bunker walls of Building 219E.

Thallium. Thallium concentrations in excess of the screening level occur at the following locations:

- North, east, and west of Building 218A
- East of Building 218B
- East and south of Building 218C
- West and northeast of Building 220
- Within the bunker walls surrounding Buildings 219C, E, and H

Thallium exceeded the screening level in 13 samples, but it exceeded the unadjusted MSSL of 5.5 mg/kg at only three locations (SS-218-A-1, SS-218A-3, and SS-218B-2 in 2001). The highest thallium concentration was measured at SS-218A-1, at an estimated concentration of 8.64 mg/kg.

Volatile Organic Compounds

PCE and TCE exceeded screening levels in 3 of 11 surface soil samples in the northern part of the former Hanley Area, downgradient from the former Building 220 in 2007. VOCs exceeding screening levels are shown in Figure 2-7. PCE exceeded the screening level in SB-024, SB-027, and SB-028, with the highest PCE concentration at SB-028 (6,400 micrograms per kilogram [µg/kg]) observed in 2007. TCE exceeded the screening level in one sample (SB-028) observed in 2007.

Polycyclic Aromatic Hydrocarbons

The following PAHs exceeded screening levels in one or more samples collected from the former Hanley Area:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenz(a,h)anthracene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Pyrene

These PAHs exceeded screening levels in SB-020 (Figure 2-8) observed in 2005. Benzo(b)fluoranthene exceeded the screening level in SB-010 and CSS-009. During the 2008 field investigation, one surface soil sample (HA-22) was collected to assess PAH concentrations near SB-020. PAH concentrations in HA-22 fell below screening levels, suggesting that soil in the area was reworked after the original sample was collected in 2005, indicating that the elevated PAH concentrations in the area are isolated in occurrence. The former source of PAHs in surface soil east of former Building 220 located on the north part of the site is not known, but may be related to the proximity to the asphalt drive.

Polychlorinated Biphenyls

The PCB Aroclor 1260 exceeded its screening level (Figure 2-8), which corresponds to the Toxic Substances Control Act-defined acceptable level of 1 mg/kg. The exceeding concentrations are limited to an area near the southern boundary of the former Hanley Area. The contamination is associated with an historical release from a former transformer located near former Building 228C. Though the extent of the PCB impact is not defined laterally, the low mobility of PCBs suggests that the vertical extent is limited to roughly the upper 2 feet below ground.

2.5.3.2 Subsurface Soil

Subsurface soil samples (collected at depths of more than 2 feet below ground) have been collected during investigations performed in 1998, 2001, 2005, 2007, and 2008. Analytical results from subsurface soil samples are provided in Tables 2-5, Tables 2-7 through 2-12, and Table 2-15. Various metals and VOCs were measured at concentrations above screening levels in subsurface soil beneath the former Hanley Area. The metals in the subsurface were comparable to naturally occurring concentrations in Missouri soils (Tidball 1984); therefore, no further action is needed to address them. Subsurface VOC contamination in saturated soil is present around former Building 220 in the northern part of the site (Figure 2-9). VOC contaminant mass near former Building 220 is likely related to the migration of the constituents in groundwater. Dense nonaqueous phase liquid (DNAPL) was not observed during previous investigations. However, PCE observed in soil at the 2007 soil boring SB-023 (3,200,000 μg/kg) at 25 to 26 feet below ground (Figure 2-9) could indicate the presence of DNAPL above the weathered shale.

2.5.3.3 Groundwater

Metals

Groundwater samples were collected from monitoring wells MW-101 through MW-105 in 2001 and MW-101 through MW-106 in 2005 and 2007. Table 2-16 presents metal concentrations measured in the groundwater samples. Concentrations of aluminum, arsenic, cadmium, iron, lead, manganese, thallium, and vanadium in groundwater exceeded screening levels in one or more samples collected in 2001, 2005, and 2006. Aluminum, iron, manganese, and vanadium concentrations in soil are comparable to naturally occurring concentrations in Missouri soils (Tidball 1984). The presence of the metals in groundwater is likely naturally occurring in the subsurface.

Arsenic. Arsenic was detected slightly above the screening level at monitoring wells MW-101 and MW-103 in 2006. Monitoring well MW-101 is located more than 320 feet south (upgradient) of the southern site boundary of the former Hanley Area. Arsenic at monitoring well MW-101 does not appear to be related to surface soil contamination observed at the former Hanley Area, as groundwater flow is to the north and northeast. The arsenic concentration observed at upgradient monitoring well MW-101 is higher than the concentration observed at monitoring well MW-103. Therefore, it is not likely that arsenic in the groundwater at monitoring well MW-103 is related to previous site activities.

Cadmium. Cadmium was detected slightly above the screening level at monitoring well MW-104 in 2006, but it was not detected in this well in 2001 or 2005. The source of cadmium is unknown, as results of previous investigations at the former Hanley Area did not indicate cadmium in soil at concentrations above the screening level. Cadmium was included as part of the SLAAP background study (URS 2004), and results from the study indicate that cadmium concentrations in soil observed at the site are representative of background. Cadmium in soil likely contributes to the elevated concentration observed in groundwater at monitoring well MW-104.

Lead. Lead was detected slightly above the screening level at monitoring well MW-106 in 2006. Lead in soil may contribute to the elevated groundwater concentration observed at monitoring well MW-106. The nearby surface soil sample SB-020 was analyzed and exhibited a lead concentration of 983.3 mg/kg in 2005.

Thallium. Thallium was detected above the screening level at monitoring wells MW-101, MW-103, and MW-106 in 2006. Thallium was not detected in those wells during previous groundwater monitoring events. Thallium was found at its highest concentration in monitoring well MW-101, more than 320 feet south (upgradient) of the southern site boundary of the former Hanley Area. Because of its upgradient location, thallium in monitoring well MW-101 is not related to onsite surface soil concentrations of thallium. The onsite thallium concentrations measured in monitoring wells MW-103 and MW-106 are not near areas where thallium was found in surface soil at concentrations above the screening level. Thallium in groundwater at monitoring wells MW-103 and MW-106 is not likely related to previous site activities.

Volatile Organic Compounds

Groundwater samples from the former Hanley Area were collected from monitoring wells and analyzed for VOCs as described below:

- In 2005 and 2006, a groundwater sample was collected from MW-106.
- In 2007, groundwater samples were collected from MW-106 through MW-114.
- In 2008, groundwater samples were collected from MW-106 through MW-117.
- In 2010, groundwater samples were collected from MW-106 through MW-118.

Results from the sampling efforts revealed dissolved-phase groundwater contamination in the northern portion of the former Hanley area. The contamination consists of three distinct plumes comprising one or more of cVOCs. In addition, other VOCs were detected at concentrations above screening levels in isolated occurrences within and around the plumes. The results are presented in Table 2-17 and depicted in Figure 2-10.

Plume A. Contaminants in Plume A consist primarily of PCE, TCE, and *cis*-1,2-DCE. The sewer system downgradient and northeast of former Building 220 is suspected to be the primary source of Plume A. The presence of TCE and *cis*-1,2-DCE may be attributed to reductive dechlorination of PCE. There is no historical record of a single large spill, but sporadic discharge of small quantities of spent product is assumed to have occurred. Figure 2-10 illustrates the extent of the PCE and TCE at concentrations above the USEPA MCL of 5 micrograms per liter (µg/L) and *cis*-1,2-DCE above the MCL of 70 µg/L. The MCLs were used as the screening levels for contaminants in groundwater. The depth of contamination is just below ground to the weathered shale interface at roughly 26 to 28 feet below ground. During the RI, groundwater levels within Plume A ranged from 0.20 foot below ground at MW-110 to 4.76 feet below ground at monitoring well MW-109.

Remediation Evaluation Model for Chlorinated Solvents (REMChlor) Version 1.0[1] was used to model the fate and transport of TCE at Plume A. TCE in groundwater was modeled because TCE has a higher water solubility level than PCE. The model was developed by Clemson University's Departments of Geological Sciences and Environmental Engineering and reviewed by USEPA and the Center for Subsurface Modeling Support. REMChlor was selected because of its ability to predict remediation effectiveness for the former Hanley Area. Use of the model for prediction of absolute plume length dynamics over time is beyond the scope of this effort.

Based on the REMChlor model predictions of a 1959 release, the leading edge of Plume A is either already near its maximum extent or will be within the next 5 years, if left untreated. The model output suggests that the TCE plume may migrate towards Stratford Avenue until year 52, which is 2011, before the plume will begin to shrink because of destructive and/or nondestructive fate and transport processes. At year 52, the TCE will have migrated about 148 feet from monitoring well MW-111 (the assumed original source area used for modeling purposes).

To assess the uncertainty of when the release(s) occurred, a spill release date of 1941 and a release date of 1979 (the known period of industrial operations) were also modeled using REMChlor, in addition to the 1959 release date. The 1941 release scenario indicates that the plume footprint is possibly decreasing. The 1979 scenario suggests that the plume will continue to migrate for 70 years after the calibration year of 2008 before it begins to shrink. At its maximum extent in 2078, the plume will have migrated 279 feet, which is an additional 131 feet downgradient from the 2008 leading edge of the plume.

Plume B. Plume B, consisting of 1,2-DCA, is largely commingled with Plume A. The source of 1,2-DCA in soil and groundwater is likely attributable to laboratory and maintenance shop activities conducted at former Building 220. 1,2-DCA was used as a degreaser, paint remover, and as a constituent in scouring compounds (Agency for Toxic Substances and Disease Registry 2005). Spent product likely was discharged into the sewer inlets on the west and east sides of the concrete loading slab at the northeast corner of former Building 220. Based on the location of the 1,2-DCA in groundwater, leaks in the sewer system may have contributed to the vertical and lateral migration of the contaminant, but the leaks in the sewer system have not been clearly identified as the potential point of release. There is no known continuing source of 1,2-DCA. Figure 2-10 illustrates the extent of Plume B at concentrations above 5 μg/L, the MCL as measured during the 2008 RI. The depth of contamination is just below ground to the weathered shale interface at roughly 24 to 30 feet below ground. During the RI, groundwater levels within Plume B ranged from 0.20 foot below ground at MW-110 to 10.31 feet below ground at monitoring well MW-106.

During the 2010 predesign groundwater investigation, 1,2-DCA was found in MW-106 and MW-107 at concentrations exceeding screening levels. The exceeding concentration in MW-107 falls outside of the Plume B footprint shown in Figure 2-10. The U.S. Army will further assess groundwater conditions in this area north of the site under OU-2: Vapor Intrusion.

As noted in the RI, modeling was not conducted for the 1,2-DCA plume because a contaminant source was not evident based on available information.

[1] http://www.epa.gov/ada/csmos/models/remchlor.html

Plume C. Plume C, southwest of former Building 220, consists of commingled CT, chloroform, and TCE. The source of Plume C is unknown. CT and TCE appear to be the original constituents of the plume, with chloroform present as a breakdown product of carbon tetrachloride. The extent of the plume is small and has been delineated in the downgradient direction. Figure 2-10 illustrates the extent of the CT and TCE at concentrations above 5 µg/L, the MCL for drinking water. The depth of contamination is more than 10 feet below ground to the weathered shale interface at roughly 34 feet below ground. During the 2010 groundwater predesign investigation, groundwater was encountered at a depth greater than 23 feet below ground at monitoring well MW-118.

Modeling was not conducted for the CT plume because of the small and isolated plume footprint; however, some migration would be expected. The CT plume is bounded by sampling locations where CT was not detected, suggesting that the CT is relatively immobile and may be entrapped within finer-grained subsurface materials. Another possible explanation for the limited extent of CT is that it was released more recently than the contaminants observed in Plumes A and B. CT is comingled with TCE in Plume C. The TCE does not appear to have degraded anaerobically, as indicated by the lack of daughter products such as *cis*-1,2-DCE.

2.5.3.4 Vapor Intrusion

Vapor intrusion will be addressed in OU-2.

2.5.3.5 Powder Well Sediment

In 2001, 22 powder wells were located across the former Hanley Area. Eighteen of the wells contained sediment with various metal concentrations exceeding conservative risk-based screening levels defined in the RI Report (CH2M HILL 2009). Explosives in powder well samples were not detected at concentrations above the screening levels.

The sediment within the powder wells, though characterized, was not evaluated in the HHRA because it will be removed as part of a remedial action. The powder well locations are shown in Figure 1-2, and analytical results are provided in Table 2-18.

2.5.4 Conceptual Site Model

A conceptual site model for the former Hanley Area is shown in Figure 2-11. The following pathways for current and future receptors were considered in developing the conceptual site model and in preparing the HHRA. Reasonable exposure scenarios were developed based on how the former Hanley Area is currently used and assumptions about its future use.

- Under current site use, onsite indoor industrial workers and offsite residents (on the Job Corps property) could be exposed to chemicals in surface soil (0 to 2 feet below ground) through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil and dust.
- Under current site use, onsite industrial workers and offsite residents (along Stratford Avenue) could be exposed to chemicals through inhalation of volatile emissions that have migrated into indoor air by vapor intrusion. This pathway will be addressed in OU-2.

- In the future, trespassers may gain access to the site if the fence is not maintained and the site is not developed. Trespassers could be exposed to chemicals in surface soil through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil and dust.
- Under future residential land use, onsite residents could be exposed to chemicals through inhalation of volatile emissions that have migrated into indoor air by vapor intrusion. This pathway will be addressed in OU-2.
- In the future, construction workers might excavate soil (0 to 10 feet below ground) for utility installation, maintenance activities, basement construction, or other purposes, bringing them into contact with chemicals in soil. Construction worker exposures to chemicals in soil could occur through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact pathways.
- Under a future residential land use scenario, onsite and offsite residents (on the Job Corps property) could be exposed to chemicals in soil from 0 to 10 feet below ground that is brought to the surface during site redevelopment. Potential exposure could occur through incidental ingestion, inhalation of volatile emissions and dust in ambient air, and dermal contact with soil/dust.
- Under current and future land use, hypothetical potable use of groundwater was evaluated at the request of MDNR and MDHSS even though the current and future exposure pathways for potable groundwater are incomplete. The exposure pathways are incomplete because of insufficient yield in the contaminated zone, as discussed in Appendix A, and because of City Ordinance 66777, which prohibits the installation of potable water supply wells. The hypothetical exposure scenarios for onsite and offsite residential use of potable groundwater are ingestion, dermal, and inhalation exposures to chemicals in bathroom air from volatilization of tap water during showering.
- Under future land use, construction workers excavating soil immediately downgradient of former Building 220 may encounter groundwater that has seeped into the excavation and chemicals could volatilize directly from groundwater into ambient air within the excavation. Potential exposure scenarios could occur through dermal contact with groundwater and inhalation of VOCs in ambient air from groundwater in excavations.
- In the future, construction workers may encounter offsite groundwater along Stratford Avenue. Potential exposure scenarios are dermal contact with groundwater and inhalation of VOCs in ambient air from groundwater in excavations.
- Sewer lines are present about 20 feet below ground in some areas of the site. Maintenance or repairs have not been needed for more than 30 years, but under future land use, utility workers may need to repair the lines from time to time. Future maintenance or repairs would be conducted over a few days' duration only.

2.6 Current and Potential Future Site and Resource Uses

The former Hanley Area consists of 14.68 acres and is used for industrial purposes. Onsite buildings and bunkers have been demolished, with the exception of Buildings 219A, 219D, 219G, and 236. According to the 88th RSC, only Building 219G is occupied. Buildings 236, 219A, and 219D are used for storage only. Building 219G is occupied during business hours and the site is completely fenced in (partially with iron fencing and the remaining with a 6-foot-tall chain-link fence).

The site is bordered by the Job Corps facility on the west and residential areas to the north, west, and southwest. The area to the east was formerly part of the St. Louis Ordnance Plant and is now owned by the General Service Administration. The 89th RRC owned the former Hanley Area until the 89th RRC was disestablished in June 2009. The 88th RSC now owns the site and occupies the Sverdrup U.S. Army Reserve Center south of the site. According to the City of St. Louis Zoning Department and Assessor's Office, the St. Louis Ordnance Plant encompasses 125 acres and includes the Job Corps property to the west of the former Hanley Area and Plant No. 2, and the property east of Goodfellow Boulevard (Plant No. 1). The entire site, as described by the City of St. Louis Zoning Department, is zoned industrial, commercial, and residential.

In 2005, the St. Louis Planning Commission adopted a strategic land use plan for the City of St. Louis. The plan provides a roadmap for future development. It identifies established neighborhoods, historic districts, and business areas that the City intends to maintain and enhance. It also identifies areas where future development and land use changes are encouraged. The St. Louis Strategic Land Use Plan identifies the former Hanley Area as a "business and industrial development area." Neighboring parcels to the south and east are similarly designated. Residential properties to the north of the former Hanley Area, across Stratford Avenue, are designated as a "neighborhood preservation area." Parcels north of the former Hanley Area that lie along Goodfellow Boulevard are designated as a "neighborhood commercial area" (St. Louis Planning and Urban Design Agency 2009). Although the General Services Administration and 88th RSC do not have immediate plans for developing the property, the City of St. Louis has expressed interest in obtaining and redeveloping the former Hanley Area in the future.

City-supplied drinking water is provided to residents and industries in the area. The city draws water from the Mississippi River from intakes upstream of the site. At its closest point, the Mississippi River is located about 3 miles from the site.

2.7 Summary of Site Risks

2.7.1 Summary of Human Health Risk Assessment

The U.S. Army completed a HHRA during the RI for the former Hanley Area (CH2M HILL 2009). The HHRA estimated the risks that contamination could pose to human health and the environment. The risk assessment also identified the contaminants and exposure pathways that need to be addressed by the remedial action.

Some samples available for the site were not used in the HHRA since it had already been agreed by MDNR and USEPA that the locations where the samples were collected will be addressed through a removal action. During a teleconference on September 2, 2008, representatives from MDNR, MDHSS, USEPA, and USACE agreed that certain areas of soil with elevated arsenic and lead concentrations would be excavated and therefore excluded from the HHRA. Those areas will be addressed through a soil removal action during remedy implementation. The surface soil samples and chemicals identified for removal are:

- Sample NS03A arsenic at 44 mg/kg; lead at 5,840 mg/kg
- Sample NS08A arsenic at 67.7 mg/kg
- Sample SS-218A-2 lead at 2,724 mg/kg
- Sample SS-219B arsenic at 108 mg/kg
- Sample SS-219C arsenic at 68.8 mg/kg

As with arsenic and lead, PCBs were excluded from the HHRA because the upcoming soil removal action will address the concentrations below.

- Sample SS-001 Aroclor 1260 at 1.44 mg/kg
- Sample SED-001 Aroclor 1260 at 569 mg/kg
- Sample SS55A Aroclor 1260 at 18,200 mg/kg

The powder wells, though adequately characterized, were evaluated in the RI. However, the powder wells were not evaluated in the HHRA because the sediment will be removed and the wells backfilled as part of a remedial action.

2.7.1.1 Selection of Chemicals of Potential Concern

Chemicals of potential concern (COPCs) are chemicals that may provide significant contributions to potential overall site risks and are potentially associated with site contamination. To identify COPCs, data from the former Hanley Area were grouped into exposure units. COPCs were identified by comparing the maximum concentration of each chemical in each exposure unit (described later in this section) against the corresponding screening level presented in the RI report (CH2M HILL 2009). Chemicals in each exposure unit with at least one concentration above the screening level were identified as COPCs.

It is noted that the RI work plan (CH2M HILL 2008) called for COPC screening in the HHRA without eliminating chemicals within background concentrations, followed by an evaluation of the risk attributable to background. The RI report followed a different sequence, performing the initial risk screening and eliminating chemicals within background levels, and then calculating the additional risk associated with chemicals within background concentrations. Although the sequence of the HHRA was performed out of order from that presented in the RI work plan, the HHRA conclusions presented in the RI report and summarized in Section 2.7.1.5 are unaffected by the sequence that was followed, because the risk attributable to the site and the risk attributable to background are the same under each sequence.

The COPCs for each exposure unit and their summary statistics (range of detected concentrations and frequency of detection) are presented in the RI report (CH2M HILL 2009). Exposure units are defined below.

Soil

To identify soil COPCs and assess potential risk, the site was divided into the following soil exposure units:

- **Onsite Surface Soil (Sitewide)—**Surface soil samples (collected from 0 to 2 feet below ground) were used for the evaluation of a current industrial worker scenario.

- **Onsite Subsurface Soil (Sitewide)—**Subsurface soil samples (collected from 0 to 10 feet below ground) were used for the evaluation of a future construction worker scenario.
- **Onsite Subsurface Soil (Exposure Units A through L)—**To evaluate residential exposure to onsite subsurface soil, the HHRA calculated risk estimates for 12 hypothetical exposure units (A through L), each roughly the size of a 1-acre residential lot, to address concerns regarding exposure concentration dilution. Figure 2-12 depicts the exposure units. For HHRA purposes, soil from the 0- to-10-foot depth range was evaluated for potential residential exposure, since in the future, soil greater than 2 feet in depth could be brought to the surface during redevelopment.

Groundwater

The site was divided into the following four groundwater exposure units:

- **Onsite Groundwater (Area Downgradient of Former Building 220)**
  - **Tap water and Indoor Air—**Onsite and offsite groundwater samples in the area downgradient of former Building 220 were used for the evaluation of a future residential scenario assuming hypothetical potable use of groundwater and vapor intrusion into indoor air.
  - **Groundwater in Excavations—**Onsite groundwater samples in the area downgradient of former Building 220 were used in evaluating a future construction worker scenario assuming that shallow groundwater seeps into an excavation where workers are present.
- **Onsite Groundwater (Sitewide Excluding Area Downgradient of Former Building 220)—**Onsite groundwater samples collected sitewide (excluding the area downgradient of former Building 220) were used to evaluate a future residential scenario (hypothetical potable groundwater use).
- **Onsite Groundwater (Within 100 feet of Building 219G)—**Groundwater sampled within 100 feet of Building 219G was used to evaluate the potential current indoor air pathway for industrial workers. A groundwater sample collected from MW-104 in 2006 was used for this evaluation. No volatile chemicals were detected in the groundwater sample, so the indoor air pathway for current industrial workers (who are only present at Building 219G) is not a concern.
- **Offsite Groundwater—**Offsite groundwater samples were used in evaluating future residential (hypothetical potable groundwater use) and construction worker (groundwater in an excavation) scenarios.

2.7.1.2 Exposure Assessment

The object of the exposure assessment was to estimate the type and magnitude of exposures to the COPCs present at or migrating from the site. The results of the exposure assessment are combined with chemical-specific toxicity information to characterize potential risks.

The exposure assessment process has three steps:

1. Characterize the exposure setting.
2. Identify potential exposure pathways.

3. Quantify potential exposures.

Each of the steps is documented in Section 7.3, Exposure Assessment, of the RI report (CH2M HILL 2009).

Potential exposure pathways and receptors are summarized in the conceptual site model presented in Figure 2-11 and discussed in Section 2.5.4. Each of the exposure pathways presented in Section 2.5.4 were quantitatively addressed in the HHRA, with the following exceptions:

- **Soil and Groundwater Exposures in Deep Excavations—**Sewer lines are present about 20 feet below ground in some areas of the site. Maintenance or repairs have not been needed for more than 30 years, but utility workers may need to repair the lines from time to time. Future maintenance or repairs would be conducted over a few days' duration only, so exposures are not expected to be significant and were not quantified.
- **Soil Exposures by Future Trespassers—**In the future, trespassers may gain access to the site if the fence is not maintained and the site is not developed. Potential exposures to trespassers were not quantified because the soil risk estimates quantified for a current industrial worker can be used to conservatively represent potential risks to trespassers, since industrial workers are exposed at a greater frequency and duration.

2.7.1.3 Toxicity Assessment

The toxicity assessment describes the relationship between magnitude of exposure to a chemical and adverse health effects. It provides, where possible, a numerical estimate of the increased likelihood and severity of adverse effects associated with chemical exposure (USEPA 1989).

For the purpose of toxicity assessment, COPCs can be classified into two broad categories: carcinogens and noncarcinogens. The classifications are used because health risks are calculated differently for carcinogenic and noncarcinogenic effects. USEPA develops separate toxicity values for carcinogenic and noncarcinogenic effects, representing the potential magnitude of adverse health effects associated with exposure to chemicals. Toxicity studies with laboratory animals or epidemiological studies of human populations provide the data used to develop toxicity values. The values represent allowable levels of exposure based upon the results of toxicity studies or epidemiological studies. The toxicity values are combined with the exposure estimates to develop numerical estimates of carcinogenic and noncarcinogenic health risks in the risk characterization process.

The following hierarchy (USEPA 2003) was used to obtain toxicity values (oral cancer slope factors, inhalation unit risk factors, oral reference doses, and inhalation reference concentrations) for COPCs:

- **Tier 1 Source, the Integrated Risk Information System** prepared and maintained by USEPA. The Integrated Risk Information System contains toxicity data and USEPA regulatory information on specific chemicals.
- **Tier 2 Source, Provisional Peer-Reviewed Toxicity Values,** a database of provisional toxicity values prepared and maintained by USEPA.

- **Tier 3 Sources:**
  - California Environmental Protection Agency toxicity database
  - USEPA's Health Effects Assessment Summary Tables
  - Minimal Risk Levels identified by the Agency for Toxic Substances and Disease Registry

The toxicity values used in the HHRA are provided in the RI report (CH2M HILL 2009).

2.7.1.4 Risk Characterization

Table 2-19 summarizes the cumulative excess lifetime cancer risk (ELCR) and screening hazard index (HI) for each receptor. The ELCR is a measure of risk of adverse health effects associated with the exposure to cause cancer. An individual ELCR of 1×10^{-5} is an upper-bound estimate of the probability that one additional case of cancer will occur in 100,000 people over a 70-year lifetime as a result of individual exposure to the chemical. *Excess* means risk beyond that from other causes (American Cancer Society statistics show the probability of risk from other causes—that is, background risk—to be as high as one in three). The HI is a measure of the risk of adverse health effects associated with noncancer effects. An HI of 1.0 or less is considered unlikely to cause noncancer adverse effects.

2.7.1.5 Identification of Chemicals of Concern

Table 2-19 lists COCs contributing significantly to the risk estimate in the environmental medium causing the target level exceedance) for receptors with risk estimates exceeding risk thresholds or triggers (1×10^{-4} ELCR or a target organ-specific HI of 1.0). For the environmental medium driving the risk estimates, COPCs with an individual ELCR greater than 1×10^{-5} or with an individual HI greater than 0.1 contributing to a target organ HI greater than 1.0 were identified as COCs.

The following exposure scenarios exceed risk triggers, with risk estimates driven by the indicated exposure pathways:

- Hypothetical future potable use of offsite groundwater by ingestion, dermal contact, and inhalation exposures by residents based on groundwater quality in monitoring wells installed in and along the right-of-way on Stratford Avenue

- Future exposure of onsite residents (incidental ingestion) to soil at Exposure Units E, I, J, and K (Figure 2-12)

- Future exposure of onsite construction workers to groundwater (in excavations in the area downgradient of former Building 220) by dermal contact

- Hypothetical future potable use of onsite groundwater by ingestion, dermal contact, and inhalation exposures by residents

The following COCs were identified at the former Hanley Area:

- Onsite Surface Soil (Sitewide): Current Industrial Workers—None
- Onsite Subsurface Soil (Sitewide): Future Construction Workers—None
- Onsite Subsurface Soil (Exposure Units A through L; Figure 2-12): Future Residents—
  - Exposure Unit A—None
  - Exposure Unit B—None

- Exposure Unit C—None
- Exposure Unit D—None
- Exposure Unit E—Antimony and thallium
- Exposure Unit F—None
- Exposure Unit G—None
- Exposure Unit H—None
- Exposure Unit I—Thallium
- Exposure Unit J—Thallium
- Exposure Unit K—Thallium
- Exposure Unit L—None

- Groundwater (Area Downgradient of Former Building 220)
  - Hypothetical Potable Use (Future Residents)—1,1,1,2-tetrachloroethane (TeCA), 1,1,2,2-tetrachloroethene, 1,1,2-trichloroethane, 1,2-DCA, benzene, CT, chloroform, *cis*-1,2-DCE, manganese, naphthalene, PCE, *trans*-1,2-DCE, and TCE
  - Groundwater in Excavations (Future Construction Workers)—CT and PCE
- Onsite Groundwater (Sitewide Excluding Area Downgradient of Building 220)
  - Hypothetical Potable Use (Future Residents)—1,2-DCA and CT
- Offsite Groundwater (Along Stratford Avenue)
  - Future Construction Worker Exposures—None
- Offsite Groundwater (Along Stratford Avenue)
  - Hypothetical Potable Use (Future Residents)—Chloroform, 1,2-DCA, manganese, PCE, and TCE—The risk estimates for this scenario are driven by the elevated concentrations detected in MW-110, situated in the middle of Stratford Avenue

VOCs are present in site groundwater in an area downgradient of former Building 220.

The following exposure scenarios did not exceed risk triggers during the RI:

- Current surface soil exposures by industrial workers and offsite residents on the Job Corps property
- Future subsurface soil exposures by construction workers
- Future subsurface soil exposures by residents at Exposure Units A, B, C, D, F, G, H, and L (Figure 2-12)
- Future offsite groundwater exposures (in excavations) by construction workers along Stratford Avenue

An assumption was made that the concentrations of chemicals in the media evaluated remain constant over time. The assumption could over- or under-estimate risk, depending on the degree of chemical degradation or transport to other media. For instance, if the VOC plume expands in the future, groundwater or indoor air concentrations at offsite residences could increase, in which case future risk presented in the HHRA may be underestimated for offsite residents.

2.7.2 Ecological Risk Assessment

Potential risks to terrestrial plants and soil invertebrates are indicated for direct exposure to chromium, lead, manganese, selenium, thallium, vanadium, and zinc. When interpreting the results for chromium and vanadium, it is important to note that the screening value for chromium is very conservative, and that the screening value for vanadium is based on other exposure routes. Ecological soil screening levels (Eco-SSLs; USEPA 2008) for terrestrial plants and soil invertebrates could not be derived for chromium and vanadium because too few studies have been conducted, but the effect levels listed in the Eco-SSL studies were much higher than the screening values used in the ecological risk assessment and generally higher than the average concentrations at the site. Although site-specific background data are unavailable, Missouri data used in the calculation of background levels in the Eco-SSLs for chromium and vanadium (averages of 50 mg/kg and 72.4 mg/kg, respectively) are higher than the average concentrations at the site.

Selenium concentrations exceeded the Eco-SSL for plants, but selenium is not expected to pose risk to terrestrial plants because the Eco-SSL was only slightly exceeded. The Eco-SSL is based primarily on toxicity to agricultural crops, which are more sensitive to selenium than other terrestrial plants. Furthermore, the soils at the site are expected to be slightly acidic and less oxidized, and, although not measured, more bioavailable forms of selenium, such as selenate (4+) and selenide (6+) are not expected to be the dominant forms of selenium present at the site. As with chromium and vanadium, selenium levels at the site appear similar to the background levels in the United States. Average concentrations of lead, manganese, and zinc exceeded Eco-SSLs only slightly, with Hazard Quotients of 1.2, 3.1, and 1.4, respectively.

Available habitat is limited to enclosed and maintained grassy areas. Although plant and invertebrate receptors are present at the site, the habitat does not represent a natural ecosystem, as it is controlled by human activity. The potential for adverse effects to terrestrial plants and soil invertebrates exists, but the nature of the habitat in the regularly disturbed area is likely to limit the diversity and abundance of terrestrial plants and soil invertebrates and the overall potential for adverse effects to receptor communities. The conditions suggest that risks are negligible, and no further investigation is warranted.

2.7.3 Basis for Action

The response action selected in this DD is necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from this site that may present an imminent and substantial endangerment to public health or welfare.

2.8 Remedial Action Objectives

RAOs are goals specific to media or operable units for protecting human health and the environment. They specify the COCs, media of interest, and exposure pathways. Typically, RAOs are developed based on the exposure pathways found to pose potentially unacceptable risks according to the results of the HHRA and ecological risk assessment and to satisfy ARARs.

RAOs were developed for the former Hanley Area in part based on the contaminant levels and exposure pathways found to pose potentially unacceptable risk to human health, as determined during the RI, with the exception of the vapor intrusion pathway, which will be addressed under OU-2. The RAOs, remediation goals, and remediation strategies developed address constituents posing unacceptable risk under the exposure scenarios evaluated during the RI.

COC concentrations in various environmental media at the site pose unacceptable risks to human health based on the various exposure pathways. Therefore, the following RAOs were developed for the site:

- Prevent unacceptable risk to residents from ingestion of onsite soil containing antimony and thallium within Exposure Units E, I, J, and K.
- Prevent unacceptable risk to onsite construction workers from dermal contact with groundwater containing CT and PCE.
- Remove soil to prevent future human exposure to onsite soil with elevated concentrations of arsenic, lead, and Aroclor 1260 at the following historical sample locations:
  - Sample NS03A arsenic at 44 mg/kg; lead at 5,840 mg/kg
  - Sample NS08A arsenic at 67.7 mg/kg
  - Sample SS-001 Aroclor 1260 at 1.4 mg/kg
  - Sample SED-001 Aroclor 1260 at 569 mg/kg
  - Sample SS-218A-2 lead at 2,724 mg/kg
  - Sample SS-219B arsenic at 108 mg/kg
  - Sample SS-219C arsenic at 68.8 mg/kg
  - Sample SS55A Aroclor 1260 at 18,200 mg/kg
- Remove the sediment within onsite powder wells to prevent future human exposures.

PRGs developed in the feasibility study (CH2M HILL 2010) are risk-based or applicable or relevant and appropriate requirement-based chemical-specific concentrations that help refine the RAOs and define the extent of contaminated media requiring remedial action. The following soil PRGs were selected as remediation goals for the selected remedy:

- Thallium 7 mg/kg
- Antimony 31 mg/kg
- Lead 400 mg/kg
- Arsenic 13.2 mg/kg
- Aroclor 1260 1 mg/kg

Groundwater PRGs developed during the feasibility were chosen as remediation goals for the selected remedy. The remediation goals to prevent unacceptable risk to onsite construction workers for dermal contact with COCs in groundwater consist of the following:

- CT: 3,200 μg/L
- PCE: 21,000 μg/L

As stated in Section 2.7.1.2, groundwater COCs were identified for the potable use exposure pathway. However, St. Louis Ordinance 66777, which prohibits the installation of potable water supply wells, is already in place as an institutional control and removes the exposure pathway for onsite and offsite receptors to use the groundwater as a potable resource. For this reason, a RAO associated with the potable use exposure pathway was not necessary. In the unlikely event that the City Ordinance 66777 is repealed, the U.S. Army and MDNR will evaluate alternative measures to protect current and future residents from consuming groundwater as a potable drinking water source.

2.9 Description of Alternatives

The FS report (CH2M HILL 2010) developed remedial alternatives for the former Hanley Area using the following process:

1. Develop RAOs based on risk assessment findings and ARARs (Section 2.8).
2. Evaluate PRGs based on regulatory requirements, standards, and guidance to meet the site-specific RAOs. The following PRGs were developed in the FS:
   - Soil PRGs were developed to prevent unacceptable risk to residents from ingestion of onsite soil containing thallium and antimony within Exposure Units E, I, J, and K and to prevent unacceptable risk to human receptors to onsite soil containing elevated concentrations of arsenic, lead, and Aroclor 1260.
   - Groundwater PRGs were developed to prevent unacceptable risk to onsite construction workers for dermal contact with CT and PCE.
3. TTZs were defined for the areas of where soil and groundwater concentrations exceed the PRGs.
4. Develop remedial alternatives by considering general response actions: media-specific actions that satisfy RAOs. Actions for mitigating risk posed by affected media may be applied individually or in combination. General response actions for unsaturated surface soil and sediment were not developed because the lead agency (U.S. Army) and lead regulatory agency (MDNR) agreed to address COCs in soil by removal and offsite disposal. Since removal and disposal activities are being conducted for metals and Aroclor 1260 within and near the areas with thallium concentrations above the PRGs, removal and disposal is the recommended remedial action to address thallium in soil. General response actions identified for groundwater consisted of no action, institutional controls, monitoring, containment, in situ treatment, collection and ex situ treatment, removal, disposal, and discharge.
5. Within each remaining general response action, remedial technologies were identified and screened using the following criteria:
   - **Effectiveness** is the ability of the technology or process option to perform adequately to achieve the remedial objectives alone or as part of an overall system.
   - **Implementability** refers to the relative degree of difficulty expected in implementing a particular measure under practical technical, regulatory, and schedule constraints.

- **Relative cost** is comparative only and is judged similarly to effectiveness. It is used to preclude further evaluation of process options that are very costly when there are other choices that perform similar functions with comparable effectiveness. It includes construction and long-term O&M costs.

  Technologies and process options were screened based on professional experience, published sources, and other relevant documentation. Details regarding the screening of technologies and process options are provided in the FS report (CH2M HILL 2010). The technologies retained following screening consisted of no action, monitoring, in situ treatment, removal, and disposal.

The technologies that remained following screening were assembled into remedial alternatives that meet the RAOs for the site. The following remedial alternatives were evaluated:

- Alternative 1—No Action
- Alternative 2—In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal, and Offsite Disposal
- Alternative 3—In Situ Groundwater Treatment using Chemical Processes and Soil Mixing, Soil and Powder Well Sediment Removal, and Offsite Disposal
- Alternative 4—Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal, and Offsite Disposal

The major components of the remedial alternatives identified are defined in the following subsections.

2.9.1 Alternative 1—No Action

Alternative 1 consists of taking no action. The NCP requires that a No-Action Alternative be retained throughout the FS process as a baseline for comparison to the other approaches. No action would leave affected soil, groundwater, and powder well sediment in place at the site. No mechanisms would be in place to prevent or control exposure to contaminants. Alternative 1 allows natural processes such as dispersion, degradation, and dilution to reduce contaminants. Lack of active cleanup or controls may allow receptors to be exposed to contaminants. There are no capital or O&M costs for the Alternative 1. Therefore, a cost estimate was not necessary.

2.9.2 Common Elements among Alternatives 2, 3, and 4

Common elements among Alternatives 2, 3, and 4 include the following:

- Soil and powder well sediment removal and offsite disposal
- Plume C monitoring
- LUCs
- Five-year reviews

Alternatives 2, 3, and 4 all include removal and offsite disposal of surface soil contaminated with metals and Aroclor 1260 to address soil TTZs (shown as soil removal areas in Figure 2-13), powder well sediment removal, and LUCs. Five-year site reviews are included in each alternative as they are required for sites containing COC concentrations above respective remediation goals. The common elements are briefly summarized in the following subsections. They are discussed in greater detail in Section 2.12.

The common elements have been included as part of the remedy and cost estimates for each of the three alternatives. For cost estimating purposes, the estimated duration of Alternatives 2, 3, and 4 was chosen as 50 years. Although the actual monitoring period may be 100 years, cost estimating periods beyond 50 years have little effect on the present worth estimate.

2.9.2.1 Soil and Powder Well Sediment Removal and Offsite Disposal

This common element consists of excavating areas of surface soil contaminated with arsenic, lead, thallium, and Aroclor 1260, transporting it offsite, and disposing of it at a permitted landfill. Samples of the soil will be collected for disposal characterization. Before excavation, hand auger soil borings will be advanced to delineate the presence of COCs in soils around previous sample locations. Soil removal areas are shown on Figure 2-13. Note that samples obtained at many of the historic soil sample locations shown in Figure 2-13 were composite samples. Following excavation, each area will be backfilled, regraded, reseeded, and restored to its original condition. Clean, imported material will be used as backfill.

As part of the remedial action at the former Hanley Area, the 22 powder wells will be decommissioned. The sediment will be removed and disposed based on characterization sampling, and the wells will be filled with clean, imported soil to ground surface. The sediment will be disposed of offsite at a permitted landfill.

2.9.2.2 Plume C Monitoring

Groundwater monitoring will be performed within Plume C to confirm that the exposure pathway between construction workers and contaminated groundwater remains incomplete as long as concentrations of CT remain above the risk threshold for direct contact risk to construction workers.

2.9.2.3 Land Use Controls

LUCs will be established over the Plume C footprint as long as CT concentrations remain above the groundwater remediation goal. Figure 2-14 presents the LUC boundaries at the former Hanley Area. LUCs are discussed further in Section 2.12.2.4.

2.9.2.4 Five-Year Reviews

Five-year site reviews are a common element to be included as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. Five year reviews are discussed further in Section 2.12.2.5.

2.9.3 Alternative 2—In Situ Groundwater Treatment Using Thermal Technologies

Alternative 2 relies on in situ thermal technologies to decrease PCE concentrations within the Plume A TTZ (Figure 2-15), which corresponds to the area where groundwater concentrations exceed construction worker PRGs but does not extend into Stratford Avenue.

Thermal treatment processes work by increasing the temperature of the contaminated soil and groundwater through the introduction of steam or electrical energy. The primary in situ heating processes include steam-enhanced extraction, electrical resistance heating, and thermal conductive heating (TCH). At the site, TCH is considered the most robust technology because of the clayey hydrogeologic setting. Recent applications have shown that electrical resistance heating has not performed as well as TCH in clayey sites, since electrical resistance heating relies on saturated soil conditions in the treatment zone to conduct electrical current effectively. Therefore, TCH technology was used for cost estimating purposes.

Estimated Capital Cost:	$2,638,000
Estimated Annual O&M (Years 1 and 2):	$67,000
Estimated Annual O&M (After Year 2):	$36,000
Estimated Periodic Cost (Five-year reviews):	$15,000
Estimated Present Worth:	$3,754,000

2.9.4 Alternative 3—In Situ Groundwater Treatment Using Chemical Processes and Soil Mixing

Alternative 3 relies on in situ groundwater treatment using chemical processes known as chemical reduction or chemical oxidation to decrease PCE concentrations in the Plume A TTZ (Figure 2-15). The TTZ will be treated by applying a chemical reductant to soil and groundwater in place. Chemical reduction using soil mixing procedures was selected as the basis of the cost estimate for this alternative.

Mechanical soil mixing involves using an in situ blender (such as a large-diameter auger or trenching machine) to effectively distribute chemical amendments throughout the soil medium to treat PCE through reductive dechlorination. The process has been successfully applied at other sites. This process is practicable and implementable at the site and is compatible with the friable clayey soils found at the site.

In this alternative, a one-pass trenching machine method for soil mixing was assumed for cost estimating purposes. The one-pass trenching machine resembles a large chainsaw mounted on an excavator platform. The rotating cutting chain mixes the amendment and soil as it travels along its path. During mixing operations, soil samples will be collected at various depths to verify proper mixing and usage of the amendment.

After implementation of soil mixing, groundwater samples will be collected from within the treatment zone and downgradient of the treatment zone to evaluate the impact on COC concentrations in groundwater. Fieldwork to complete soil mixing activities is expected to take about 1 month, with a treatment time of roughly 3 months based on the properties of the zero valent iron and chemical concentrations within the Plume A TTZ. PCE concentrations in groundwater may be below remediation goals within a year. Five-year site reviews will be conducted.

Estimated Capital Cost:	$1,772,000
Estimated Annual O&M (Years 1 and 2):	$67,000
Estimated Annual O&M (After Year 2):	$36,000
Estimated Periodic Cost (Five-year reviews):	$15,000
Estimated Present Worth:	$2,888,000

2.9.5 Alternative 4—Groundwater Source Removal by Excavation

Alternative 4 relies on soil removal to decrease PCE concentrations in groundwater within the Plume A TTZ. Soil excavation immediately removes the contaminated media. Alternative 4 combines physical soil removal with disposal at a permitted landfill. The TTZ is consistent with Alternatives 2 and 3 (Figure 2-15). A remedial design sampling event will delineate the TTZ before soil removal. Contaminated soil will be removed using a backhoe. Contaminated soil above and below the groundwater table (to the top of the weathered shale) will be excavated from the TTZ. Some contaminated soil may have to be left in place if it is not safe or practical to be removed (for example, would require excavation too close to utilities or the roadway). Excavation near roadways or utilities will be conducted in a manner that protects structural integrity, such as the use of sheet piling.

Excavated soil may be staged temporarily onsite until waste characterization sampling is completed. For estimating purposes, it is assumed that part of the soil will be classified as hazardous waste. Excavated soil will be placed on plastic sheeting and covered with plastic to control dust and emissions and to shield the soil from precipitation. Best management stormwater pollution prevention measures will be implemented.

Following excavation, clean, imported material will be used to backfill the excavation. Fill materials will be placed in the excavation in 1-foot lifts and compacted. The area will be regraded, reseeded, and restored to its original condition. Fieldwork to complete excavation activities is expected to take approximately 2 months, with an immediate treatment time. Five-year site reviews will be conducted.

Estimated Capital Cost:	$1,971,000
Estimated Annual O&M (Years 1 and 2):	$67,000
Estimated Annual O&M (After Year 2):	$36,000
Estimated Periodic Cost (Five-year reviews):	$15,000
Estimated Present Worth:	$3,087,000

2.10 Comparative Analysis of Alternatives

The NCP uses nine criteria to evaluate remedial alternatives individually and comparatively to help select a preferred alternative, as outlined in 40 *Code of Federal Regulations* §300.430 (f)(1)(i). They are classified as threshold, balancing, and modifying criteria.

Threshold criteria are standards that an alternative must meet for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them or it is unacceptable. The following are the threshold criteria:

- Overall protection of human health and the environment
- Compliance with ARARs

Balancing criteria weigh the tradeoffs among alternatives. They represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one balancing criterion can offset a low rating on another. The following are balancing criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying criteria are the following:

- Community acceptance
- State/support agency acceptance

Each alternative was evaluated in the FS to determine how well it satisfies the seven feasibility evaluation criteria (the threshold and balancing criteria described above) and how it compares to the other alternatives under consideration. Table 2-20 shows the results of the evaluation for each alternative with respect to the criteria listed above.

2.10.1 Overall Protection of Human Health and the Environment

All of the alternatives, except Alternative 1 (No Action), provide protection of human health and the environment by meeting the RAOs and are rated high in this category. Alternative 1 does not provide protection of human health and the environment; therefore, it is rated low in this category.

2.10.2 Compliance with ARARs

Alternative 1 is in compliance with the action-specific ARARs like Alternatives 2 through 4. However, it is not in compliance with the chemical-specific ARARs because unacceptable risks could still exist for construction workers to groundwater or to receptors associated with COCs in soil. Alternatives 2, 3, and 4 are in compliance because the remediation goals would eventually be met at the site. Alternatives 2, 3, and 4 are rated high, and Alternative 1 is rated low for not meeting the ARARs. The ARARs are presented in Table 2-21.

2.10.3 Long-Term Effectiveness and Permanence

Under all the alternatives there would be no residual risks to potable water use receptors because of an existing city ordinance. Risks to construction workers would remain due to no controls under Alternative 1. Alternatives 2, 3, and 4 would have no residual risk to soil COCs, and risks to the construction worker would be managed through treatment and control of exposure. Under Alternative 1, the COCs would naturally attenuate, slowly decreasing COC mass, but the amount of the decrease would remain unknown. Alternatives 2, 3, and 4 would remove the COCs to their remediation goals, and nearby residents would only have a temporary impact due to the noise and increase in roadway traffic because of the excavation activities. Alternatives 2, 3, and 4 were rated high because of their long-term effectiveness and permanence; however, Alternative 1 was rated low.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

For Alternatives 2, 3, and 4, most of the COCs would be destroyed or removed from the site resulting in significant reduction of toxicity, mobility, or volume. Natural attenuation would then slowly decrease concentrations of COCs in groundwater over time. Alternative 1 would leave the contamination in place and natural attenuation over time would slowly decrease the VOC concentrations, however the amount of the decrease would remain unknown. Alternatives 1, no action, and 4, removal by excavation, would not use treatment to decrease the mass of contaminated media. However, Alternatives 2 and 3 would both use treatment to address groundwater, therefore meeting the preference for treatment. Surface soil and sediment from powder wells would not be treated but would instead be excavated and disposed offsite. Alternatives 1 and 4 received low rankings because treatment is not part of the alternative. Alternatives 2 and 3 received the highest rating in this category.

2.10.5 Short-Term Effectiveness

Alternative 1 would not achieve protection and therefore was rated low. Alternatives 2, 3, and 4 would achieve protection rapidly onsite due to the existing ordinance and depth to groundwater. However, groundwater under Stratford Avenue would not be addressed during the remedial action; therefore, protection would not be achieved rapidly offsite.

2.10.6 Implementability

Alternatives 1 and 4 would be the easiest to implement and therefore were rated the highest because Alternative 1 does not require an active remedy and Alternative 4 does not require treatment. Alternatives 2 and 3 would be feasible but complex due to the nature of the treatment processes. Alternatives 2, 3, and 4 would be reliable and feasible, and materials and services are readily available, except Alternative 2 would likely require an additional power source. Both Alternatives 2 and 3 were rated moderately.

2.10.7 Cost

Alternative 1 costs much less than the other alternatives and is rated highly. Although Alternative 1 is the least costly of the remedial alternatives, it is not protective of human health and the environment. The cost of Alternative 2 is the highest followed by Alternatives 4 and 3. The present worth of Alternatives 2, 3, and 4 is presented in Sections 2.9.3, 2.9.4, and 2.9.5, respectively.

2.10.8 State/Support Agency Acceptance

MDNR has expressed support for Alternatives 2, 3, and 4. The State does not believe that Alternative 1 provides adequate protection of human health and environment.

2.10.9 Community Acceptance

As noted in Section 2.3, the Proposed Plan for the former Hanley Area was made available for public review and comment on November 25, 2010. A public meeting was held on December 13, 2010, and the public comment period was established from November 29 through December 29, 2010. The community did not submit written comments during the public comment period, and they did not raise concerns regarding Alternative 3 during the public meeting. The Army has worked through various outlets (for example, fact sheets, letters, a public meeting, and a public comment period) to inform the community of the Proposed Plan and the remedial alternatives. No comments were submitted and no concerns were raised regarding the Proposed Plan. Based on these community outreach efforts, USACE is confident that community acceptance of Alternative 3 has been reached.

2.11 Principal Threat Waste

The NCP expects that treatment will be used to address principal threat wastes to the extent practicable to reduce their toxicity, mobility, or volume. Principal threat wastes are defined by USEPA as "source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur" (USEPA 1991). Although principal threat waste was not observed during previous investigations at the former Hanley Area, PCE observed in soil at soil boring SB-023 (3,200,000 µg/kg) at 25 to 26 feet below ground (Figure 2-15) could indicate the presence of DNAPL above the weathered shale. As shown in Figure 2-15, SB-023 lies within the soil TTZ that would be addressed under Alternatives 2, 3, and 4. Alternatives 2 and 3 would include in situ treatment (thermal technologies and chemical processes/soil mixing, respectively) to address potential principal threat waste. Alternative 4 would not use treatment to address the soil TTZ; instead, it would involve the excavation and offsite disposal of the material. Depending on waste characterization of the excavated material, offsite treatment could be required before the material can be permanently disposed.

2.12 Selected Remedy

The selected remedy for OU-1 is Alternative 3—In Situ Groundwater Treatment using Chemical Processes and Soil Mixing, Soil and Powder Well Sediment Removal, and Offsite Disposal. Figures 2-13, 2-14, and 2-15 depict the primary features of the selected remedy.

2.12.1 Summary of the Rationale for the Selected Remedy

As presented in Table 2-20, Alternatives 2, 3, and 4 each protect human health and the environment, comply with ARARs, and achieve long-term and short-term effectiveness by addressing risks to current and future receptors. Each alternative is implementable, although Alternative 4 is more implementable than Alternative 3, which, in turn, is slightly more implementable than Alternative 2.

Alternative 3 was selected over Alternative 2 because Alternative 3 is more cost-effective and slightly more implementable. Alternative 3 was selected over Alternative 4 because chemical processes and soil mixing (in situ groundwater treatment) addresses the balancing criterion of reduction of toxicity, mobility, or volume through treatment, while excavation and offsite disposal under Alternative 4 does not. Alternative 4 would move the contaminated media from Plume A from one location to another, while Alternative 3 would reduce contaminant toxicity, mobility, and volume in place, without requiring offsite transport and disposal.

2.12.2 Description of the Selected Remedy

The selected remedy consists of in situ groundwater treatment using chemical processes and soil mixing, soil and powder well sediment removal offsite disposal, LUCs, and five-year reviews.

2.12.2.1 In Situ Groundwater Treatment Using Chemical Processes and Soil Mixing

Alternative 3 relies on in situ groundwater treatment using chemical processes known as chemical reduction or chemical oxidation to decrease PCE concentrations in the Plume A TTZ (Figure 2-15). The TTZ will be treated by applying a chemical reductant to in situ soil and groundwater. Chemical reduction using soil mixing procedures was selected as the basis of the cost estimate for this alternative. Section 2.9.4 presents a detailed description of this component of the selected remedy.

Groundwater monitoring will be performed to assess in situ chemical reduction at Plume A. Monitoring will also identify areas that may be susceptible to indoor air risk, which will be addressed under OU-2. The details of the groundwater monitoring program, such as the number and location of wells to be sampled and the frequency, will be provided in the long-term management plan for the site. For cost estimating, it is assumed that groundwater samples will be collected quarterly for the first 2 years. Following year 2, groundwater samples will be collected annually to monitor VOCs at the site to identify changes in the plume that might affect the protectiveness of the selected remedy.

2.12.2.2 Soil and Powder Well Sediment Removal and Offsite Disposal

Soil removal activities consist of excavating areas of surface soil contaminated with metals and Aroclor 1260, transporting the soil offsite, and disposing of it at a permitted landfill. Before excavation, hand auger soil borings will be advanced to delineate the presence of COCs in soils around the following sample locations:

- Sample SS-218A-1 thallium at 8.64 J mg/kg
- Sample SS-218A-3 thallium at 7.67 J mg/kg
- Sample NS03A arsenic 44 at mg/kg; lead at 5,840 mg/kg
- Sample NS08A arsenic at 67.7 mg/kg
- Sample SS-001 Aroclor 1260 at 1.44 mg/kg
- Sample SED-001 Aroclor 1260 at 569 mg/kg
- Sample SS-218A lead at 2,724 mg/kg
- Sample SS-219B arsenic at 108 mg/kg
- Sample SS-219C arsenic at 68.8 mg/kg
- Sample SS55A Aroclor 1260 at 18,200 mg/kg

Utilities will be marked before excavation. Excavation will be performed using a backhoe. It is assumed for cost estimating purposes that excavation will be required to a depth of 2 feet below ground in areas not covered with concrete, but the depth will be determined based on confirmation sampling conducted before excavation. Soil samples from the area will be collected and analyzed for the corresponding COC to determine excavation limits. If contaminant concentrations exceed remediation goals along areas covered with concrete and asphalt (i.e., former building foundations, concrete bunkers, barrier walls, and sidewalks), then the Army will implement LUCs that prohibit removal of the surface materials (concrete or asphalt) without proper health and safety training and personal protective equipment.

Figure 2-13 shows estimated excavation limits. Samples of the soil will be collected for disposal characterization. The excavated soil will be disposed of offsite at a permitted Subtitle D landfill. The alternative assumes that the excavated soil will not be characterized as hazardous waste. Following excavation and confirmation sampling, the area will be backfilled, regraded, reseeded, and restored to its original condition. Clean, imported material will be used as backfill.

As part of the remedial action at the former Hanley Area, the 22 powder wells shown in Figure 2-13 will be decommissioned. The sediment will be removed and disposed of based on characterization sampling, and the wells will be filled with clean, imported soil to ground surface. The sediment will be disposed of offsite at a permitted landfill.

2.12.2.3 Plume C Monitoring

Groundwater monitoring will be performed within Plume C to confirm that the exposure pathway between construction workers and contaminated groundwater remains incomplete as long as concentrations of CT remain above the risk threshold for direct contact risk to construction workers. Details of the monitoring program, such as number and location of wells to be sampled, will be provided in a long-term management plan. For cost estimating, it is assumed that 10 groundwater samples and depth to water measurements will be conducted quarterly for the first 2 years, followed by a decrease in frequency to annual monitoring.

2.12.2.4 Land Use Controls

LUCs will be implemented to address the following potential risk that is not being immediately mitigated by other components of the selected remedy: construction worker direct contact with groundwater CT concentrations exceeding the remediation goal in excavations within the Plume C footprint.

LUCs will be established over the Plume C footprint as long as CT concentrations remain above the groundwater remediation goal. The LUC will prohibit construction activities below the groundwater table without proper health and safety training and personal protective equipment.

Figure 2-14 shows the LUC boundaries at the former Hanley Area. As noted in Section 2.12.2.2, additional LUCs will be implemented if contaminant concentrations in surface soil exceed remediation goals along areas covered with concrete and asphalt. The LUCs will prohibit removal of the surface materials (concrete or asphalt) without proper health and safety training and personal protective equipment. Prohibited land uses within the boundaries shown in Figure 2-14 consist of those that expose construction workers to contaminated groundwater without proper health and safety training and personal protective equipment.

LUCs will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure.

The U.S. Army will be responsible for implementing, maintaining, reporting on, and enforcing the LUCs. The U.S. Army will prepare a Land Use Control Implementation Plan (LUCIP) to define restrictions within the LUCs, establish LUC boundaries, and explain how they will be implemented, monitored, and enforced. Upon transfer of property ownership, the U.S. Army will include restrictions in the property deed to document the LUCs defined in the LUCIP. The *Army Defense Restoration Program Management Guidance for Active Installations* (Department of the Army 2004) provides guidelines for conveying LUCs during a property transfer from the Army to a nonfederal entity. At sites where a CERCLA hazardous substance has been stored, released, or disposed of on federal property where the United States sells or otherwise transfers the impacted property, CERCLA Section 120(h)(3) specifically dictates deed covenant language. For property sold or to be otherwise transferred from the United States, the Army will prepare all required deed covenants to comply with CERCLA Section 120(h)(3).

2.12.2.5 Five-Year Reviews

Five-year site will be conducted as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure, per the NCP. The five-year reviews will be terminated once COCs are at or below the remediation goals and monitoring confirms that no unacceptable risks are posed by Plume C. This will be fulfilled by demonstrating that groundwater in Plume C remains deeper than 10 feet below ground or that concentrations within the plume have fallen below remediation goals. Once the conditions are confirmed for OU-1, the U.S. Army will recommend terminating the five-year reviews, in consultation with MDNR and subject to their approval. Once MDNR approves of terminating the five-year reviews, the basis for termination will be documented in a final five-year review report.

The five-year review will consider all complete exposure pathways and COCs that remain above unrestricted use concentrations. The five-year review will also assess the effectiveness of LUCs in protecting against onsite residential and industrial worker exposure to groundwater and surface soil COCs. The time that natural attenuation takes to return groundwater to the potable use levels is estimated to be more than 84 years for Alternatives 2, 3, and 4.

2.12.3 Summary of the Estimated Remedy Costs

The cost estimate for the selected remedy was developed as part of the FS and is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the selected remedy. Major changes may be documented in a memorandum to the administrative record file, an explanation of significant differences, or a DD amendment. Table 2-22 presents the estimated costs for the selected remedy. They are order-of-magnitude engineering costs and thus expected to be within +50 and -30 percent of the actual project cost.

2.12.4 Expected Outcomes of the Selected Remedy

The selected remedy for OU-1 will address areas of soil and groundwater contamination that pose unacceptable risks to human health. The available onsite land use will be residential, because unacceptable risks to residents will be addressed through LUCs, City Ordinance 66777, in situ groundwater treatment, soil removal and offsite disposal, and the removal of sediment from powder wells. Soil PRGs developed during the FS will serve as the cleanup levels (remediation goals) for the soil removal action. Soil remediation goals are presented in Table 2-23.

Risks to onsite construction workers through dermal contact with groundwater will be addressed through chemical processes and soil mixing in the Plume A TTZ (Figure 2-15).

Groundwater PRGs developed during the FS will serve as the remediation goals during chemical treatment and soil mixing. Table 2-23 shows groundwater remediation goals.

LUCs will be established over Plume C as long as CT concentrations remain above the groundwater remediation goal established in the FS. The LUC will prohibit construction activities below the groundwater table without proper health and safety training and personal protective equipment.

Onsite and offsite use of groundwater for potable use is prohibited by City of St. Louis Ordinance 66777. The groundwater use restriction will remain in place for the foreseeable future. The time that natural attenuation takes to return groundwater to the potable use levels is estimated to be more than 84 years.

The selected remedy will allow for beneficial reuse of the former Hanley Area, either by the U.S. Army or a future property owner. The remedy will allow the former Hanley Area to be developed as a “business and industrial development area” in accordance with the St. Louis Strategic Land Use Plan (Section 2.6). Alternatively, the property can be redeveloped as a residential area, subject to the LUCs and the provisions of City Ordinance 66777.

Because of the uncertainty of indoor air risk, the potential migration of contaminated vapors from groundwater to indoor air will be further assessed under OU-2

2.13 Statutory Determinations

The selected remedy for OU-1 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, and are cost-effective. In addition, it satisfies the statutory requirements of CERCLA and the five-year review requirements.

2.13.1 Protection of Human Health and Environment

The selected remedy protects human health and the environment. Existing or potential risks posed by the site will be eliminated, reduced, or controlled by the following response actions:

- Soil removal and offsite disposal will reduce risk to future onsite residents posed by surface soil to within USEPA’s acceptable ELCR range of 10^{-4} to 10^{-6} for carcinogens and below the HI of 1.0 for noncarcinogens.
- Removal and offsite disposal of sediment, if present, at 22 powder well locations will prevent future human and ecological exposures to the material.
- In the Plume A TTZ, the response action will reduce risk that groundwater poses to future onsite construction workers to within the ELCR range of 10^{-4} to 10^{-6} for carcinogens and below the HI of 1.0 for noncarcinogens, which will be accomplished through in situ groundwater treatment using chemical processes and soil mixing.
- Groundwater monitoring within Plume C will confirm that the exposure pathway between construction workers and groundwater contaminated with CT remains incomplete because of the depth to the groundwater table.

- Onsite LUCs will prohibit construction activities that expose onsite construction workers to contaminated groundwater within Plume C.

The vapor intrusion pathway will be addressed under OU-2.

Although it is not part of the selected remedy, City of St. Louis Ordinance 66777 provides protection against exposure to contaminated groundwater.

2.13.2 Compliance with ARARs

The selected remedy will comply with the ARARs presented in Table 2-21.

2.13.3 Cost-Effectiveness

The selected remedy is cost-effective and slightly less expensive than other alternatives considered, with the exception of Alternative 1, no action. Costs for Alternatives 2, 3, and 4 are presented in Sections 2.9.3, 2.9.4, and 2.9.5, respectively. A detailed cost estimate for the selected remedy, Alternative 3, is presented in Table 2-22.

2.13.4 Use of Permanent Solutions and Alternative Treatment Technology

The selected remedy provides long-term effectiveness and permanence because it will remove soil concentrations that pose a risk, and risks to the construction worker will be managed through in situ groundwater treatment and control of exposure. The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner. The use of treatment in the selected remedy is discussed in Section 2.13.5.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy satisfies the statutory preference for treatment as a principal element of the remedy. The selected remedy includes in situ groundwater treatment using chemical processes and soil mixing as a principal element.

2.13.6 Five-Year Review Requirements

As required by the NCP, five-year reviews will be conducted as long as hazardous substances remain at the site at concentrations that do not allow unlimited use and unrestricted exposure. The five-year reviews will be terminated once COCs are at or below the remediation goals and monitoring confirms that no unacceptable risks are posed by Plume C. This will be fulfilled by demonstrating that groundwater in Plume C remains deeper than 10 feet below ground or that concentrations within the plume have fallen below remediation goals. Once the conditions are confirmed at the former Hanley Area, the U.S. Army will recommend terminating the five-year reviews, in consultation with MDNR and subject to their approval. Once MDNR approves of terminating the five-year reviews, the basis for termination will be documented in a final five-year review report.

2.14 Documentation of Significant Changes

The Proposed Plan for the Former Hanley Area was released for public comment on November 29, 2010, and ended on December 29, 2010. The Proposed Plan identified in situ groundwater treatment using chemical processes and soil mixing, soil and powder well sediment removal, and offsite disposal as the Preferred Alternative for soil and groundwater remediation. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

TABLE 2-1
1991 USATHAMA Soil RCRA TCLP Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	Sample ID>>	SS41A	SS44B	SS47B	SS51B
	Sample Interval (ft)>>	0-1	1-2	1-2	1-2
RCRA Metals (mg/L)	TCLP Threshold				
Arsenic	5	LT	LT	LT	LT
Barium	100	**0.781**	**0.956**	**0.881**	**0.682**
Cadmium	1	**0.00478**	**0.00559**	LT	LT
Chromium	5	LT	LT	LT	LT
Lead	5	LT	LT	LT	**0.0471**
Selenium	1	LT	LT	LT	LT
Silver	5	LT	LT	LT	LT

Notes:
Analyzed using ICAP method
Bold = Detected concentration
LT = Less than certified reporting limit
RCRA = Resource Conservation and Recovery Act
TCLP = Toxicity Characteristic Leaching Procedure
mg/L = milligrams per liter

TABLE 2-2
1991 USATHAMA TAL Inorganics Soil Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Inorganics (mg/kg)	Reporting Limits	Sample ID>>	SS40A	SS40B	SS41A	SS42A	SS43A	SS43B	SS44A	SS44B	SS45A	SS45B	SS46A	SS46B	SS47A	SS47B
		Sample Interval (ft)>>	0-1	1-2	0-1	0-1	0-1	1-2	0-1	1-2	0-1	1-2	0-1	1-2	0-1	1-2
		Screening Levels (0-10')														
Aluminum	14.1	7,700*	**10,400**	**12,100**	**6,980**	**11,600**	**12,400**	**12,900**	**8,640**	**10,600**	**9,320**	**9,320**	**7,160**	**8,710**	**11,100**	**12,000**
Antimony	3.8	3.1*	NRQ	NRQ	LT	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NRQ	NRQ	LT	NRQ	LT
Arsenic	0.25	12.3	NRQ	NRQ	**8.92**	NRQ	NRQ	NRQ	NRQ	NRQ	**9.31**	NRQ	NRQ	**8.44**	NRQ	LT
Barium	29.6	1,600*	**204**	**184**	**120**	**194**	**394**	**224**	**249**	**248**	**286**	**188**	**196**	**431**	**244**	**292**
Beryllium	1.8	16*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Cadmium	3.05	3.9*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Calcium	59	-	**22,100**	**6,290**	**214,000**	**30,500**	**14,600**	**53,900**	**9,380**	**13,800**	**20,200**	**19,600**	**15,900**	**8,880**	**8,880**	**5,020**
Chromium	12.7	38	LT	**25.7**	LT	LT	**24.6**	LT	LT	**57.7**	LT	LT	LT	LT	LT	LT
Cyanide	0.92	120*	NRQ	NRQ	LT	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NRQ	NRQ	LT	NRQ	LT
Cobalt	15	900	NRQ	NRQ	LT	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NRQ	NRQ	LT	NRQ	LT
Copper	58.6	290*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Iron	50	5,500*	**18,700**	**20,300**	**10,700**	**17,630**	**19,100**	**17,900**	**5,800**	**17,300**	**16,400**	**14,700**	**15,100**	**6,000**	**17,100**	**19,100**
Lead	0.177	400	**39.3**	**10.3**	**115**	**74.4**	**78.7**	**34**	**27.1**	**28.5**	**56.5**	**15.9**	**18.3**	**71.9**	**94.5**	**18.8**
Magnesium	50	-	**6,970**	**5,400**	**15,500**	**6,750**	**5,260**	**6,670**	**6,010**	**6,720**	**4,890**	**3,860**	**10,200**	**5,020**	**5,000**	**4,010**
Manganese	0.275	350*	**723**	**720**	**601**	**708**	**1,040**	**753**	**1,060**	**898**	**638**	**795**	**1,070**	**921**	**991**	**1,030**
Mercury	0.05	2.3*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Nickel	12.6	130	**29**	**30.1**	**LT**	**27.1**	**28.5**	**26.8**	**29.2**	**32.2**	**28**	**25**	**27.9**	**28.3**	**29.0**	**31.2**
Potassium	37.5	-	**1,120**	**1,240**	**1,060**	**1,410**	**1,540**	**1,540**	**1,090**	**1,100**	**979**	**928**	**1,100**	**1,400**	**1,400**	**1,320**
Selenium	0.25	5	NRQ	NRQ	LT	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NRQ	NRQ	LT	NRQ	LT
Silver	2.5	34	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Sodium	150	-	**581**	**584**	**508**	**475**	**484**	**321**	**515**	**678**	**362**	**444**	**609**	**440**	**346**	**419**
Thallium	31.3	0.7	NRQ	NRQ	LT	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NRQ	NRQ	LT	NRQ	LT
Vanadium	13	39*	NRQ	NRQ	**33.3**	NRQ	NRQ	NRQ	NRQ	**44.1**	NRQ	NRQ	NRQ	**42.5**	NRQ	**50.2**
Zinc	30.2	2,300*	**141**	**92.6**	**119**	**132**	**197**	**105**	**104**	**98.3**	**220**	**94.1**	**84.6**	**177**	**152**	**107**

Notes:

Bold = Detected concentration

Gray highlight = A detected concentration above the selected screening level

Samples ending in 'A' were collected from a depth interval of 0-1 ft.

Samples ending in 'B' were collected from a depth interval of 1-2 ft.

LT = Less than reporting limit

mg/kg = milligrams per kilogram

NR = Not reported

NRQ = Analysis not requested for this sample

* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-2
1991 USATHAMA TAL Inorganics Soil Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Inorganics (mg/kg)	Reporting Limits	Sample ID>> / Sample Interval (ft)>> / Screening Levels (0-10')	SS48A 0-1	SS48B 1-2	SS49A 0-1	SS49B 1-2	SS50A 0-1	SS50B 1-2	SS51A 0-1	SS51B 1-2	SS52A 0-1	SS52B 1-2	SS53A 0-1	SS53B 1-2	SS54A 0-1	SS54B 1-2
Aluminum	14.1	7,700*	**11,100**	**10,400**	**9,410**	**9,440**	**9,630**	**9,590**	**10,700**	**10,500**	**8,570**	NR	**13,700**	**11,700**	**11,800**	**10,900**
Antimony	3.8	3.1*	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	NR	NRQ	LT	NRQ	LT
Arsenic	0.25	12.3	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	**10**	NRQ	**9.62**	NRQ	**7.37**
Barium	29.6	1,600*	**234**	**176**	**255**	**293**	**279**	**230**	**243**	**205**	**216**	NR	**313**	**283**	**233**	**211**
Beryllium	1.8	16*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Cadmium	3.05	3.9*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Calcium	59	-	**24,800**	**14,700**	**12,800**	**12,000**	**9,780**	**7,070**	**7,520**	**9,020**	**5,810**	**10,060**	**10,500**	**15,000**	**23,300**	**12,700**
Chromium	12.7	38	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Cyanide	0.92	120*	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	LT	NRQ	LT	NRQ	LT
Cobalt	15	900	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	LT	NRQ	LT	NRQ	LT
Copper	58.6	290*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Iron	50	5,500*	**18,600**	**15,400**	**16,500**	**17,800**	**4,600**	**15,900**	**17,500**	**16,700**	**4,900**	**16,100**	**19,800**	**18,100**	**17,700**	**17,200**
Lead	0.177	400	**40.7**	**11.9**	**23.4**	**65.9**	**25.7**	**17.9**	**26.2**	**23.8**	**28.9**	**14.9**	**21.6**	**23.6**	**52.4**	**23.3**
Magnesium	50	-	**4,760**	**5,870**	**5,930**	**4,720**	**4,960**	**4,250**	**5,000**	**4,140**	**3,000**	**4,510**	**5,680**	**5,990**	**7,710**	**5,500**
Manganese	0.275	350*	**863**	**597**	**1,040**	**1,120**	**1,050**	**978**	**964**	**927**	**1,050**	**905**	**1,140**	**1,080**	**956**	**954**
Mercury	0.05	2.3*	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Nickel	12.6	130	**28.3**	LT	**29.9**	**30.5**	**27.0**	**25.6**	**29.5**	**25.7**	LT	**29.2**	**30.8**	**30.5**	**27.9**	**48.6**
Potassium	37.5	-	**1,530**	**891**	**1,930**	**2,220**	**1,460**	**1,160**	**1,290**	**998**	**1,230**	**1,240**	**1,690**	**1,420**	**1,390**	**1,130**
Selenium	0.25	5	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	LT	NRQ	LT	NRQ	LT
Silver	2.5	34	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Sodium	150	-	**364**	**378**	**435**	**461**	**484**	**495**	**443**	**371**	**354**	**412**	**459**	**462**	**492**	**627**
Thallium	31.3	0.7	NRQ	LT	NRQ	NRQ	NRQ	NRQ	NRQ	LT	NRQ	LT	NRQ	LT	NRQ	LT
Vanadium	13	39*	NRQ	**46.1**	NRQ	NRQ	NRQ	NRQ	NRQ	**48.7**	NRQ	**51.2**	NRQ	**48**	NRQ	**49.4**
Zinc	30.2	2,300*	**137**	**72.9**	**109**	**164**	**102**	**92.5**	**107**	**87.5**	**118**	**91.9**	**110**	**109**	**112**	**86.1**

Notes:

Bold = Detected concentration

Gray highlight = A detected concentration above the selected screening level

Samples ending in 'A' were collected from a depth interval of 0-1 ft.

Samples ending in 'B' were collected from a depth interval of 1-2 ft.

LT = Less than reporting limit

mg/kg = milligrams per kilogram

NR = Not reported

NRQ = Analysis not requested for this sample

* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-3
1991 USATHAMA Soil PCB Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	**SS55A**
		Sample Interval (ft)>>	**0-1**
PCBs (mg/kg)	**Reporting Limit**	**TSCA Threshold**	
Aroclor 1260	33	1	**18,200**

Notes:
Bold = Detected concentration
PCBs = polychlorinated biphenyls
mg/kg = milligrams per kilogram
TSCA = Toxic Substances Control Act

TABLE 2-4
1991 USATHAMA Soil TCL SVOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	SS41A	SS44B	SS46B	SS47B	SS48B	SS51B	SS52B	SS53B	SS54B
		Sample Interval (ft)>>	0–1	1–2	1–2	1–2	1–2	1–2	1–2	1–2	1–2
SVOCs (µg/kg)	Reporting Limits	Screening Levels (0-10')									
Anthracene	30	2,200,000*	LT	LT	LT	NRQ	LT	**100**	LT	**80**	LT
Benz[a]anthracene	170	887	LT	LT	LT	NRQ	LT	**290**	LT	**210**	**170**
Benz[b]fluoranthene	210	626	LT	LT	LT	NRQ	LT	**480**	LT	**390**	LT
Benzo[k]fluoranthene	70	1,500	LT	LT	LT	NRQ	LT	**150**	LT	**130**	**80**
Chrysene	120	15,000	LT	LT	LT	NRQ	**270**	**530**	**220**	**450**	**290**
Fluoranthene	70	230,000*	**110**	**110**	LT	LT	**340**	**910**	**290**	**760**	**450**
Phenanthrene	30	1,040	LT	LT	LT	NRQ	**140**	**600**	**130**	**470**	**160**
Pyrene	30	230,000*	**100**	**90**	LT	LT	**270**	**650**	**220**	**520**	**360**

Notes:
Bold = Detected concentration
Samples ending in 'A' were collected from a depth interval of 0-1 ft. Samples ending in 'B' were collected from a depth interval of 1-2 ft.
LT = Less than certified reporting limit
NRQ = Analysis not requested for this sample
SVOC = semi-volatile organic compound
TCL = Target Compound List
µg/kg = micrograms per kilogram
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
Samples were collected for explosives analyses, which resulted in no detections.

TABLE 2-5
1998 HARZA Soil RCRA Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	NS02A	NS02B	NS03A	NS03B	NS05A	NS05B	NS07A	NS07B	NS08A	NS08B
			Sample Interval (ft)>>	0–1	1–2	0–1	1–2	0–1	1–2	0–1	1–2	0–1	1–2
RCRA Metals (mg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	**Test Method**										
Arsenic	12.3	12.3	SW6010/7000	**14.5**	**5**	**44**	**15.9**	**11.4**	**7.1**	**13.6**	**11.5**	**67.7**	**16.7**
Barium	1,600[b]	100,000	SW6010/7000	**141**	**209**	**123**	**109**	**109**	**79.3**	**130**	**141**	**144**	**153**
Cadmium	3.9[b]	56[b]	SW6010/7000	ND	ND	**0.74**	ND	**0.72**	**0.61**	ND	ND	ND	ND
Chromium	38	500	SW6010/7000	**19.8**	**15.9**	**21.5**	**17.4**	**20**	**22.5**	**16**	**14.1**	**16.6**	**16.9**
Lead	400	800	SW6010/7000	**48.8**	**51.4**	**5,840**	**87.3**	**102**	**185**	**20.5**	**32.3**	**56.6**	**32.6**
Mercury	2.3[b]	34[b]	SW6010/7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	5	570[b]	SW6010/7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	34	570[b]	SW6010/7000	ND	ND	**1.3**	**0.72**	**23.2**	**82.6**	ND	ND	ND	ND

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
Samples ending in 'A' were collected from a depth interval of 0-1 ft.
Samples ending in 'B' were collected from a depth interval of 1-2 ft.
mg/kg = milligrams per kilogram
ND = Chemical not detected
RCRA = Resource Conservation and Recovery
NS10, NS15, SN16, and NS17 are sediment
NS14A = Sample collected at 6-8' bgs
NS14B = Sample collected at 16-18' bgs
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-5
1998 HARZA Soil RCRA Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	NS09A	NS09B	NS11A	NS11B	NS12A	NS12B	NS13A	NS13B	NS14A	NS14B
			Sample Interval (ft)>>	0–1	1–2	0–1	1–2	0–1	1–2	0–1	1–2	6–8	16–18
RCRA Metals (mg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	**Test Method**										
Arsenic	12.3	12.3	SW6010/7000	**5.3**	**7.5**	**10.1**	**7.8**	**9.9**	**7.4**	**11.4**	**6.3**	**7.8**	**7.3**
Barium	1,600[b]	100,000	SW6010/7000	**148**	**128**	**196**	**130**	**178**	**152**	**723**	**179**	**137**	**86.4**
Cadmium	3.9[b]	56[b]	SW6010/7000	ND	ND	**2.1**	ND	**0.97**	ND	**1.8**	ND	ND	ND
Chromium	38	500	SW6010/7000	**18.3**	**20.3**	**18.6**	**15.8**	**15.2**	**13.2**	**22.1**	**16.4**	**14.7**	**12.8**
Lead	400	800	SW6010/7000	**40.5**	**17.4**	**335**	**15.2**	**88.7**	**30.3**	**206**	**27.7**	**13.7**	**7.3**
Mercury	2.3[b]	34[b]	SW6010/7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	5	570[b]	SW6010/7000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	34	570[b]	SW6010/7000	**0.65**	**0.67**	**0.76**	ND	**0.7**	ND	**0.68**	ND	ND	**0.69**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
Samples ending in 'A' were collected from a depth interval of 0-1 ft.
Samples ending in 'B' were collected from a depth interval of 1-2 ft.
mg/kg = milligrams per kilogram
ND = Chemical not detected
RCRA = Resource Conservation and Recovery
NS10, NS15, SN16, and NS17 are sediment
NS14A = Sample collected at 6-8' bgs
NS14B = Sample collected at 16-18' bgs
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-6
1998 HARZA Soil TCL SVOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	NS02B	NS03A	NS03B	NS05B	NS07A	NS07B	NS08A	NS08B
	Screening Levels	Sample Interval (ft)>>	1-2	0-1	1-2	1-2	0-1	1-2	0-1	1-2
TCL SVOCs (µg/kg)	**(0-10')**	**Test Method**								
Benzo(b)flouranthene	2,300	SW8270B	**134**	**161**	**104**	ND	**392**	**117**	**172**	**255**
Benzo(k)flouranthene	23,000	SW8270B	**105**	**137**	**79.2**	ND	**310**	ND	**92**	**180**
Benzo(a)pyrene	230	SW8270B	**107**	**130**	**89.2**	**65.9**	**301**	**90.9**	**124**	**212**
Indeno(1,2,3-cd)pyrene	2,300	SW8270B	**64.2**	**69.4**	ND	ND	**143**	ND	ND	ND
Benzo(g,h,i)perylene	478	SW8270B	ND	ND	ND	ND	**137**	ND	ND	**105**

Notes:
Reporting limits were not included in the in the 1998 *Site Investigation Report* (HARZA 1998).
Bold = Detected concentration
Samples ending in 'A' were collected from a depth interval of 0-1 ft. Samples ending in 'B' were collected from a depth interval of 1-2 ft.
ND = Not detected above the laboratory reporting limit
SVOC = Semivolatile organic compound
TCL = Target Compound List
µg/kg = micrograms per kilogram
Samples were collected for VOCs and explosives. RDX and HMX were detected at NS03A and NS03B.

TABLE 2-7
2001 TapanAm Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	SS-218A-1	SS-218A-2	SS-218C-1	SS-218A-3	SS-218B-1	SS-218B-2	SS-218C-2	SS-218C-3	SS-219A-1	SS-219A-2	SS-219A-3	SS-219B	SS-219C	SS-219D-1
			Sample Interval (ft)>>	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1
Target Analyte List Metals (mg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	Test Method														
Aluminum	7,700*	100,000	SW6010B	**8,148**	**6,133**	**6,987**	**8,982**	**7,570**	**7,756**	**8,492**	**7,972**	**9,152**	**8,808 J**	**8,967 J**	**8,438**	**9,780**	**8,885**
Antimony	3.1*	45*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2.59 J**	ND	**6.9**	ND	ND
Arsenic	12.3	12.3	SW6010B	**8.25**	**6.23**	**6.65**	**6.71**	ND	ND	ND	ND	ND	**6.67 J**	**4.93**	**108**	**68.8**	ND
Barium	1,600*	100,000	SW6010B	**205**	**128**	**107**	**184**	**182**	**178**	**215**	**193**	**0.0**	**149**	**129**	**135**	**125**	**157**
Beryllium	16*	220*	SW6010B	**0.592**	**0.511 J**	**0.428 J**	**0.526 J**	**0.501 J**	**0.467 J**	**0.523 J**	**0.471 J**	**0.538**	**0.517 J**	**0.528 J**	**0.531**	**0.558**	**0.556**
Cadmium	3.9*	56*	SW6010B	**1.28**	**3.29**	**0.851**	**1.52**	**1.96**	**1.16**	**1.65**	**0.834**	**0.701**	**0.493 J**	**0.409 J**	**1.22**	**0.721**	**0.592**
Calcium	-	-	SW6010B	**18,438**	**5,180**	**28,032**	**3,603**	**5,945**	**4,348**	**14,555**	**3,590**	**4,691**	**5,166**	**3,519**	**3,991**	**3,979**	**3,412**
Chromium	38	500	SW6010B	**14.5**	**28.5**	**12.1**	**13.7**	**17.4**	**19.2**	**21.2**	**11.8**	**15.8**	**14.2**	**15**	**14.8**	**15.5**	**15.6**
Cobalt	900	2,100	SW6010B	**8.78**	**8.4**	**6.34**	**9.82**	**8.73**	**8.44**	**9.48**	**8.71**	**8.54**	**8.54**	**8.12**	**10.2**	**8.5**	**9.28**
Copper	290*	4,200*	SW6010B	**59.6**	**2,565**	**29.1**	**62.9**	**143**	**35.6**	**107**	**36.4**	**27.1**	**21.1**	**17.4**	**24.5**	**18.8**	**21.1**
Iron	5,500*	100,000	SW6010B	**16,703**	**11,494**	**11,678**	**16,445**	**15,232**	**15,068**	**17,530**	**15,446**	**16,282**	**16,790**	**15,617**	**15,861**	**16,173**	**16,681**
Lead	400	800	SW6010B	**151**	**2,724**	**86.7**	**154**	**299**	**165**	**445**	**74.1**	**83.2**	**35.1**	**27.7**	**363**	**33.1**	**43.6**
Magnesium	-	-	SW6010B	**5,925**	**1,799**	**12,698**	**2,520**	**2,978**	**2,615**	**5,076**	**2,608**	**2,608**	**3,500**	**2,149**	**2,204**	**2,162**	**2,427**
Manganese	350*	3,500*	SW6010B	**787**	**501**	**460**	**750**	**530**	**649**	**617**	**708**	**610**	**667**	**581**	**662**	**600**	**682**
Mercury	2.3*	34*	SW7470A	ND	ND	ND	ND	**0.068 J**	ND	**0.06**	ND	**0.056 J**	**0.057 J**	ND	ND	ND	**0.054 J**
Nickel	130	2,300*	SW6010B	**17.8**	**15.2**	**12.9**	**19.9**	**18.0**	**18.0**	**18.7**	**19.5**	**18.2**	**19.2**	**16.8**	**18.3**	**16.8**	**18.7**
Potassium	-	-	SW6010B	**1,326**	**830**	**1,108**	**1,308**	**1,403**	**1,193**	**1,115**	**1,379**	**1,530**	**1,449**	**1,406**	**873**	**782**	**1,421**
Selenium	5	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	34	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	-	-	SW6010B	**66.2**	**52.3**	**106**	**57J**	**43 J**	**57 J**	**58.2**	**53.2**	**49.0**	**46.3 J**	**51.4 J**	**65.1 J**	**57.3 J**	**42.8J**
Thallium	0.7	79	SW6010B	**8.64 J**	ND	**2.74**	**7.67**	ND	**5.78 J**	ND	**1.94**	ND	ND	ND	ND	**2.64 J**	ND
Vanadium	39*	570*	SW6010B	**22.7**	**22.9**	**19.6**	**24.5**	**22.5**	**22.9**	**23.7**	**22.2**	**27.2**	**26.3**	**26.5**	**25.5**	**28.0**	**28.2**
Zinc	2,300*	100,000	SW6010B	**127**	**359**	**88.4**	**117**	**277**	**128**	**379**	**102**	**191**	**83.7**	**64.8**	**90.6**	**53.8**	**94.7**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
B = Blank detection
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
ND = Chemical not detected
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] Samples were collected offsite and not included in the human health risk assessment.
- = No screening level available.
Surface soil samples were also collected for explosives analysis; information provided in the 2001 Preliminary Assessment/Site Inspection Report indicated no detections in surface soil.

TABLE 2-7
2001 TapanAm Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	SS-219D-2	SS-219D-3	SS-219E	SS-219G-1	SS-219G-2	SS-219G-3	SS-219H	SS-219J-1	SS-BAK1[b]	SS-BAK2[b]	SS-BAK3[b]	SS-220-1	SS-220-2	SS-220-3
			Sample Interval (ft)>>	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1
Target Analyte List Metals (mg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	Test Method														
Aluminum	7,700*	100,000	SW6010B	**8,095**	**7,516**	**8,960**	**8,925**	**8,431**	**11,990**	**8,799**	**8,488**	**5,114**	**5,126**	**7,947**	**6,333**	**8,148**	**7,896**
Antimony	3.1*	45*	SW6010B	ND	**2.14 J**	ND	ND	ND	ND	**2.2 J**	**5.73 J**	ND	ND	ND	ND	ND	ND
Arsenic	12.3	12.3	SW6010B	ND	ND	**23.5**	**5.1 J**	**7.3 J**	**6.63 J**	ND	**4.93 J**	**3.93 J**	**6.13**	ND	ND	ND	**8.08 J**
Barium	1,600*	100,000	SW6010B	**178**	**114**	**129**	**141**	**161**	**154**	**114**	**206**	**140**	**126**	**151**	**122**	**124**	**153**
Beryllium	16*	220*	SW6010B	**0.629**	**0.482**	**0.538**	**0.552 J**	**0.56**	**0.632**	**0.532**	**0.505 J**	**0.341**	**0.358 J**	**0.461**	**0.452 J**	**0.603**	**0.54**
Cadmium	3.9*	56*	SW6010B	**0.728**	**0.43 J**	**0.853**	**0.618**	**0.694**	ND	**0.314 J**	**1.72**	**0.728**	**0.655**	**0.483 J**	**1.03**	**0.859**	**1.32**
Calcium	-	-	SW6010B	**3,009**	**2,797**	**15,838 B**	**3,886**	**3,948**	**2,544**	**3,612**	**12,223**	**4,455 B**	**2,404 B**	**1,599 B**	**4,186 B**	**4,987 B**	**4,322 B**
Chromium	38	500	SW6010B	**13.7**	**13.2**	**16.2**	**15.3**	**14.9**	**17.0**	**16.0**	**18.6**	**9.08**	**9.87**	**10.7**	**11.7**	**20.8**	**14.9**
Cobalt	900	2,100	SW6010B	**9.64**	**7.3**	**8.78**	**8.52**	**9.01**	**10.2**	**8.73**	**8.95**	**8.21**	**7.7**	**8.93**	**8.23**	**8.23**	**9.42**
Copper	290*	4,200*	SW6010B	**20.3**	**14.5**	**34.3**	**23.9**	**192**	**17.6**	**19.9**	**129**	**12.4**	**13**	**11.2**	**21.8**	**18.8**	**37 J**
Iron	5,500*	100,000	SW6010B	**14,422**	**13,876**	**15,913**	**16,523**	**16,074**	**19,388**	**16,267**	**15,810**	**9,693**	**9,683**	**14,062**	**12,153**	**15,683**	**15,873**
Lead	400	800	SW6010B	**112**	**38.6**	**164.0**	**43.9**	**137**	**20**	**69.6**	**1,118**	**37.3**	**53.5**	**19.6**	**100**	**65**	**510 J**
Magnesium	-	-	SW6010B	**1,898**	**1,852**	**4,417**	**2,288**	**2,376**	**2,595**	**2,057**	**5,255**	**1,673**	**1,212**	**1,768**	**1,806**	**2,342**	**2,568**
Manganese	350*	3,500*	SW6010B	**763**	**562**	**617**	**601**	**683**	**708**	**516**	**639**	**1,128**	**1,132**	**791**	**676**	**591**	**622**
Mercury	2.3*	34*	SW7470A	ND	ND	**0.57 J**	ND	ND	ND	ND	**0.068 J**	ND	ND	ND	ND	ND	ND
Nickel	130	2,300*	SW6010B	**15.8**	**15.2**	**17.2**	**19.1**	**18.7**	**21.0**	**18.5**	**19.8**	**11.0**	**10.9**	**13.3**	**13.5**	**17.1**	**16.5**
Potassium	-	-	SW6010B	**980**	**1,136**	**998**	**1,194**	**1,337**	**1,144**	**693**	**1,165**	**981**	**816**	**751**	**1,112**	**1,115**	**927**
Selenium	5	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	**4.52 J**	**3.98 J**	**6.42 J**	ND	**5.65 J**
Silver	34	570*	SW6010B	ND	ND	4	ND	ND	ND	ND	**0.9 J**	ND	ND	ND	ND	ND	ND
Sodium	-	-	SW6010B	**41.9 J**	**32.2 J**	**54.8 J**	**45 J**	**39.1 J**	**53.5 J**	**46.6 J**	**63.2 J**	**46.3 J**	**28.5 J**	**39.6 J**	**36J**	**49.6 J**	**60.1 J**
Thallium	0.7	79	SW6010B	ND	ND	**4.52 J**	ND	ND	ND	**2.18 J**	ND	**2.68 J**	ND	**2.14 J**	**2.36 J**	ND	ND
Vanadium	39*	570*	SW6010B	**24.4**	**22.7**	**25.2**	**27.9**	**26.3**	**31.4**	**25.9**	**22.7**	**16.8**	**16.8**	**21.9**	**20.4**	**27.4**	**24.7**
Zinc	2,300*	100,000	SW6010B	**106**	**64.8**	**110 B**	**88.8**	**86.7**	**56.7**	**81.7**	**343**	**61.3 B**	**64.2 J**	**20.1 B**	**106 B**	**86.5 B**	**213 B**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
B = Blank detection
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
ND = Chemical not detected
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] Samples were collected offsite and not included in the human health risk assessment.
- = No screening level available.
Surface soil samples were also collected for explosives analysis; information provided in the 2001 Preliminary Assessment/Site Inspection Report indicated no detections in surface soil.

TABLE 2-7
2001 TapanAm Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	SS-220-4	SS-227A-1	SS-227B-1	SS-227J-1	SS-227O-1	SS-227M-1	SS-228A-1	SS-228B-1	SS-228C-1	SS-228D-1	SS-228E-1	SS-228F-1	SS-228G-1	SS-228M-1
			Sample Interval (ft)>>	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1	0–1
Target Analyte List Metals (mg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	Test Method														
Aluminum	7,700*	100,000	SW6010B	8,681	8,259	7,519	7,052	6,292	8,300	7,960	6,794	6,105	7,580	5,500	6,563	6,840	7,845
Antimony	3.1*	45*	SW6010B	ND	ND	4.24 J	ND	14.1	ND	2.86 J	3.15 J	2.76 J	ND	ND	ND	ND	ND
Arsenic	12.3	12.3	SW6010B	4.38 J	11.7 J	ND	6.74 J	16.5	5.12 J	18.9	16.5	13.6	ND	13.7 J	ND	ND	ND
Barium	1,600*	100,000	SW6010B	145	87.9	96.9	123	191	133	132	120	98.3	99.9	101	80 J	102	122
Beryllium	16*	220*	SW6010B	0.563	0.615 J	0.537 J	0.476 J	0.492 J	0.535	0.509 J	0.484 J	0.461 J	0.453 J	0.416 J	0.425 J	0.457 J	0.507 J
Cadmium	3.9*	56*	SW6010B	0.873	0.898 J	ND	0.976	1.63	0.835	ND	1.03	0.916	1.07	1.09	ND	1.27	ND
Calcium	-	-	SW6010B	4,067 B	41,580	48,162	6,635	29,036	11,796	18,073	31,578	32,412	58,763	34,375	80,321	44,598	46,341
Chromium	38	500	SW6010B	18.9	16.8	15.2	13.7	20	15.7	13.5	13	14.5	13.8	10.6	12.2	14.1	15.2
Cobalt	900	2,100	SW6010B	8.95	9.68 J	7.08 J	8.31	7.95	9.05	7.27	7.45	6.94	7.2 J	7.49 J	6.61 J	7.11 J	8.62 J
Copper	290*	4,200*	SW6010B	38.0	30.2	18.1	25.1	77.2	34.4	22.7	25.4	26.2	24.7	30.8	18.9	29.5	20.5
Iron	5,500*	100,000	SW6010B	15,493	16,529	13,277	13,749	12,936	15,513	14,484	12,305	11,621	12,777	11,050	10,659	11,899	13,941
Lead	400	800	SW6010B	134	120	44.7	126	304.2	103	73.9	1,416	371	68.8	245	85.9	159	63.5
Magnesium	-	-	SW6010B	2,426	8,637	7,370	2,577	6,316	3,280	4,531	5,872	6,999	20,570	8,727	14,009	9,275	10,785
Manganese	350*	3,500*	SW6010B	665	611	483	558	509	619	551	502	472	461 B	602	463	440	512 B
Mercury	2.3*	34*	SW7470A	0.079 J	ND	ND	ND	0.054 J	0.075 J	ND	ND	0.055 J	ND	0.05 J	ND	ND	ND
Nickel	130	2,300*	SW6010B	18.2	19.9	15.5	15.8	15.6	18	16.9	16.9	15.9	14.8	14.0	15.2 J	15.5	14.6
Potassium	-	-	SW6010B	880	1,080	974 J	1,353	970	1,001	1,015	1,385	1,154	970 J	916	1,008 J	1,228	1,679
Selenium	5	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	34	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	-	-	SW6010B	43.6 J	66.6 J	65.1 J	54.2 J	54.1 J	56.6 J	63.2 J	59.2 J	53.6 J	216.0 J	53.2 J	74 J	77.9 J	94.8 J
Thallium	0.7	79	SW6010B	2.23 J	ND	ND	4.66 J	ND	5.07 J	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	39*	570*	SW6010B	27.1	24.3	21.9	22.2	20.3	25.1	22.7	19.9	18.8	19.4	15.9	16.4 J	20.0	23.3
Zinc	2,300*	100,000	SW6010B	117 B	1,305	77.6	193	323	116	182	177	285	337 B	215	111	243	152 B

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
B = Blank detection
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
ND = Chemical not detected
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] Samples were collected offsite and not included in the human health risk assessment.
- = No screening level available.
Surface soil samples were also collected for explosives analysis; information provided in the 2001 Preliminary Assessment/Site Inspection Report indicated no detections in surface soil.

TABLE 2-7
2001 TapanAm Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Screening Levels (0-10')	Screening Levels[a] (>10')	Test Method	SS-228WX-1	SS-228YZ-1	SS-236-1	SS-DPILE-1	PW12	PW13	SEW1	SEW2	SEW3
			Sample Interval (ft)>>	0–1	0–1	0–1	0–1	7–8	7–8	26.5–27.5	28–29	20.5–21
Aluminum	7,700*	100,000	SW6010B	**7,157**	**7,197**	**7,775**	**6,902**	**8,325**	**14,655**	**13,898**	**9,275**	**12,149**
Antimony	3.1*	45*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	12.3	12.3	SW6010B	ND	ND	**14.2**	**11.0 J**	**8.59 J**	ND	ND	**8.37 J**	**15.8**
Barium	1,600*	100,000	SW6010B	**127**	**108**	**136**	**141**	**93.6**	**168**	**61.7**	**67.1**	**301**
Beryllium	16*	220*	SW6010B	**0.463 J**	**0.477**	**0.581**	**0.509 J**	**0.364 J**	**0.986**	**0.603**	**0.373 J**	**0.564**
Cadmium	3.9*	56*	SW6010B	**1.49**	**3.17**	**0.779**	**0.693 J**	**0.529**	**0.709**	**0.321 J**	**0.363 J**	**0.737**
Calcium	-	-	SW6010B	**50,160**	**63,774**	**4,757**	**40,449**	**2,364**	**4,448**	**2,223**	**3,017**	**2,163**
Chromium	38	500	SW6010B	**16.1**	**19.7**	**15.2**	**13**	**13.2**	**20.3**	**20.9**	**16.9**	**16.6**
Cobalt	900	2,100	SW6010B	**7.44 J**	**8.49 J**	**11.6**	**8.61 J**	**5.13**	**12.6**	**3.15 J**	**11.9**	**13.1**
Copper	290*	4,200*	SW6010B	**50.5**	**150**	**22**	**23**	**9.03**	**17.4**	**8.77**	**10.5**	**18.5**
Iron	5,500*	100,000	SW6010B	**12,174**	**14,610**	**14,793**	**13,835**	**17,437**	**22,519**	**14,076**	**11,585**	**16,329**
Lead	400	800	SW6010B	**155**	**610**	**117**	**97.1**	**7.37 J**	**11**	**8.84 J**	**7.89 J**	**30.2**
Magnesium	-	-	SW6010B	**9,127**	**13,520**	**2,177**	**7,786**	**1,927**	**3,093**	**1,873**	**2,617**	**2,477**
Manganese	350*	3,500*	SW6010B	**529 B**	**518 B**	**546**	**624**	**306 B**	**695 B**	**47.6 B**	**147 B**	**952 B**
Mercury	2.3*	34*	SW7470A	**0.08 J**	**0.058 J**	**0.056 J**	ND	ND	ND	ND	ND	**0.073 J**
Nickel	130	2,300*	SW6010B	**13.7**	**16.7**	**18.3**	**15.4**	**11.1**	**24.4**	**10.6**	**12**	**19.3**
Potassium	-	-	SW6010B	**1,272**	**1,049 J**	**10,923**	**683 J**	**482**	**688**	**495**	**523**	**1,440**
Selenium	5	570*	SW6010B	ND	**12.4 J**	ND	ND	ND	ND	ND	ND	ND
Silver	34	570*	SW6010B	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	-	-	SW6010B	**63.6 J**	**81.4 J**	**42.6 J**	**57.2 J**	**37.8 J**	**76.6 J**	**63.7 J**	**111 J**	**102 J**
Thallium	0.7	79	SW6010B	ND	ND	ND	ND	**3.62 J**	**5.19 J**	ND	**3.06 J**	**4.81 J**
Vanadium	39*	570*	SW6010B	**21.3**	**20.3**	**24.4**	**21.7**	**22**	**32.9**	**22.2**	**23.9**	**30.1**
Zinc	2,300*	100,000	SW6010B	**262 B**	**1,001 B**	**170**	**143**	**29.2 B**	**52.1 B**	**22.2 B**	**36.1 B**	**68.6 B**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
B = Blank detection
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
ND = Chemical not detected
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[a] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] Samples were collected offsite and not included in the human health risk assessment.
- = No screening level available.
Surface soil samples were also collected for explosives analysis; information provided in the 2001 Preliminary Assessment/Site Inspection Report indicated no detections in surface soil.

TABLE 2-8
2005 USACE Soil PCB Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	SED-001	SS-001
		Sample Interval (ft)>>	NA	NA
PCBs (mg/kg)	**TSCA Threshold**	**Test Method**		
Aroclor 1260	1	8082	**569**	**1.44**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the screening level
mg/kg = milligrams per kilogram
NA = Sample interval was not available
PCB = polychlorinated biphenyl
TSCA = Toxic Substances Control Act

TABLE 2-9
2005 USACE Soil VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	**SB-002**	**SB-014**	**SB-016**
		Sample Interval (ft)>>	**NA**	**NA**	**NA**
VOCs (µg/kg)	**Screening Levels (0-10')**	**Test Method**			
Carbon tetrachloride	70	SW8260B	NR	**4.3 J**	**3.0 J**
m-Xylene and p-Xylene	210,000	SW8260B	**2.6 J**	NR	NR

Notes:
Bold = Detected concentration
J = Reported value is estimated
NA = Sample interval was not available
NR = Not reported
VOC = volatile organic compound
µg/kg = micrograms per kilogram

TABLE 2-10
2005 USACE Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Screening Levels (0-10')	Sample ID>> / Sample Interval (ft)>> / Test Method	SB-001 NA	SB-002 NA	SB-003 0-1	SB-005 NA	SB-006 0-1	SB-007 11-12	SB-008 NA	SB-009 NA	SB-010 NA	SB-010 0-1	SB-011 NA	SB-012 NA
Aluminum	7,700[a]	6010B/6020A	**6,030.6**	**5,840.1**	**6,755.4**	**7,129.1**	**7,674**	**8,651.6**	**7,104.3**	**7,027**	**6,837.1**	NR	**5,395.6**	**7,161.8**
Antimony	3.1[a]	6010B/6020A	**1.2 J**	NR	**5.3**	NR	NR	**3**	NR	NR	**1.5 J**	NR	NR	NR
Arsenic	12.3	6010B/6020A	**5.6**	**7.3**	**6.9**	**5.4**	**13.3**	**8.3**	**7.6**	**7.8**	**6.8**	NR	**6.1**	**7.0**
Barium	1,600[a]	6010B/6020A	**101.7**	**91.6**	**115.5**	**129.4**	**110.1**	**188.2**	**152**	**159.8**	**207.1**	NR	**151.1**	**149.8**
Beryllium	16[a]	6010B/6020A	**0.6**	**0.5 J**	**0.3 J**	**0.5 J**	**0.4 J**	**0.3 J**	**0.4 J**	**0.4 J**	**0.4 J**	NR	**0.3 J**	**0.3 J**
Cadmium	3.9[a]	6010B/6020A	**1.1 J**	NR	NR	NR	**0.9 J**	**1.5**	**0.5 J**	**0.7 J**	**0.9 J**	NR	**0.7 J**	**0.7 J**
Calcium	-	6010B/6020A	**54,916**	**46,903**	**52,444**	**5,234.3**	**7,023.6**	**10,240**	**4,741**	**4,449.5**	**10,181**	NR	**14,720**	**4,280.2**
Chromium	38	6010B/6020A	**13.6**	**11**	**11.5**	**13.8**	**14.1**	**23.7**	**11.9**	**11.6**	**16.1**	NR	**14.1**	**12.1**
Cobalt	900	6010B/6020A	**8.3**	**6.8**	**6.9**	**9.7**	**9.8**	**6.5**	**8.3**	**8.9**	**9.4**	NR	**7.3**	**8.6**
Copper	290[a]	6010B/6020A	**24.8**	**17.5**	**16.1**	**17.1**	**33.4**	**23.7**	**24.7**	**25.5**	**41.8**	NR	**21.0**	**23**
Iron	5,500[a]	6010B/6020A	**14,238**	**12,138**	**13,306**	**17,675**	**16,493**	**26,292**	**14,892**	**15,646**	**15,569**	NR	**12,114**	**15,438**
Lead	400	6010B/6020A	**107.2**	**45.8**	**28.3**	**48.8**	**112.5**	**195.7**	**45.5**	**43.6**	**85.3**	**983.0**	**165.7**	**43**
Magnesium	-	6010B/6020A	**7,598.9**	**6,949.9**	**15,724**	**1,987.2**	**2,574.1**	**2,249.9**	**2,336**	**2,137**	**3,023.8**	NR	**2,313.4**	**2,297.8**
Manganese	350[a]	6010B/6020A	**486.6**	**435.2**	**540.8**	**423.1**	**564.6**	**719.1**	**647.6**	**766.8**	**780.8**	NR	**570.2**	**672.3**
Mercury	2.3[a]	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nickel	130	6010B/6020A	**16.4**	**15.1**	**15.6**	**17.7**	**16.8**	**18.2**	**15.2**	**18.4**	**18.9**	NR	**12.7**	**16.9**
Potassium	-	6010B/6020A	**736.6 J**	**502.1 J**	**681 J**	**481.8 J**	**552.1**	**539.4 J**	**486.1**	**686.3**	**830**	NR	**684.3**	**921.9**
Selenium	5	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Silver	34	6010B/6020A	NR	**0.6 J**	NR	**0.6 J**	NR	**0.6 J**	NR	**0.6 J**	NR	NR	NR	NR
Sodium	-	6010B/6020A	**49.4**	**71.1**	**65.1**	**32.6**	**45.2**	**59.4**	**28**	**27.2**	**28.5**	NR	**20.5**	**20.5**
Thallium	0.7	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Vanadium	39[a]	6010B/6020A	**22.1**	**20.6**	**22.4**	**27.0**	**26.4**	**26.9**	**23.1**	**24.3**	**24.7**	NR	**21.6**	**24.2**
Zinc	2,300[a]	6010B/6020A	**418.7**	**64.9**	**48.9**	**42.8**	**154.2**	**150.3**	**61.3**	**81.8**	**91.3**	NR	**100.6**	**64.6**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level.
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
NR = Not reported
SB-004 surface soil sample was not collected
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[b]This sample ID is most likely MW-106
Depths for SB samples reported were known
- = No screening level available.

TABLE 2-10
2005 USACE Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Screening Levels (0-10')	Sample ID>> / Sample Interval (ft)>> / Test Method	SB-013	SB-014	SB-015	SB-016	SB-017	SB-018	SB-019	SB-020	SB-020	SB-021	SB-022	SB-208[b]
		Sample Interval (ft)>>	NA	NA	NA	NA	NA	NA	NA	0-1	8-9	NA	NA	NA
Aluminum	7,700[a]	6010B/6020A	**7,176.9**	**7,985.7**	**6,973.3**	**5,136.1**	**6,725.2**	**6,652.9**	**7,458.3**	**5,119.1**	NR	**7,012.3**	**7,621.8**	**7,321.8**
Antimony	3.1[a]	6010B/6020A	NR	NR	NR	**1.4 J**	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	12.3	6010B/6020A	**9.0**	**7.3**	**7.2**	**6.9**	**5.7**	**6**	**5.9**	**6**	NR	**7.4**	**4**	**5.8**
Barium	1,600[a]	6010B/6020A	**165.1**	**145.5**	**162.6**	**122.4**	**139.6**	**121.6**	**129.5**	**167.7**	NR	**137.6**	**99.6**	**112.4**
Beryllium	16[a]	6010B/6020A	**0.3 J**	**0.4 J**	**0.4 J**	**0.4 J**	**0.4 J**	**0.4 J**	**0.4 J**	**0.4 J**	NR	**0.3 J**	**0.3 J**	**0.4 J**
Cadmium	3.9[a]	6010B/6020A	**0.5 J**	**0.5 J**	**1.2**	**1.1 J**	**0.5 J**	**0.6 J**	**0.5 J**	**2.8**	NR	**0.6 J**	**0.3 J**	**0.4 J**
Calcium	-	6010B/6020A	**8,737.2**	**10,598**	**4,083.7**	**52,527**	**7,136.1**	**4,358.3**	**4,758.5**	**11,337**	NR	**2,528.9**	**2,431**	**11,086**
Chromium	38	6010B/6020A	**9.5**	**12.3**	**13.3**	**11.1**	**14.7**	**12.6**	**12.7**	**34.2**	NR	**10.6**	**12.6**	**13.0**
Cobalt	900	6010B/6020A	**8.5**	**8.5**	**8.5**	**6.7**	**6.9**	**7.3**	**7.7**	**7.7**	NR	**8.9**	**7.7**	**8.6**
Copper	290[a]	6010B/6020A	**16.5**	**16.7**	**115.3**	**35.1**	**16.6**	**21.3**	**14.5**	**126.6**	NR	**14.8**	**11.1**	**14.1**
Iron	5,500[a]	6010B/6020A	**15,569**	**15,918**	**15,390**	**13,155**	**14,153**	**13,762**	**14,235**	**14,092**	**23,197**	**15,605**	**13,488**	**16,010**
Lead	400	6010B/6020A	**33.5**	**24.9**	**125.1**	**108.8**	**42.4**	**52.6**	**17.8**	**983.3**	NR	**17.3**	**13.5**	**19**
Magnesium	-	6010B/6020A	**2,580.1**	**2,736.6**	**2,152.2**	**12,303**	**2,113.4**	**1,828.5**	**2,050.8**	**2,021.9**	NR	**2,143.7**	**2,043.1**	**2,335.3**
Manganese	350[a]	6010B/6020A	**828.8**	**592.3**	**652.5**	**588.6**	**596.5**	**539.4**	**672.7**	**560.3**	NR	**1,025.3**	**549.8**	**618.6**
Mercury	2.3[a]	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nickel	130	6010B/6020A	**18.1**	**16.7**	**15.4**	**15.4**	**14.6**	**14.4**	**15.4**	**15**	NR	**20.6**	**12.1**	**16.2**
Potassium	-	6010B/6020A	**986.7**	**819.7**	**748.8**	**737.4 J**	**851.9**	**890.2**	**463.6 J**	**1,525**	NR	**325.8 J**	**265.2 J**	**350.2 J**
Selenium	5	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Silver	34	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	**0.6 J**	NR	**0.5 J**	NR	NR
Sodium	-	6010B/6020A	**27.6**	**79.0**	**23.9**	**88.9**	**21.1**	**16.4**	**33.7**	**30.4**	NR	**49.8**	**24.1**	**25.2**
Thallium	0.7	6010B/6020A	NR	**0.3 J**	NR	NR	**0.3 J**	NR	NR	**0.4 J**	NR	**0.3 J**	NR	NR
Vanadium	39[a]	6010B/6020A	**22**	**24.9**	**24.6**	**18.4**	**24.1**	**25**	**25.4**	**21.1**	NR	**22.8**	**26.8**	**27.3**
Zinc	2,300[a]	6010B/6020A	**58.5**	**51.4**	**129.7**	**208.2**	**62.2**	**67**	**49.1**	**393.3**	NR	**45.9**	**33.7**	**37**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level.
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
NR = Not reported
SB-004 surface soil sample was not collected
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[b]This sample ID is most likely MW-106
Depths for SB samples reported were known
- = No screening level available.

TABLE 2-10
2005 USACE Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Screening Levels (0-10')	Sample ID>> / Sample Interval (ft)>> / Test Method	CSS-001	CSS-002	CSS-003	CSS-004	CSS-005	CSS-006	CSS-007	CSS-008	CSS-009	CSS-010	CSS-011	CSS-012
		Sample Interval (ft)>>	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
		Test Method												
Aluminum	7,700[a]	6010B/6020A	**5,748.2**	**5,821**	**6,382.4**	**7,358.6**	**6,464.2**	**6,847.8**	**6,995.7**	**6,287.4**	**4,192.7**	**7,148.2**	**7,355.6**	**7,729.0**
Antimony	3.1[a]	6010B/6020A	**1.2 J**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	12.3	6010B/6020A	**5.9**	**6.3**	**4**	**7**	**6.2**	**5.5**	**6.2**	**5.7**	**5.8**	**6.8**	**6.7**	**7.5**
Barium	1,600[a]	6010B/6020A	**106.9**	**109.8**	**97.9**	**140.6**	**141**	**176.5**	**129.3**	**115.8**	**86.2**	**177.7**	**169.1**	**146.2**
Beryllium	16[a]	6010B/6020A	NR	**0.4 J**	NR	**0.3 J**	**0.3 J**	**0.3 J**	**0.4 J**	NR	NR	**0.5**	**0.5**	**0.4 J**
Cadmium	3.9[a]	6010B/6020A	**1.1 J**	**0.5**	**0.5 J**	**0.3 J**	**0.5 J**	**0.8 J**	**0.6 J**	**0.6 J**	**0.4 J**	**0.6 J**	**0.9 J**	**0.5 J**
Calcium	-	6010B/6020A	**48,984**	**30,669**	**49,170**	**7,994.7**	**13,723**	**10,753**	**8,807.4**	**48,589**	**10,646**	**7,405.5**	**9,460**	**3,434.9**
Chromium	38	6010B/6020A	**10**	**8.2**	**14.2**	**5.7**	**6.4**	**7.3**	**8**	**8.1**	**3.8**	**7.6**	**18.7**	**6.9**
Cobalt	900	6010B/6020A	**8.2**	**9.8**	**8.5**	**8.7**	**7.8**	**8.8**	**8.1**	**10.5**	**5.1**	**12.4**	**8.1**	**9.7**
Copper	290[a]	6010B/6020A	**43.6**	**17.2**	**20.4**	**20.7**	**20.6**	**38.7**	**23.6**	**23.8**	**12**	**22.8**	**410.2**	**16.7**
Iron	5,500[a]	6010B/6020A	**21,855**	**13,020**	**13,258**	**15,411**	**13,429**	**14,467**	**14,827**	**13,028**	**9,094.2**	**18,123.0**	**15,177.0**	**15,843**
Lead	400	6010B/6020A	**1,022.9**	**44.3**	**143.3**	**34.6**	**56.1**	**73.9**	**42.3**	**51.4**	**27.7**	**40.3**	**78**	**24.9**
Magnesium	-	6010B/6020A	**7,977.9**	**5,266.4**	**7,703.6**	**3,740.2**	**4,056.1**	**2,791.7**	**3,134.3**	**2,468.9**	**1,398.7**	**2,475.6**	**2,184.9**	**2,118.7**
Manganese	350[a]	6010B/6020A	**516.8**	**594.2**	**526.6**	**654.6**	**617.9**	**673.7**	**546.4**	**656.2**	**336.3**	**938.2**	**406.9**	**761.9**
Mercury	2.3[a]	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nickel	130	6010B/6020A	**19.7**	**14.7**	**17.8**	**18.1**	**15.6**	**17.6**	**16.9**	**14.1**	**9.9**	**19.6**	**16.2**	**19.2**
Potassium	-	6010B/6020A	**712.1 J**	**616.7**	**515.2 J**	**700.9**	**759.6**	**651.3**	**747.5**	**972.9 J**	**382.9 J**	**721.5**	**449.8**	**593.4**
Selenium	5	6010B/6020A	NR	NR	NR	**0.5 J**	**0.6 J**	**0.5 J**	**0.6 J**	**0.7 J**	**0.6 J**	**0.6 J**	**0.5 J**	NR
Silver	34	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Sodium	-	6010B/6020A	**42.7**	**39.3**	**39.1**	**28.3**	**31.5**	**46.5**	**25.8**	**24.1 J**	**24.7**	**23.4**	**32.5**	**22.9**
Thallium	0.7	6010B/6020A	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**0.2**
Vanadium	39[a]	6010B/6020A	**22.5**	**23.4**	**23.5**	**24.1**	**22**	**22.3**	**23.9**	**22**	**13.9**	**29.1**	**25.8**	**25.9**
Zinc	2,300[a]	6010B/6020A	**272.4**	**92.9**	**73.3**	**66.1**	**93.4**	**249.7**	**84**	**111.5**	**53.3**	**72.4**	**102.8**	**67.8**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level.
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
NR = Not reported
SB-004 surface soil sample was not collected
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[b]This sample ID is most likely MW-106
Depths for SB samples reported were known
- = No screening level available.

TABLE 2-10
2005 USACE Soil TAL Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Screening Levels (0-10')	Sample ID>> / Sample Interval (ft)>> / Test Method	CSS-013 / 0-1	CSS-014 / 0-1	CSS-015 / 0-1
Aluminum	7,700[a]	6010B/6020A	**9,733.4**	**5,510.8**	**7,440**
Antimony	3.1[a]	6010B/6020A	NR	**1.2 J**	NR
Arsenic	12.3	6010B/6020A	**8.3**	**10.3**	**13**
Barium	1,600[a]	6010B/6020A	**151.1**	**134.3**	**125.7**
Beryllium	16[a]	6010B/6020A	**0.5**	**0.3 J**	**0.4 J**
Cadmium	3.9[a]	6010B/6020A	**0.8 J**	**0.7 J**	**0.5 J**
Calcium	-	6010B/6020A	**3,651.3**	**5,044.8**	**5,552.7**
Chromium	38	6010B/6020A	**8.6**	**9.1**	**7.2**
Cobalt	900	6010B/6020A	**10.1**	**7.2**	**8.5**
Copper	290[a]	6010B/6020A	**64.5**	**28**	**20.9**
Iron	5,500[a]	6010B/6020A	**17,813**	**11,512**	**14,421**
Lead	400	6010B/6020A	**40**	**176.9**	**40.2**
Magnesium	-	6010B/6020A	**2,060.5**	**2,125.2**	**2,173.7**
Manganese	350[a]	6010B/6020A	**562.0**	**528.3**	**622.8**
Mercury	2.3[a]	6010B/6020A	NR	NR	NR
Nickel	130	6010B/6020A	**18.2**	**13.8**	**15.9**
Potassium	-	6010B/6020A	**480.2**	**454.5**	**530.1**
Selenium	5	6010B/6020A	**0.6 J**	**0.6 J**	**0.7 J**
Silver	34	6010B/6020A	NR	NR	NR
Sodium	-	6010B/6020A	**25.6**	**32.3**	**17.5**
Thallium	0.7	6010B/6020A	NR	NR	NR
Vanadium	39[a]	6010B/6020A	**30.5**	**19.7**	**25.5**
Zinc	2,300[a]	6010B/6020A	**87.5**	**110.6**	**56.4**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level.
J = Reported value is estimated
mg/kg = milligrams per kilogram
NA = Sample interval was not available
NR = Not reported
SB-004 surface soil sample was not collected
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[b]This sample ID is most likely MW-106
Depths for SB samples reported were known
- = No screening level available.

TABLE 2-11
2005 USACE Soil PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	SB-001	SB-002	SB-002	SB-003	SB-005	SB-006	SB-008	SB-009	SB-010	SB-011
		Sample Interval (ft)>>	NA	NA	3-4	NA	NA	NA	NA	NA	0-1	NA
PAHs (µg/kg)	**Screening Levels (0-10')**	**Test Method**										
Acenaphthene	370,000[a]	SW8270C SIM	**3.3 J**	**13.2**	NR	NR	**9.1**	**2.3 J**	**20.0 J**	**29.1**	**115.2**	**27.3**
Acenaphthylene	30.5	SW8270C SIM	**2.2 J**	**3.7 J**	NR	NR	NR	NR	NR	**9**	NR	NR
Anthracene	2,200,000[a]	SW8270C SIM	**11.4**	**2.4 J**	NR	**4.2 J**	**4.1 J**	**5.2 J**	**4.9 J**	**44.4**	**173.7**	**661.7**
Benzo(a)anthracene	887	SW8270C SIM	**80.1**	**24**	NR	**30.7**	**21.4**	**54.5**	**37.4**	**111.3**	**729.5**	**325.2**
Benzo(a)pyrene	735	SW8270C SIM	**75.7**	**19.8**	**121**	**29.5**	**19.7**	**48.5**	**32.1**	**80**	**505.3**	**264.1**
Benzo(b)fluoranthene	626	SW8270C SIM	**122.8**	**28.4**	NR	**46.7**	**27.8**	**80.2**	**55.7**	**129.8**	**818.6**	**469.7**
Benzo(g,h,i)perylene	478	SW8270C SIM	**65.8**	**15.5**	NR	**25.8**	**14.3**	**36.2**	**26.4**	**52.3**	**355.5**	**200.8**
Benzo(k)fluoranthene	1,500	SW8270C SIM	**37.5**	**9.61**	NR	**14.3**	**88.5**	**19.7**	**17.2**	**40.2**	**280**	**125.9**
Chrysene	15,000	SW8270C SIM	**90**	**18**	NR	**34.2**	**22**	**50.2**	**38.1**	**90.6**	**562**	**329.6**
Dibenz(a,h)anthracene	303	SW8270C SIM	**12.1**	**3.0 J**	NR	**4.8 J**	**3.0 J**	**7.4 J**	**5.1 J**	**11.4**	**81.1**	**41.1**
Fluoranthene	230,000[a]	SW8270C SIM	**172.4**	**37**	NR	**63.2**	**42.1**	**96**	**65.7**	**251.7**	**1,461.5**	**830**
Fluorene	260,000[a]	SW8270C SIM	**3.8 J**	**10.7**	NR	NR	**9.6**	NR	NR	**15.5**	**53.2**	**25.3**
Indeno(1,2,3-cd)pyrene	415	SW8270C SIM	**58.1**	**14.8**	NR	**22.3**	**13.1**	**31.3**	**23.3**	**46.2**	**338.7**	**177.9**
Naphthalene	12,000[a]	SW8270C SIM	**2.09 J**	**7.12 J**	NR	NR	NR	**2.4 J**	NR	**4.2 J**	**12 J**	**3.8 J**
Phenanthrene	1,040	SW8270C SIM	**65.2**	**13.2**	NR	**21.3**	**18.2**	**22.7**	**22.3**	**164**	**808.1**	**436.5**
Pyrene	230,000[a]	SW8270C SIM	**143.5**	**35.5**	NR	**54.2**	**40.9**	**79.1**	**57.5**	**199**	**1,239.6**	**604.5**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
J = Reported value is estimated
NA = Sample interval was not available
NR = Not reported
PAH = polycyclic aromatic hydrocarbon
µg/kg = micrograms per kilogram
Depths for SB samples reported were known
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-11
2005 USACE Soil PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

PAHs (µg/kg)	Screening Levels (0-10')	Sample ID>> Sample Interval (ft)>> Test Method	SB-012 NA	SB-013 NA	SB-014 NA	SB-015 NA	SB-016 NA	SB-017 NA	SB-017 3-4	SB-018 NA	SB-019 NA
Acenaphthene	370,000[a]	SW8270C SIM	NR	NR	**55.9**	**8.5 J**	**14.5**	**75.6**	NR	**12.1**	**3.2 J**
Acenaphthylene	30.5	SW8270C SIM	NR	NR	NR	NR	4.3 J	NR	NR	NR	**3.9 J**
Anthracene	2,200,000[a]	SW8270C SIM	**4.4 J**	ND	**150.2**	**13.1**	**26.9**	**111.9**	NR	**22.8**	**7.2 J**
Benzo(a)anthracene	887	SW8270C SIM	**76.1**	**5.8 J**	**522.1**	**77.2**	**205.2**	**363**	NR	**140.1**	**48.8**
Benzo(a)pyrene	735	SW8270C SIM	**50.7**	**3.9 J**	**345**	**64.3**	**187.8**	**261.7**	**131**	**109.2**	**43.8**
Benzo(b)fluoranthene	626	SW8270C SIM	**111.7**	**7.9 J**	**603.4**	**112.1**	**331.5**	**456.8**	NR	**192**	**77.3**
Benzo(g,h,i)perylene	478	SW8270C SIM	**48.1**	**3.9 J**	**238.2**	**50.5**	**153.8**	**166.2**	NR	**83.1**	**35**
Benzo(k)fluoranthene	1,500	SW8270C SIM	**27.3**	**2.1 J**	**187**	**33**	**95.1**	**104.1**	NR	**45.6**	**19.8**
Chrysene	15,000	SW8270C SIM	**70**	**5.3 J**	**481.1**	**86.3**	**245.8**	**304**	NR	**120.4**	**56.8**
Dibenz(a,h)anthracene	303	SW8270C SIM	**9.9**	NR	**54.5**	**10.5**	**32**	**37**	NR	**17**	**6.6 J**
Fluoranthene	230,000[a]	SW8270C SIM	**128.4**	**10.1**	**1,317.4**	**176.4**	**497.9**	**836.8**	NR	**273**	**105.8**
Fluorene	260,000[a]	SW8270C SIM	ND	ND	**61.3**	**5.5 J**	**9.4**	**38.3**	NR	**6.6 J**	**2 J**
Indeno(1,2,3-cd)pyrene	415	SW8270C SIM	**42.3**	**3.4 J**	**223.6**	**44.9**	**148.8**	**149.8**	NR	**69.6**	**32.7**
Naphthalene	12,000[a]	SW8270C SIM	NR	NR	**3.3 J**	**2.5 J**	**2.7 J**	**6 J**	NR	NR	**7.2 J**
Phenanthrene	1,040	SW8270C SIM	**29.8**	**4.9 J**	**823.3**	**86.3**	**190**	**492.9**	NR	**112.1**	**40**
Pyrene	230,000[a]	SW8270C SIM	**105.7**	**8.5**	**897.8**	**140.5**	**378.4**	**673**	NR	**228**	**92.6**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
J = Reported value is estimated
NA = Sample interval was not available
NR = Not reported
PAH = polycyclic aromatic hydrocarbon
µg/kg = micrograms per kilogram
Depths for SB samples reported were known
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-11
2005 USACE Soil PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	SB-019	SB-020	CSS-001	CSS-002	CSS-003	CSS-004	CSS-005	CSS-006	CSS-007
		Sample Interval (ft)>>	3-4	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
PAHs (µg/kg)	**Screening Levels (0-10')**	**Test Method**									
Acenaphthene	370,000[a]	SW8270C SIM	NR	**41,912.1**	NR	NR	NR	NR	**23.4**	**3.5 J**	**9.8**
Acenaphthylene	30.5	SW8270C SIM	NR	NR	NR	NR	NR	NR	**5.79**	NR	NR
Anthracene	2,200,000[a]	SW8270C SIM	NR	**54,777**	NR	NR	NR	NR	**69.4**	**10.9**	**28.5**
Benzo(a)anthracene	887	SW8270C SIM	NR	**245,704**	NR	NR	NR	NR	**201**	**73.1**	**220.4**
Benzo(a)pyrene	735	SW8270C SIM	**119**	**196,359**	NR	NR	NR	NR	**142.8**	**61.5**	**171.7**
Benzo(b)fluoranthene	626	SW8270C SIM	NR	**388,878**	NR	NR	NR	NR	**246.1**	**90.6**	**337.3**
Benzo(g,h,i)perylene	478	SW8270C SIM	NR	**136,295**	NR	NR	NR	NR	**112.5**	**88.4**	**156.6**
Benzo(k)fluoranthene	1,500	SW8270C SIM	NR	**104,945**	NR	NR	NR	NR	**396.7**	**19.1**	**85.9**
Chrysene	15,000	SW8270C SIM	NR	**328,483**	NR	NR	NR	NR	**150.4**	**67.1**	**189.4**
Dibenz(a,h)anthracene	303	SW8270C SIM	NR	**30,616**	NR	NR	NR	NR	**30.1**	**10.9**	**37.7**
Fluoranthene	230,000[a]	SW8270C SIM	NR	**797,026**	NR	NR	NR	NR	**470.8**	**172.2**	**510**
Fluorene	260,000[a]	SW8270C SIM	NR	**36,137**	NR	NR	NR	NR	**25**	**4.1**	**7.6 J**
Indeno(1,2,3-cd)pyrene	415	SW8270C SIM	NR	**131,387**	NR	NR	NR	NR	**129.1**	**51.8**	**177.7**
Naphthalene	12,000[a]	SW8270C SIM	NR	**21,848 J**	NR	NR	NR	NR	**6.3 J**	NR	NR
Phenanthrene	1,040	SW8270C SIM	NR	**632**	NR	NR	NR	NR	**296.5**	**65.3**	**152.9**
Pyrene	230,000[a]	SW8270C SIM	NR	**703,713**	NR	NR	NR	NR	**320.8**	**110.8**	**308.4**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
J = Reported value is estimated
NA = Sample interval was not available
NR = Not reported
PAH = polycyclic aromatic hydrocarbon
µg/kg = micrograms per kilogram
Depths for SB samples reported were known
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-11
2005 USACE Soil PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Sample ID>>	CSS-008	CSS-009	CSS-010	CSS-011	CSS-012	CSS-013	CSS-014	CSS-015
		Sample Interval (ft)>>	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
PAHs (µg/kg)	**Screening Levels (0-10')**	**Test Method**								
Acenaphthene	370,000[a]	SW8270C SIM	**8.6**	**59.1**	**14.7**	**17.8**	**10.4**	**6.2 J**	NR	NR
Acenaphthylene	30.5	SW8270C SIM	NR	NR	NR	NR	NR	NR	NR	NR
Anthracene	2,200,000[a]	SW8270C SIM	**288.3**	**125.1**	**43.1**	**35,530**	**30.1**	**11**	NR	NR
Benzo(a)anthracene	887	SW8270C SIM	**215.2**	**551.5**	**232.4**	**108.9**	**118.7**	**59**	NR	NR
Benzo(a)pyrene	735	SW8270C SIM	**164.6**	**434.3**	**169.3**	**82.3**	**78.2**	**47.2**	NR	NR
Benzo(b)fluoranthene	626	SW8270C SIM	**325.2**	**766.9**	**387.9**	**171.3**	**17.2**	**93.5**	NR	NR
Benzo(g,h,i)perylene	478	SW8270C SIM	**152.3**	**338.8**	**152.9**	**85.7**	**61.8**	**44**	NR	NR
Benzo(k)fluoranthene	1,500	SW8270C SIM	**84.2**	**185.7**	**57.2**	**27.2**	**24.5**	**24.3**	NR	NR
Chrysene	15,000	SW8270C SIM	**187.1**	**577.6**	**209.4**	**89.2**	**89.5**	**51.6**	NR	NR
Dibenz(a,h)anthracene	303	SW8270C SIM	**35.7**	**69.3**	**40.1**	**26.7**	**25.6**	**22.9**	NR	NR
Fluoranthene	230,000[a]	SW8270C SIM	**520.4**	**1,590**	**611.8**	**266.0**	**248.9**	**139.4**	NR	NR
Fluorene	260,000[a]	SW8270C SIM	**8**	**60.2**	**14.2**	**12.8**	**10.7**	**3.4**	NR	NR
Indeno(1,2,3-cd)pyrene	415	SW8270C SIM	**176.6**	**314.4**	**168.3**	**79.3**	**68.2**	**48.3**	NR	NR
Naphthalene	12,000[a]	SW8270C SIM	NR	**14.5 J**	NR	**3.1 J**	**3.2 J**	NR	NR	NR
Phenanthrene	1,040	SW8270C SIM	**159.6**	**922.1**	**260.4**	**142.2**	**135.9**	**53.8**	NR	NR
Pyrene	230,000[a]	SW8270C SIM	**305.3**	**1,039.6**	**358.2**	**173.5**	**168**	**88.9**	NR	NR

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
J = Reported value is estimated
NA = Sample interval was not available
NR = Not reported
PAH = polycyclic aromatic hydrocarbon
µg/kg = micrograms per kilogram
Depths for SB samples reported were known
[a]MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

TABLE 2-12
2007 USACE Soil VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Sample ID>>	SB-023	SB-023	SB-023	SB-023	SB-023	SB-023	SB-024	SB-024	SB-024	SB-024	SB-025	SB-025	SB-025	SB-025	SB-026	SB-026
			Sample Interval (ft)>>	1.7–2.2	5–6	10–11	16–17	21–22	25–26	0.5–1	5–6	16–17	21–22	0.5–1	5–6	14–15	21–22	0.5–1	5–6
VOCs (µg/kg)	**Screening Levels (0-10')**	**Screening Levels[a] (>10')**	**Test Method**																
n-Butylbenzene	14,000[b]	240,000[b]	SW8260B	<6.0	<6.4	<6.5	<2.2 JB	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
sec -Butylbenzene	11,000[b]	220,000[b]	SW8260B	<6.0	<6.4	<6.5	**1.3 J**	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Carbon tetrachloride	70	580	SW8260B	<6.0	<6.4	**200.0**	**21.0**	**13.0**	**3.5 J**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Chloroform	250	580	SW8260B	<6.0	<6.4	**2.2 J**	**.68 J**	**0.73 J**	<5.8	<6.0	<6.4	**0.47 J**	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,2-Dichlorobenzene	17,000	370,000	SW8260B	<6.0	<6.4	<6.5	<6.2	<5.9	<5.8	**5.5 J**	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,3-Dichlorobenzene	6,900[b]	14,000[v]	SW8260B	<6.0	<6.4	<6.5	<6.2 J	<5.9	<5.8	**0.78 J**	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,1-Dichloroethene	60	47,000[b]	SW8260B	**0.86 J**	<6.4	**2.2 J**	<6.2	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,2-Dichloroethane	20	840	SW8260B	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
cis -1,2-Dichloroethene	400	16,000[b]	SW8260B	**700.0**	**120.0**	**52.0**	**11.0**	**16.0**	**6.6**	**32.0**	**500.0**	**140.0**	**11.0**	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
trans -1,2-Dichloroethene	700	20,000[b]	SW8260B	**36.0**	**8.5**	**0.4 J**	<6.2	<5.9	<5.8	**1.6 J**	**16.0**	**0.54 J**	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Ethylbenzene	13,000	230,000	SW8260B	<6.0	<6.4	**19.0**	**120.0**	**7.8**	**3.0 J**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Hexachlorobutadiene	2,000	2,500	SW8260B	<6.0 J	<6.4 J	<6.5 J	**8.6**	<5.9 J	<5.8 J	<6.0 J	<6.4 J	<6.3 J	<6.1 J	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Isopropylbenzene	37,000	58,000[b]	SW8260B	<6.0	<6.4	<6.5	**0.78 J**	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
4-Isopropyltoluene (p-isopropylte)	-	-	SW8260B	<6.0	<6.4	**1.7 J**	**8.8 J**	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Naphthalene	12,000[b]	21,000[b]	SW8260B	<6.0	<6.4	<6.5 J	<1.8 JB	<5.9	<5.8 J	<6.0 J	<6.4 J	<6.3 J	<6.1 J	<1.2 JBU	<6.3	<6.5	<6.0	<1.7 JBU	<6.5
1,1,1,2-Tetrachloroethane	3,000	7,600	SW8260B	<6.0	<6.4	**140.0**	**120.0**	**18.0**	**13.0**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,1,2,2-Tetrachloroethane	3	970	SW8260B	<6.0	<6.4	<6.5	<6.2	<5.9	**1.2 J**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Tetrachloroethene	60	1,700	SW8260B	**130.0 J**	**4,900.0**	**180,000.0 J**	**110,000.0 J**	**27,000.0**	**3,200,000.0 J**	**280.0 J**	**19.0**	**3,500.0**	**1,100.0**	**1.2 J**	<6.3	**6.1 J**	<6.0	**1.2 J**	**0.46 J**
Toluene	12,000	520,000	SW8260B	<6.0	<6.4	**7.3**	**4.6 J**	<5.9	<5.8	**0.66 J**	<6.4	<6.3	<6.1	**0.68 J**	<6.3	<6.5	<6.0	<6.5	<6.5
1,2,4-Trichlorobenzene	5,000	26,000[b]	SW8260B	<6.0	<6.4	<6.5	<6.2 J	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,1,1-Trichloroethane	2,000	1,400,000	SW8260B	<6.0	<6.4	**1.2 J**	<6.2	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,1,2-Trichloroethane	20	2,100	SW8260B	<6.0	<6.4	**15**	**4.9 J**	**3.1 J**	**2.9 J**	<6.0	<6.4	**0.62 J**	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
Trichloroethene	43	100	SW8260B	**590.0**	**520.0**	**140.0**	**140.0**	**18**	**6.0**	<6.0	**130.0**	**61 J**	**9.3**	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
1,2,4-Trimethylbenzene	5,700	19,000[b]	SW8260B	<6.0	<6.4	<1.2 JBU	<5.1 JBU	<5.9	<5.8	<0.93 JBU	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<1.4 JBU	<6.5
1,3,5-Trimethylbenzene	2,100[b]	7,800[b]	SW8260B	<6.0	<6.4	<2.0 JBU	**7.7 J**	<5.9	<5.8	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
o-Xylene	210,000	280,000	SW8260B	<6.0	<6.4	**8.3**	**32**	**2.1 J**	**0.97 J**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5
m-and-p-Xylene	210,000	210,000	SW8260B	<6.0	<6.4	**58**	**400**	**26**	**10**	<6.0	<6.4	<6.3	<6.1	<6.2	<6.3	<6.5	<6.0	<6.5	<6.5

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
< = Chemical not detected
B = Blank detection
D = Qualified at dilution
J = Estimated, assigned by laboratory
JBU = Not detected, "U" qualifier assigned
NR = Not reported
VOC = volatile organic compound
µg/kg = micrograms per kilogram
[a]Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
- = No screening level available.

TABLE 2-12
2007 USACE Soil VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

VOCs (µg/kg)	Screening Levels (0-10')	Screening Levels[a] (>10')	SB-026 14–15	SB-027 0.5–1	SB-027 5–6	SB-027 15–16	SB-027 20–21	SB-028 0.5–1	SB-028 5–6	SB-028 15–16	SB-028 20–21	SB-029 0.5–1	SB-029 5–6	SB-029 15–16	SB-029 20–21	SB-030 1.3–1.8	SB-030 5–6	SB-030 15–16	SB-030 21–22	SB-031 1.3–1.8
n-Butylbenzene	14,000[b]	240,000[b]	<6.3	**2.5 J**	<6.5	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<6.5 J	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
sec -Butylbenzene	11,000[b]	220,000[b]	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<6.5 J	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
Carbon tetrachloride	70	580	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
Chloroform	250	580	<6.3	<6.2	<6.5	**3.0 J**	**0.6 J**	<6.4	<6.5	**2.2 J**	**1.2 J**	<6.4	<6.5	**2.2 J**	<6.1	NR	NR	NR	NR	NR
1,2-Dichlorobenzene	17,000	370,000	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
1,3-Dichlorobenzene	6,900[b]	14,000[v]	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<6.5 J	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
1,1-Dichloroethene	60	47,000[b]	<6.3	<6.2	<6.5	**1.1 J**	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
1,2-Dichloroethane	20	840	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	<6.2	**2.6 J**	**12.0**	**130.0**	<6.1
cis -1,2-Dichloroethene	400	16,000[b]	<6.3	**0.7 J**	**14**	**18**	**3.6 J**	**86 J**	**50.0**	**160.0**	**63.0**	**0.67 J**	**58.0**	**100.0**	**140.0**	**0.80 J**	**19.0 J**	**8.4 J**	**0.95 J**	**53.0 J**
trans -1,2-Dichloroethene	700	20,000[b]	<6.3	<6.2	**1.6 J**	<6.3	<6.4	**1.9 J**	**1.4 J**	**1.3 J**	**0.41 J**	<6.4	**0.62 J**	**1.7 J**	**2.0 J**	<6.2 J	**1.0 J**	<6.1 J	<6.2 J	**13 J**
Ethylbenzene	13,000	230,000	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
Hexachlorobutadiene	2,000	2,500	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
Isopropylbenzene	37,000	58,000[b]	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
4-Isopropyltoluene (p-isopropylte)	-	-	<6.3	**1.5 J**	<6.5	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<6.5 J	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
Naphthalene	12,000[b]	21,000[b]	<6.3	**8.7**	<6.5	<6.3	<6.4	<3.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<1.4 JBU	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
1,1,1,2-Tetrachloroethane	3,000	7,600	<6.3	<6.2	<6.5	**6 J**	<6.4	<6.4	<6.5	**4.5 J**	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
1,1,2,2-Tetrachloroethane	3	970	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
Tetrachloroethene	60	1,700	<6.3	**100.0 J**	**320.0**	**8,000.0**	**2,900.0**	**6,400.0**	**780.0**	**3,500.0**	**2,300.0**	**17.0 J**	**48.0 J**	**550.0**	**610.0**	<6.2	**58.0**	**2,100.0 D**	**1,000.0 D**	<6.1
Toluene	12,000	520,000	<6.3	**1.0 J**	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
1,2,4-Trichlorobenzene	5,000	26,000[b]	<6.3	**2.1 J**	<6.5	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<6.5 J	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
1,1,1-Trichloroethane	2,000	1,400,000	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	<6.2	<6.4	<6.1	<6.2	<6.1
1,1,2-Trichloroethane	20	2,100	<6.3	<6.2	<6.5	**1.7 J**	**0.8 J**	<6.4	<6.5	**0.88 J**	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
Trichloroethene	43	100	<6.3	**7.0**	**52.0**	**110.0**	**20.0**	**810.0**	**43.0**	**110.0**	**54.0**	**2.2 J**	**31.0**	**59.0**	**66.0**	**0.65 J**	**42.0 J**	**14.0 J**	**11.0 J**	**41.0 J**
1,2,4-Trimethylbenzene	5,700	19,000[b]	<6.3	**11.0**	<6.5	<0.84 JBU	<6.4	<1.9 JBU	<6.5	<6.2	<6.3	<6.4	<2.0 JBU	<0.71 JBU	<6.1	NR	NR	NR	NR	NR
1,3,5-Trimethylbenzene	2,100[b]	7,800[b]	<6.3	**5.1 J**	**0.89 J**	<6.3	<6.4	<6.4 J	<6.5 J	<6.2 J	<6.3 J	<6.4 J	<0.83 JBU	<6.2 J	<6.1 J	NR	NR	NR	NR	NR
o-Xylene	210,000	280,000	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR
m-and-p-Xylene	210,000	210,000	<6.3	<6.2	<6.5	<6.3	<6.4	<6.4	<6.5	<6.2	<6.3	<6.4	<6.5	<6.2	<6.1	NR	NR	NR	NR	NR

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
< = Chemical not detected
B = Blank detection
D = Qualified at dilution
J = Estimated, assigned by laboratory
JBU = Not detected, "U" qualifier assigned
NR = Not reported
VOC = volatile organic compound
µg/kg = micrograms per kilogram
[a]Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
- = No screening level available.

TABLE 2-12
2007 USACE Soil VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

VOCs (µg/kg)	Screening Levels (0-10')	Screening Levels[a] (>10')	SB-031 5–6	SB-031 14–15	SB-031 21–22	SB-032 1.1–1.6	SB-032 5–6	SB-032 15–16	SB-032 21–22	SB-033 0.5–1	SB-033 5–6	SB-033 13–14	SB-033 19–20	SB-033 23–24	SB-034 0.5–1	SB-034 5–6	SB-034 14–15	SB-034 20–21
n-Butylbenzene	14,000[b]	240,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
sec -Butylbenzene	11,000[b]	220,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon tetrachloride	70	580	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chloroform	250	580	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,2-Dichlorobenzene	17,000	370,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,3-Dichlorobenzene	6,900[b]	14,000[v]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,1-Dichloroethene	60	47,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,2-Dichloroethane	20	840	**7.1**	**49.0**	**3.9 J**	<6.3	**1.4 J**	**11.0**	<6.2	<6.3	<6.4	<6.2	<6.3	<6.2	<6.4	<6.5	<6.1	<6.1
cis -1,2-Dichloroethene	400	16,000[b]	**43.0 J**	<6.3 J	<6.1 J	<6.3 J	**3.9 J**	<6.4 J	<6.2	<6.3	**7.6**	**190.0 JD**	**340.0 JD**	**280.0 J**	**8.7**	**1.7 J**	**17.0**	**7.3**
trans -1,2-Dichloroethene	700	20,000[b]	**6.8 J**	<6.3 J	<6.1 J	<6.3 J	<6.7 J	<6.4 J	<6.2	<6.3	<6.4	**3.9 J**	**6.8**	**3.3 J**	<6.4	<6.5	**0.45 J**	<6.1
Ethylbenzene	13,000	230,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hexachlorobutadiene	2,000	2,500	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Isopropylbenzene	37,000	58,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4-Isopropyltoluene (p-isopropylte)	-	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Naphthalene	12,000[b]	21,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,1,1,2-Tetrachloroethane	3,000	7,600	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,1,2,2-Tetrachloroethane	3	970	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tetrachloroethene	60	1,700	**920.0 D**	**460.0 D**	**4.1 J**	<6.3	<6.7	**10.0**	**0.40 J**	**11.0**	**11.0**	**1,100.0 D**	**1,500.0 D**	**890.0 J**	**52.0**	**28.0**	**1,000.0 D**	**380.0 D**
Toluene	12,000	520,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,2,4-Trichlorobenzene	5,000	26,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,1,1-Trichloroethane	2,000	1,400,000	<6.3	<6.3	<6.1	<6.3	<6.7	<6.4	<6.2	<6.3	<6.4	<6.2	<6.3	<6.2	<6.4	<6.5	**0.94 J**	**0.53 J**
1,1,2-Trichloroethane	20	2,100	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Trichloroethene	43	100	**180.0 J**	**16.0 J**	**1.2 J**	<6.3 J	**4.2 J**	**3.0 J**	<6.2	**1.1 J**	**6.5**	**120.0**	**180.0 JD**	**140.0**	**16.0**	**32.0**	**38.0**	**17.0**
1,2,4-Trimethylbenzene	5,700	19,000[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1,3,5-Trimethylbenzene	2,100[b]	7,800[b]	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
o-Xylene	210,000	280,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
m-and-p-Xylene	210,000	210,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level
< = Chemical not detected
B = Blank detection
D = Qualified at dilution
J = Estimated, assigned by laboratory
JBU = Not detected, "U" qualifier assigned
NR = Not reported
VOC = volatile organic compound
µg/kg = micrograms per kilogram
[a]Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.
[b] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
- = No screening level available.

TABLE 2-13
2008 RI Surface Soil TAL Metals and PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

					Location>>	HA-01	HA-02	HA-03	HA-04	HA-05	HA-06	HA-07	HA-08	HA-09	HA-10	HA-11	HA-12
					Sample ID>>	HA-01-S-00	HA-02-S-00	HA-03-S-00	HA-04-S-00	HA-05-S-00	HA-06-S-00	HA-07-S-00	HA-08-S-00	HA-09-S-00	HA-10-S-00	HA-11-S-00	HA-12-S-00
					Sample Depth (ft)>>	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–0.25	0–2	0–2
					Sample Date>>	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008
Target Analyte List Metals	Units	Minimum Method Detection Limit	Minimum Reporting Limit	Screening Level (0-10')	Test Method												
Arsenic	mg/kg	0.3042	0.6084	12.3	SW6010B	**8.82**	**9.41**	**10**	**5.94**	**36.3**	**18.2**	**8.11**	**7.39**	**5.9**	**8.06**	**9.42**	**8.41**
Lead	mg/kg	0.1957	0.4598	400	SW6010B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polycyclic Aromatic Hydrocarbons	Units			Screening Level (0-10')	Test Method												
1-Methylnaphthalene	µg/kg	34	196.6	--	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	µg/kg	28	196.6	--	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	µg/kg	28	196.6	370,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	µg/kg	32	196.6	30.5	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	µg/kg	32	196.6	2,200,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	µg/kg	26	196.6	887	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	µg/kg	22	196.6	735	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	µg/kg	33.2	196.6	626	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	µg/kg	23	196.6	478	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	µg/kg	27	196.6	1,500	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	µg/kg	25.1	196.6	15,000	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	µg/kg	29	196.6	303	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	µg/kg	21	196.6	230,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	µg/kg	31	196.6	260,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	µg/kg	25.1	196.6	415	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	µg/kg	30	196.6	12,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	µg/kg	30	196.6	1,040	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	µg/kg	23	196.6	230,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note:
Bold type indicates a concentration above the sample quantification limit.
Gray highlight = A detected concentration above the selected screening level
Results reported as dry unit weight.
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
J = Reported value is estimated
NA = Not Analyzed
U = Not detected above the laboratory reporting limit.
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram

TABLE 2-13
2008 RI Surface Soil TAL Metals and PAH Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

					Location>>	HA-13	HA-14	HA-15	HA-16	HA-17	HA-18	HA-19	HA-20	HA-21	HA-22
					Sample ID>>	HA-13-S-00	HA-14-S-00	HA-15-S-00	HA-16-S-00	HA-17-S-00	HA-18-S-00	HA-19-S-00	HA-20-S-00	HA-21-S-00	HA-22-S-00
					Sample Depth (ft)>>	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2	0–2
					Sample Date>>	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/14/2008	5/14/2008	5/14/2008	5/14/2008	5/14/2008	5/14/2008
Target Analyte List Metals	Units	Minimum Method Detection Limit	Minimum Reporting Limit	Screening Level (0-10')	Test Method										
Arsenic	mg/kg	0.3042	0.6084	12.3	SW6010B	**9.05**	**8.19**	**9.14**	**5.47**	NA	NA	NA	NA	NA	NA
Lead	mg/kg	0.1957	0.4598	400	SW6010B	NA	NA	NA	NA	NA	NA	NA	**54.8 J**	**31 J**	**65 J**
Polycyclic Aromatic Hydrocarbons	Units			Screening Level (0-10')	Test Method										
1-Methylnaphthalene	µg/kg	34	196.6	--	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
2-Methylnaphthalene	µg/kg	28	196.6	--	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
Acenaphthene	µg/kg	28	196.6	370,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
Acenaphthylene	µg/kg	32	196.6	30.5	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
Anthracene	µg/kg	32	196.6	2,200,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**103 J**
Benzo(a)anthracene	µg/kg	26	196.6	887	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**505**
Benzo(a)pyrene	µg/kg	22	196.6	735	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**475**
Benzo(b)fluoranthene	µg/kg	33.2	196.6	626	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**604**
Benzo(g,h,i)perylene	µg/kg	23	196.6	478	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**242 J**
Benzo(k)fluoranthene	µg/kg	27	196.6	1,500	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**238 J**
Chrysene	µg/kg	25.1	196.6	15,000	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**512**
Dibenz(a,h)anthracene	µg/kg	29	196.6	303	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**65.2 J**
Fluoranthene	µg/kg	21	196.6	230,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**1140**
Fluorene	µg/kg	31	196.6	260,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
Indeno(1,2,3-cd)pyrene	µg/kg	25.1	196.6	415	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**211 J**
Naphthalene	µg/kg	30	196.6	12,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	243 U
Phenanthrene	µg/kg	30	196.6	1,040	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**527**
Pyrene	µg/kg	23	196.6	230,000*	SW8270C	NA	NA	NA	NA	NA	NA	NA	NA	NA	**901**

Note:
Bold type indicates a concentration above the sample quantification limit.
Gray highlight = A detected concentration above the selected screening level
Results reported as dry unit weight.
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
J = Reported value is estimated
NA = Not Analyzed
U = Not detected above the laboratory reporting limit.
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram

TABLE 2-14

2008 RI Surface Soil TCLP RCRA Analytical Results

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

					Location>>	HA-05	HA-06	HA-11	HA-13	HA-15	HA-17	HA-18	HA-19
					Sample ID>>	HA-05-S-00	HA-06-S-00	HA-11-S-00	HA-13-S-00	HA-15-S-00	HA-17-S-00	HA-18-S-00	HA-19-S-00
					Sample Depth (ft)>>	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2
					Sample Date>>	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/13/2008	5/14/2008	5/14/2008	5/14/2008
RCRA Metals	Units	Minimum Method Detection Limit	Minimum Reporting Limit	TCLP Limit	Test Method								
Arsenic	mg/L	0.03	0.1	5	SW6010B	**0.0598 J**	**0.0829 J**	**0.0992 J**	0.03 U	**0.0387 J**	0.043 U	0.043 U	**0.0524 J**
Barium	mg/L	0.0022	0.1	100	SW6010B	**1.33**	**1.29**	**1.59**	**1.54**	**1.08**	**1.28**	**1.22**	**1.04**
Cadmium	mg/L	0.0072	0.05	1	SW6010B	0.0072 U	0.0072 U	0.0072 U	0.0072 U	0.0072 U	0.0072 U	0.0072 U	0.0072 U
Chromium	mg/L	0.004	0.1	5	SW6010B	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	**0.0116 J**	**0.00851 J**
Lead	mg/L	0.037	0.15	5	SW6010B	**0.0382 J**	**0.0566 J**	0.0624 J	0.037 U	0.037 U	**0.0392 J**	0.037 U	0.037 U
Mercury	mg/L	0.00025	0.002	0.2	SW7470A	0.00025 R	0.00025 R	0.00025 R	0.00025 R	0.00025 R	0.00025 U	0.00025 U	0.00025 U
Selenium	mg/L	0.04	0.15	1	SW6010B	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Silver	mg/L	0.0051	0.1	5	SW6010B	0.0051 U	0.0051 U	0.0051 U	0.0051 U	0.0051 U	0.0051 U	0.0051 U	0.0051 U

Note:

Bold type indicates a concentration above the sample quantification limit.

R = Compound may or may not be present.

RCRA = Resource Conservation and Recovery Act

TCLP = Toxicity Characteristic Leaching Procedure

U = Not detected above the laboratory reporting limit.

mg/kg = milligrams per kilogram

TABLE 2-15
Confirmation Soil TCL VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Compound List VOC	Units	Minimum Method Detection Limit	Minimum Reporting Limit	Screening Level (0-10')	Screening Levels[b] (>10')	Location>>	CB-01	CB-01[c]	CB-02	CB-03	CB-04	CB-05[c]	CB-05[c]	CB-06	CB-07
						Sample ID>>	CB-01-S-30	Soil-2	CB-02-S-30	CB-03-S-8	CB-04-S-19	Soil-3	Soil-1	CB-06-S-21.5	CB-07-S-2
						Sample Depth (ft)>>	30-30.5	30-32	30-30.5	8-10	19-20	4-13	13-21	21.5-22.5	2-3
						Sample Date>>	5/21/2008	5/21/2008	5/21/2008	5/22/2008	5/22/2008	5/23/2008	5/23/2008	5/23/2008	5/29/2008
						Test Method									
1,1,1,2-Tetrachloroethane	µg/kg	0.405	1.84	3,000	7,600	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,1,1-Trichloroethane	µg/kg	0.604	1.84	2,000	1,400,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,1,2,2-Tetrachloroethane	µg/kg	0.558	1.84	3	970	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 UJ	2.7 U
1,1,2-Trichloroethane	µg/kg	0.36	1.84	20	2,100	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,1-Dichloroethane	µg/kg	0.666	1.84	23,000	2,300,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,1-Dichloroethene	µg/kg	0.574	1.84	60	47,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,1-Dichloropropene	µg/kg	0.581	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2,3-Trichlorobenzene	µg/kg	0.62	1.84	-	-	SW8260B	398 U	116 U	**1 J**	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2,3-Trichloropropane	µg/kg	0.757	1.84	320	1,600	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2,4-Trichlorobenzene	µg/kg	0.604	1.84	5,000	26,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2,4-Trimethylbenzene	µg/kg	0.46	1.84	5,700	19,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2-Dibromo-3-chloropropane	µg/kg	0.995	9.3	2.6	20	SW8260B	1,990 U	116 U	12.6 U	12.1 U	12 U	115 U	115 U	12 UJ	13.5 U
1,2-Dibromoethane(EDB)	µg/kg	0.39	1.84	28	70	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115U	2.4 U	2.7 U
1,2-Dichlorobenzene	µg/kg	0.39	1.84	17,000	370,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,2-Dichloroethane	µg/kg	0.444	1.84	20	840	SW8260B	398 U	116 U	2.5 U	2.4 U	**33**	115 U	115 U	2.4 U	2.7 U
1,2-Dichloropropane	µg/kg	0.444	1.84	30	850	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,3,5-Trimethylbenzene	µg/kg	0.497	1.84	2,100[a]	7,800[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,3-Dichlorobenzene	µg/kg	0.428	1.84	6,900[a]	14,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,3-Dichloropropane	µg/kg	0.38	1.84	11,000[a]	41,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
1,4-Dichlorobenzene	µg/kg	0.543	1.84	2000	8100	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
2,2-Dichloropropane	µg/kg	0.589	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
2-Butanone	µg/kg	0.77	9.3	3,200,000[a]	3,400,000[a]	SW8260B	1,990 U	1,160 U	12.6 U	12.1 U	12 U	1,150 U	1,150 U	12 UJ	**1.3 J**
2-Chlorotoluene	µg/kg	0.52	1.84	160,000[a]	510,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
2-Hexanone	µg/kg	0.995	9.3	-	-	SW8260B	1,990 U	NA	12.6 U	12.1 U	12 U	NA	NA	12 U	13.5 U
4-Chlorotoluene	µg/kg	0.428	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
4-Isopropyltoluene	µg/kg	0.46	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
4-Methyl-2-pentanone	µg/kg	1.3	9.3	-	-	SW8260B	1,990 U	NA	12.6 U	12.1 U	12 U	NA	NA	12 U	**2.4 J**
Acetone	µg/kg	4.74	9.3	16,000	6,000,000[a]	SW8260B	1,990 U	1,160 U	12.6 U	12.1 U	12 U	1,150 U	1,150 U	12 UJ	13.5
Acrolein	µg/kg	4.9	23	-	-	SW8260B	4,970 U	NA	31.4 U	30.3 U	30.1 U	NA	NA	30.1 UJ	33.8 U
Acrylonitrile	µg/kg	1.55	5.15	-	-	SW8260B	995 U	NA	6.3 U	6 U	6 U	NA	NA	6 U	6.8 U
Benzene	µg/kg	0.38	1.84	30	1,600	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Bromobenzene	µg/kg	0.428	1.84	7,300	12,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Bromochloromethane	µg/kg	0.842	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Bromodichloromethane	µg/kg	0.497	1.84	600	2,600	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Bromoform	µg/kg	1.3	4.6	800	240,000	SW8260B	995 U	116 U	6.3 U	6 U	6 U	115 U	115 U	6 U	6.8 U
Bromomethane	µg/kg	0.581	1.84	200	1,500	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 UJ	2.7 U
Carbon disulfide	µg/kg	0.352	1.84	32,000	720,000[a]	SW8260B	398 U	NA	2.5 U	2.4 U	2.4 U	NA	NA	2.4 U	2.7 U
Carbon tetrachloride	µg/kg	0.604	1.84	70	580	SW8260B	**27,300 J**	**6,670**	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Chlorobenzene	µg/kg	0.321	1.84	1,000	50,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Chloroethane	µg/kg	1.68	4.6	3,000	7,200	SW8260B	995 U	116 U	6.3 UJ	6 U	6 U	115 U	115 U	6 U	6.8 U
Chloroform	µg/kg	0.543	1.84	250	580	SW8260B	**669**	**268**	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Chloromethane	µg/kg	0.428	1.84	11,000[a]	17,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U

TABLE 2-15

Confirmation Soil TCL VOC Analytical Results

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

						Location>>	CB-01	CB-01[c]	CB-02	CB-03	CB-04	CB-05[c]	CB-05[c]	CB-06	CB-07
						Sample ID>>	CB-01-S-30	Soil-2	CB-02-S-30	CB-03-S-8	CB-04-S-19	Soil-3	Soil-1	CB-06-S-21.5	CB-07-S-2
						Sample Depth (ft)>>	30-30.5	30-32	30-30.5	8-10	19-20	4-13	13-21	21.5-22.5	2-3
						Sample Date>>	5/21/2008	5/21/2008	5/21/2008	5/22/2008	5/22/2008	5/23/2008	5/23/2008	5/23/2008	5/29/2008
Target Compound List VOC	Units	Minimum Method Detection Limit	Minimum Reporting Limit	Screening Level (0-10')	Screening Levels[b] (>10')	Test Method									
cis -1,2-Dichloroethene	µg/kg	0.918	1.84	400	16,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	**40 J**	**29.8 J**	2.4 U	2.7 U
cis -1,3-Dichloropropene	µg/kg	0.275	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Dibromochloromethane	µg/kg	0.46	1.84	400	2600	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Dibromomethane	µg/kg	0.918	1.84	14,000[a]	59,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 UJ
Dichlorodifluoromethane	µg/kg	0.52	1.84	9,400[a]	340,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Ethylbenzene	µg/kg	0.497	1.84	13,000	230,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Hexachlorobutadiene	µg/kg	1.84	3.67	2,000	2,500	SW8260B	796 U	116 U	5 U	4.8 U	4.8 U	115 U	115 U	4.8 UJ	5.4 U
Isopropylbenzene (Cumene)	µg/kg	0.604	1.84	37,000[a]	58,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115U	2.4 U	2.7 U
Methyl iodide	µg/kg	0.474	1.84	-	-	SW8260B	398 U	NA	2.5 U	2.4 U	2.4 U	NA	NA	2.4 U	2.7 U
Methylene chloride	µg/kg	0.77	4.6	20	22,000	SW8260B	**181 J**	116 U	6.3 U	6 UJ	6 UJ	115 U	115 U	6 UJ	6.8 UJ
MTBE	µg/kg	0.46	1.84	23,000	79,000	SW8260B	398 U	232 U	2.5 U	2.4 U	2.4 U	231 U	231 U	2.4 U	2.7 U
Naphthalene	µg/kg	0.321	1.84	12,000[a]	21,000[a]	SW8260B	398 U	116 U	**1.4 J**	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
n-Butylbenzene	µg/kg	0.367	1.84	14000[a]	240,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
n-Propylbenzene	µg/kg	0.54	1.84	14,000[a]	240,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
o-Xylene	µg/kg	0.497	1.84	190,000	280,000	SW8260B	398 U	**33.9 J**	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
p,m-Xylene	µg/kg	1.07	3.67	200,000	210,000	SW8260B	796 U	**30.7 J**	5 U	4.8 U	4.8 U	231 U	231 U	4.8 U	5.4 U
sec-Butylbenzene	µg/kg	0.574	1.84	11,000[a]	220,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Styrene	µg/kg	0.428	1.84	4,000	1,700,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
tert-Butylbenzene	µg/kg	0.558	1.84	13,000[a]	390,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Tetrachloroethene	µg/kg	0.918	4.6	60	1,700	SW8260B	995 U	116 U	6.3 U	6 U	**1.8 J**	**1,940**	**1,360**	**2.8 J**	6.8 U
Toluene	µg/kg	0.46	1.84	12,000	520,000	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
trans -1,2-Dichloroethene	µg/kg	0.558	1.84	700	20,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
trans -1,3-Dichloropropene	µg/kg	0.543	1.84	-	-	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Trichloroethene	µg/kg	0.918	1.84	43	100	SW8260B	**5,250**	**1,390**	2.5 U	2.4 U	2.4 U	**53.2 J**	**27.1 J**	2.4 U	2.7 U
Trichlorofluoromethane	µg/kg	0.627	1.84	39,000[a]	140,000[a]	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Vinyl acetate	µg/kg	0.46	1.84	99,000[a]	160,000[a]	SW8260B	398 U	NA	2.5 U	2.4 U	2.4 U	NA	NA	2.4 U	2.7 U
Vinyl chloride	µg/kg	0.474	1.84	10	860	SW8260B	398 U	116 U	2.5 U	2.4 U	2.4 U	115 U	115 U	2.4 U	2.7 U
Corresponding ECD Response (µV)							8,390,720	8,771,673	--	253,968	840,048	6,769,231	8,771,673	175,824	439,560

Note:

Bold = A concentration above the sample quantification limit

Gray highlight = A detected concentration above the selected screening level

Results reported as dry unit weight.

[a] MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

[b] Screening value based on USEPA Region 6 MSSLs for industrial outdoor worker.

[c] Soil samples were analyzed by Applied Sciences Laboratory

ECD = electron capture detector

J = Reported value is estimated

NA = Not Analyzed

U = Not detected above the laboratory reporting limit.

VOC = volatile organic compound

µg/kg = micrograms per kilograms

µV = microvolt

TABLE 2-16
2001 TapanAm and 2005/2006 USACE Groundwater Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	Sample ID>>	MW-101	MW-101	MW-101	MW-102	MW-102	MW-102	MW-103	MW-103	MW-103
	Year Sampled>>	2001	2005	2006	2001	2005	2006	2001	2005	2006
Metals (mg/L)	**Screening Levels**									
Aluminum	3.7*	**0.458**	**0.608**	**2.5**	ND	ND	ND	ND	ND	ND
Antimony	0.0015*	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.045	ND	**0.042**	**0.0478**	ND	**0.0211**	**0.0166**	ND	**0.0352**	**0.0472**
Barium	0.73*	**0.552**	**0.503**	**0.61**	**0.202 J**	**0.32885**	**0.371**	**0.0831 J**	**0.07851**	**0.176 J**
Beryllium	0.0073*	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.0018*	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	-	**121**	**114.89**	**120**	**87.6**	**98.861**	**108**	**151**	**206.95**	**193 J**
Chromium	-	**0.011 J**	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	0.073	**0.0168 J**	**0.01017 J**	**0.0144**	ND	ND	ND	**0.0153 J**	**0.0142 J**	**0.0166 B**
Copper	0.14*	ND	ND	**0.0083**	ND	ND	ND	ND	ND	ND
Iron	2.6*	**61**	**73.589**	**81.4**	**1.84**	**28.466**	**28.4**	**3.02**	**38.452**	**52.7**
Lead	0.015	ND	**0.00249**	**0.0024**	ND	**0.000823 J**	ND	ND	ND	ND
Magnesium	-	**56.2**	**53.129**	**56.3**	**44.3**	**50.575**	**55**	**69.1**	**74.716**	**76.5**
Manganese	0.17*	**15.2 J**	**16.138**	**15**	**9.05**	**9.519**	**9.63**	**11.7**	**23.492**	**19**
Mercury	0.00068	NRQ	ND	ND	NRQ	ND	ND	NRQ	ND	**0.00026**
Nickel	0.073*	**0.0184 J**	ND	ND	ND	ND	ND	**0.0227 J**	ND	ND
Postassium	-	ND	ND	ND	ND	ND	**1.89 J**	**2.62 J**	**26.146 J**	**1.54 J**
Selenium	0.018*	ND	**0.00594**	ND	ND	**0.00309**	ND	ND	**0.00421**	ND
Silver	0.018*	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	-	**77**	**68.119**	**81**	**79.3**	**67.51**	**83.2**	**82.1**	**74.654**	**81.9**
Thallium	0.00026*	ND	ND	**0.017**	ND	ND	ND	ND	ND	**0.0103**
Vanadium	0.018*	ND	ND	**0.0082**	ND	ND	ND	ND	ND	ND
Zinc	1.1*	ND	ND	**0.0212**	ND	ND	ND	ND	ND	ND

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above selected screening level
B = Blank Detection
J = Reported value is estimated
ND = Chemical not detected
NR = Not reported
NRQ = Analysis not requested for this sample

* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
- = No screening level available.

TABLE 2-16
2001 TapanAm and 2005/2006 USACE Groundwater Metals Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	Sample ID>>	MW-104	MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106
	Year Sampled>>	2001	2005	2006	2001	2005	2006	2005	2006
Metals (mg/L)	**Screening Levels**								
Aluminum	3.7*	**0.12 J**	**0.545**	**11.1**	ND	**0.232**	**0.678**	**0.4277**	**109**
Antimony	0.0015*	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.045	ND	ND	ND	ND	ND	ND	ND	ND
Barium	0.73*	**0.055 J**	**0.0327**	ND	**0.072 J**	**0.125**	**0.061 J**	**0.0793**	**0.189**
Beryllium	0.0073*	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.0018*	ND	ND	**0.0078**	ND	ND	ND	ND	ND
Calcium	-	**130**	**119.99**	**112 J**	**33.4**	**48.43**	**47.6**	**68.287**	**62 J**
Chromium	-	ND	ND	**0.0108**	ND	ND	ND	ND	**0.0167**
Cobalt	0.073	ND	ND	**0.0070 B**	ND	ND	ND	ND	ND
Copper	0.14*	ND	ND	**0.0255**	ND	ND	ND	ND	ND
Iron	2.6*	**0.85**	**1.7635**	**16.1**	**0.21**	**0.491**	**0.665**	**0.793**	**10.2**
Lead	0.015	ND	**0.000781 J**	**0.0045 B**	ND	**0.00066 J**	ND	**0.00698**	**0.0202**
Magnesium	-	**52.1**	**47.198**	**45.7**	**12.9**	**20.398**	**20.7**	**26.112**	**27.6**
Manganese	0.17*	**9.41**	**7.3307**	**7.17**	**0.131**	**0.0383**	**0.0169**	**0.257**	**0.124**
Mercury	0.00068	NRQ	ND	ND	NRQ	ND	ND	ND	ND
Nickel	0.073*	ND	ND	**0.0116 B**	ND	ND	ND	ND	ND
Postassium	-	**2.61 J**	ND	**4.66 J**	ND	ND	ND	ND	**1.77 J**
Selenium	0.018*	ND	**0.00116 J**	ND	ND	**0.00218**	ND	**0.004**	**0.0052**
Silver	0.018*	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	-	**58.5**	**47.075**	**50.6**	**23.6**	**24.117**	**26**	**37.311**	**38.7**
Thallium	0.00026*	ND	ND	ND	ND	ND	ND	ND	**0.0033 B**
Vanadium	0.018*	ND	ND	**0.0219**	ND	ND	ND	ND	**0.022 B**
Zinc	1.1*	ND	ND	**0.0309**	ND	ND	**0.0112 B**	ND	**0.0485**

Notes:
Bold = Detected concentration
Gray highlight = A detected concentration above selected screening level
B = Blank Detection
J = Reported value is estimated
ND = Chemical not detected
NR = Not reported
NRQ = Analysis not requested for this sample

* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
- = No screening level available.

TABLE 2-17
Groundwater VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	Units	Screening Level	Test Method	MW-106	MW-106	MW-106	MW-106	MW-106	MW-107	MW-107	MW-107	MW-108	MW-108	MW-108
			Location>>	MW-106	MW-106	MW-106	MW-106	MW-106	MW-107	MW-107	MW-107	MW-108	MW-108	MW-108
			Sample Date>>	2/1/2005	Feb-06	4/21/2007	6/3/2008	8/13/2010	4/20/2007	6/5/2008	8/11/2010	4/20/2007	6/4/2008	8/11/2010
1,1,1,2-Tetrachloroethane	µg/L	0.43	SW8260B	NA	NA	5 U	1 U	0.5 U	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U
1,1,2,2-Tetrachloroethane	µg/L	0.055	SW8260B	NA	NA	5 U	1 U	1 U	5 U	1 U	1 U	5 U	1 U	1 U
1,1,2-Trichloroethane	µg/L	0.2	SW8260B	NA	NA	NA	1 U	1.1 U	NA	1 UJ	1.1 U	NA	1 U	1.1 U
1,2-Dichloroethane	µg/L	0.12	SW8260B	**62.2**	**4.3 J**	**4.4 J**	**3.3**	**54.9**	**3.0 J**	1 UJ	**22.7**	5 U	1 U	0.5 U
Benzene	µg/L	0.35	SW8260B	ND	5 U	5 U	1 U	0.5 U	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U
Carbon tetrachloride	µg/L	0.17	SW8260B	ND	5 U	5 U	1 U	1 U	5 U	1 UJ	1 U	5 U	1 U	1 U
Chloroform	µg/L	0.17	SW8260B	ND	5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U
cis -1,2-Dichloroethene	µg/L	6.1*	SW8260B	ND	5 U	5 U	1 U	0.5 U	5 U	1 UJ	**0.57**	**10**	**9.4**	**6.6**
Methylene chloride	µg/L	4	SW8260B	ND	5 U	NA	0.54 U	5 U	NA	1 UJ	5 U	NA	0.53 U	5 U
Naphthalene	µg/L	0.62*	SW8260B	NA	NA	NA	1 U	5 R	NA	1 UJ	5 U	NA	1 U	5 U
Tetrachloroethene	µg/L	0.1	SW8260B	**0.34 J**	**0.44 J**	5 U	1 U	**0.32 J**	5 U	1 U	1.1 U	5 U	1 U	1.1 U
trans -1,2-Dichloroethene	µg/L	11*	SW8260B	ND	5 U	5 U	1 U	0.5 U	5 U	1 UJ	0.5 U	**0.54 J**	**0.6 J**	**0.35 J**
Trichloroethene	µg/L	0.028	SW8260B	**0.28 J**	5 U	5 U	1 U	**0.21 J**	5 U	1 U	**0.39 J**	**18**	**16.8**	**4.6**
Vinyl chloride	µg/L	0.015	SW8260B	ND	5 U	5 U	1 U	1 U	5 U	1 U	1 U	5 U	1 U	**0.19 J**

Note:
* USEPA Region 6 Medium-Specific Screening Levels for residential water adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
D = Quantified at dilution
J = Reported value is estimated
NA = Not Analyzed
ND = Not Detected
R = The sample results are rejected due to deficiencies in the ability to analyze the sample and to meet the quality control criteria. The presence or absence of the analyte cannot be verified.
U = Not detected above the laboratory reporting limit.
VOC = volatile organic compound
Bold indicates the analyte was detected
Shading indicates the analyte exceeded screening criteria

TABLE 2-17
Groundwater VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Location>>	MW-109	MW-109	MW-109	MW-110	MW-110	MW-110	MW-111	MW-111	MW-111
			Sample Date>>	4/22/2007	6/4/2008	8/11/2010	4/22/2007	6/5/2008	8/11/2010	4/21/2007	6/6/2008	8/13/2010
	Units	Screening Level	Test Method									
1,1,1,2-Tetrachloroethane	µg/L	0.43	SW8260B	5 U	1 U	0.5 U	5 U	20 UJ	25 U	**16**	50 U	**17.4 J**
1,1,2,2-Tetrachloroethane	µg/L	0.055	SW8260B	5 U	1 U	1 U	5 U	20 U	50 U	**0.58 J**	50 U	100 U
1,1,2-Trichloroethane	µg/L	0.2	SW8260B	NA	1 U	1.1 U	NA	20 UJ	57 U	NA	50 U	114 U
1,2-Dichloroethane	µg/L	0.12	SW8260B	5 U	1 U	0.5 U	**150**	**100 J**	**68.2**	5 U	50 U	50 U
Benzene	µg/L	0.35	SW8260B	5 U	1 U	0.5 U	5 U	20 UJ	25 U	**0.22 J**	50 U	50 U
Carbon tetrachloride	µg/L	0.17	SW8260B	5 U	1 U	1 U	5 U	20 UJ	51 U	**2.7 J**	50 U	102 U
Chloroform	µg/L	0.17	SW8260B	5 U	1 U	0.5 U	**0.35 J**	20 U	25 U	**20**	**23.8 J**	**21.7 J**
cis -1,2-Dichloroethene	µg/L	6.1*	SW8260B	**1.7 J**	**1.5**	**1.3**	**46**	**82.2 J**	**143**	**250 JD**	**281**	**330**
Methylene chloride	µg/L	4	SW8260B	NA	1	5 U	NA	20 UJ	250 U	NA	50 U	**139 J**
Naphthalene	µg/L	0.62*	SW8260B	NA	1 U	5 U	NA	20 UJ	250 U	NA	50 U	500 R
Tetrachloroethene	µg/L	0.1	SW8260B	**3.9 J**	**2.9**	**1 J**	**7,700 D**	**9,440**	**13,400**	**29,000 D**	**34,900**	**43,300**
trans -1,2-Dichloroethene	µg/L	11*	SW8260B	5 U	1 U	0.5 U	**0.93 J**	20 UJ	25 U	**12**	50 U	50 U
Trichloroethene	µg/L	0.028	SW8260B	**5.8**	**5.1**	**2.5**	**82**	**129**	**203**	**1,400 D**	**1,620**	**1,610**
Vinyl chloride	µg/L	0.015	SW8260B	5 U	1 U	1 U	5 U	20 U	50 U	**0.32 J**	50 U	100 U

Note:

* USEPA Region 6 Medium-Specific Screening Levels for residential wa
factor of 10 to account for cumulative effects from multiple noncarcinog
target organ.

D = Quantified at dilution

J = Reported value is estimated

NA = Not Analyzed

ND = Not Detected

R = The sample results are rejected due to deficiencies in the ability to analyze the sample and to meet the quality control criteria. The presence or absence of the analyte cannot be verified.

U = Not detected above the laboratory reporting limit.

VOC = volatile organic compound

Bold indicates the analyte was detected

Shading indicates the analyte exceeded screening criteria

TABLE 2-17

Groundwater VOC Analytical Results

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Location>>	MW-112	MW-112	MW-112	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-115	MW-115
			Sample Date>>	4/22/2007	6/5/2008	8/13/2010	4/21/2007	6/4/2008	8/12/2010	4/22/2007	6/3/2008	8/11/2010	6/5/2008	8/13/2010
	Units	Screening Level	Test Method											
1,1,1,2-Tetrachloroethane	µg/L	0.43	SW8260B	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U	1 UJ	0.5 U
1,1,2,2-Tetrachloroethane	µg/L	0.055	SW8260B	5 U	1 U	1 U	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	µg/L	0.2	SW8260B	NA	1 UJ	1.1 U	NA	1 U	1.1 U	NA	1 U	1.1 U	1 UJ	1.1 U
1,2-Dichloroethane	µg/L	0.12	SW8260B	5 U	1 UJ	**0.21 J**	5 U	1 U	0.5 U	**3.3 J**	1 U	0.5 U	1 UJ	0.5 U
Benzene	µg/L	0.35	SW8260B	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U	1 UJ	0.5 U
Carbon tetrachloride	µg/L	0.17	SW8260B	5 U	1 UJ	1 U	5 U	1 U	1 U	5 U	1 U	1 U	**0.38 J**	1 U
Chloroform	µg/L	0.17	SW8260B	5 U	1 U	0.5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U	1 U	0.5 U
cis -1,2-Dichloroethene	µg/L	6.1*	SW8260B	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U	5 U	1 U	**0.26 J**	1 UJ	0.5 U
Methylene chloride	µg/L	4	SW8260B	NA	1 UJ	5 U	NA	1 R	5 U	NA	1 R	5 U	1 UJ	5 U
Naphthalene	µg/L	0.62*	SW8260B	NA	1 UJ	5 R	NA	1 U	5 R	NA	1 U	5 U	1 UJ	5 R
Tetrachloroethene	µg/L	0.1	SW8260B	5 U	1 U	1.1 U	5 U	**0.88 J**	1.1 U	5 U	**0.64 J**	**0.58 J**	1 U	1.1 U
trans -1,2-Dichloroethene	µg/L	11*	SW8260B	5 U	1 UJ	0.5 U	5 U	1 U	0.5 U	5 U	1 U	0.5 U	1 UJ	0.5 U
Trichloroethene	µg/L	0.028	SW8260B	5 U	1 U	0.5 U	5 U	1 U	0.5 U	5 U	**0.54 J**	**0.62**	1 U	0.5 U
Vinyl chloride	µg/L	0.015	SW8260B	5 U	1 U	1 U	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U

Note:

* USEPA Region 6 Medium-Specific Screening Levels for residential wa
factor of 10 to account for cumulative effects from multiple noncarcinog
target organ.

D = Quantified at dilution

J = Reported value is estimated

NA = Not Analyzed

ND = Not Detected

R = The sample results are rejected due to deficiencies in the ability to analyze the sample and to meet the quality control criteria. The presence or absence of the analyte cannot be verified.

U = Not detected above the laboratory reporting limit.

VOC = volatile organic compound

Bold indicates the analyte was detected

Shading indicates the analyte exceeded screening criteria

TABLE 2-17
Groundwater VOC Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

			Location>>	MW-116	MW-116	MW-117	MW-118
			Sample Date>>	6/4/2008	8/11/2010	6/12/2008	8/13/2010
	Units	Screening Level	Test Method				
1,1,1,2-Tetrachloroethane	µg/L	0.43	SW8260B	1 U	0.5 U	1 U	2.5 U
1,1,2,2-Tetrachloroethane	µg/L	0.055	SW8260B	1 U	1 U	1 U	5 U
1,1,2-Trichloroethane	µg/L	0.2	SW8260B	1 U	1.1 U	1 U	**1.4 J**
1,2-Dichloroethane	µg/L	0.12	SW8260B	1 U	0.5 U	1 U	2.5 U
Benzene	µg/L	0.35	SW8260B	1 U	0.5 U	1 U	**1.8 J**
Carbon tetrachloride	µg/L	0.17	SW8260B	1 UJ	1 U	1 U	**1,480**
Chloroform	µg/L	0.17	SW8260B	1 U	0.5 U	1 U	**165**
cis -1,2-Dichloroethene	µg/L	6.1*	SW8260B	1 U	0.5 U	1 U	2.5 U
Methylene chloride	µg/L	4	SW8260B	1 U	5 U	1 U	**5.9 J**
Naphthalene	µg/L	0.62*	SW8260B	1 U	5 U	1 UJ	25 R
Tetrachloroethene	µg/L	0.1	SW8260B	1 U	1.1 U	1 U	5.7 U
trans -1,2-Dichloroethene	µg/L	11*	SW8260B	1 U	0.5 U	1 U	2.5 U
Trichloroethene	µg/L	0.028	SW8260B	1 U	0.5 U	1 U	**809**
Vinyl chloride	µg/L	0.015	SW8260B	1 UJ	1 U	1 U	5 U

Note:

* USEPA Region 6 Medium-Specific Screening Levels for residential wa
factor of 10 to account for cumulative effects from multiple noncarcinog
target organ.

D = Quantified at dilution

J = Reported value is estimated

NA = Not Analyzed

ND = Not Detected

R = The sample results are rejected due to deficiencies in the ability to analyze the sample and to meet the quality control criteria. The presence or absence of the analyte cannot be verified.

U = Not detected above the laboratory reporting limit.

VOC = volatile organic compound

Bold indicates the analyte was detected

Shading indicates the analyte exceeded screening criteria

TABLE 2-18
2001 TapanAm Sediment TAL Metals and Explosives Analytical Results
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Target Analyte List Metals (mg/kg)	Test Method	Sample ID>> Screening Level	SED-PW1	SED-PW2	SED-PW8	SED-PW9	SED-PW10	SED-PW11	SED-PW12	SED-PW13	SED-PW14	SED-PW15	SED-PW16	SED-PW17	SED-PW18	SED-PW19	SED-PW20	SED-PW21	SED-PW22	SED-PW25
Aluminum	6010B, 6020B	7,700*	6,298.1	7,976.6	1,148.4	3,729	14,820	1286.6	44,378	26,883	39,560	9,644.8	10,189	3,614.20	13,438	10,372	15,618	9,155.8	15,598	8,233
Antimony	6010B, 6020B	3.1*	ND	2.75 J	ND	ND	ND	ND	42.7 J	13.87	ND	ND	ND	ND	ND	ND	ND	ND	253.8	ND
Arsenic	6010B, 6020B	12.3	ND	13.07 J	ND	34.02	21.575	ND	ND	ND	20.289 J	32.815	13.502	ND	ND	31.725 J	ND	ND	ND	ND
Barium	6010B, 6020B	1,600*	66.703 J	82.56	209.42	69.815	250.33	27.546 J	7,508.1	2,349.2	ND	2,231.7	1,560.8	1,735.6	1,274.5	1,587.30	358.52	321.5	564.91	72.869
Beryllium	6010B, 6020B	16*	0.491 J	0.759	0.386 J	0.458 J	0.86688 J	ND	ND	0.511 J	0.52686 J	0.51952 J	0.42615 J	ND	0.49381 J	0.70163 J	0.86588 J	0.60245 J	0.83045 J	0.4271 J
Cadmium	6010B, 6020B	3.9*	3.099 J	3.036	4.062	7.596	11.18	3.265 J	29.024	14.96	24.639	20.986	6.5481	25.872	50.268	21.086	13.302	11.945	21.602	2.8004
Calcium	6010B, 6020B	-	139,860	18,364	127,970	77,509	34,607	224,390	39,810	27,286	23,356	18,380	15,614	16,784	9,347.8	11,648	5,451.7	4,270.10	7,373	14,705
Chromium	6010B, 6020B	38	18.776	18.636	16.173	23.568	52.506	6.32 J	77.947	73.495	84.278	87.239	31.641	ND	145.51	97.289	ND	60.617	ND	15.55
Cobalt	6010B, 6020B	900	7.419 J	12.494	11.894 J	9.194 J	ND	ND	19.46 J	10.783	19.344 J	16.196	ND	ND	33.982	15.868 J	ND	14.515 J	15.689 J	5.3281 J
Copper	6010B, 6020B	290*	49.916 J	203.46	246.74	773.85	2,450.8	165.25	1,339	534.92	927.09	620.72	215.64	448.98	942.15	1,033.6	358.17	444.21	681.37	209.62
Iron	6010B, 6020B	5,500*	15,514	16,245	15,213	16,769	24,190	5,147.2	74,644	23,685	70,201	35,916	23,547	ND	ND	75,359	ND	72,188	62,661	13,286
Lead	6010B, 6020B	400	418.98	636.58	3,732.3	1,075.3	ND	455.51	2,803.8	1,507.4	2,339.3	1,925.3	ND	25,387	2,481.5	ND	3,567.1	1,054.8	3,692.7	245.51
Magnesium	6010B, 6020B	-	24,458	5,744.3	28,528	20,097	12,404	38,508	54,174	32,295	40,609	10,909	10,081	7,449.6	11,946	9,234.9	10,973	5,308.9	12,769	4,301
Manganese	6010B, 6020B	350*	374.31	293.8	1,140	617.53	319.85	114.11	649.65	503.76	455.58	315.98	421.24	146.56	301.3	439.57	299.62	711.94	396.2	293.31
Mercury	6010B, 6020B	2.3*	ND	ND	ND	ND	0.209 J	ND	ND	ND	0.23 J	4.954	0.354	7.112	0.464 J	ND	ND	ND	0.522	0.147 J
Nickel	6010B, 6020B	130	18.979 J	22.957	15.503 J	18.649	34.996	ND	63.493	36.53	63.052	75.198	23.981	46.712	69.237	59.015	47.915	59.971	93.414	12.645
Potassium	6010B, 6020B	-	1,102.7 J	652.73 J	ND	357.69 J	1,213.6	ND	ND	392.49 J	1,279 J	992.09 J	1,148	ND	1,075.4 J	1,289.4 J	2,608.6	964.51 J	2,423.5	1,299.9
Selenium	6010B, 6020B	5	ND	ND	ND	ND	16.256 J	ND	ND	19.21	71.041	33.008	10.869 J	24.303 J	112.45	ND	ND	ND	ND	ND
Silver	6010B, 6020B	34	ND	ND	ND	ND	2.2803	ND	ND	100.32	ND	5.197	ND	2.8539 J	38.533	ND	ND	ND	ND	ND
Sodium	6010B, 6020B	-	130.06 J	56.07 J	88.47 J	122.01 J	236.71 J	264.34 J	226.31 J	233.02 J	368.61 J	159.74 J	125.41 J	189.34 J	405.07 J	168.7 J	361.45 J	85.994 J	1,611 J	54.652 J
Thallium	6010B, 6020B	0.7	ND	ND	ND	ND	ND	ND	ND	3.58 J	25.506 J	8.4165 J	7.5503 J	14.669 J	ND	16.407 J	11.471 J	ND	13.849 J	4.0795 J
Vanadium	6010B, 6020B	39*	19.492 J	28.25	7.223 J	15.086	45.22	4.989 J	27.909 J	17.818	40.431	42.788	26.75	11.153 J	62.454	41.809	49.095	42.729	50.883	24.073
Zinc	6010B, 6020B	2,300*	247.12	477.51	1,159.1	1,005.7	ND	265.42	2,719.2	2,718.3	18,026	4,131	ND	5,874.4	17,554	2,937	ND	1,296.3	ND	438.68
Explosives (mg/kg)	**Test Method**																			
1,3,5-Trinitrobenzene	8330	180*	ND	ND	ND	ND	0.956121	ND	ND	ND	0.186067 J	ND	ND	ND	ND	ND	ND	ND	ND	NA
1,3-Dinitrobenzene	8330	0.61*	ND	ND	ND	ND	0.109497 J	ND	ND	ND	ND	0.108329 J	0.119342 J	ND	ND	ND	ND	ND	ND	NA
2,4,6-Trinitrotoluene	8330	16	ND	ND	ND	ND	ND	ND	ND	ND	0.138634 J	ND	0.585329	ND	ND	0.436835 J	ND	ND	0.154186 J	NA
2,4-Dinitrotoluene	8330	12*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.313624 J	ND	ND	ND	NA
2,6-Dinitrotoluene	8330	6.1*	ND	ND	0.185945 J	ND	ND	ND	0.543724 J	ND	ND	0.257392 J	2.37759	ND	ND	ND	2.26876	2.52715	1.46349	NA
2-Amino-4,6-dinitrotoluene	8330	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.224649 J	0.278474 J	1.62898	ND	0.189439 J	ND	ND	ND	NA
2-Nitrotoluene	8330	160*	0.19847 J	0.190825 J	0.152067 J	0.134159 J	0.293988 J	J	0.29266 J	0.250844 J	0.245209 J	0.227054 J	1.03866	0.379101 J	0.209014 J	0.237379 J	0.417755 J	0.184827 J	0.457519 J	NA
4-Amino-2,6-dinitrotoluene	8330	-	ND	0.848824	ND	ND	0.212622 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
4-Nitrotoluene	8330	40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
HMX	8330	310*	0.118892 J	0.186476 J	0.118749 J	0.140816 J	0.188532 J	0.412087 J	0.183575 J	0.343746 J	0.154288 J	0.237909 J	ND	ND	0.378299 J	0.141756 J	ND	0.153718 J	ND	NA
Nitrobenzene	8330	2*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.267917 J	ND	ND	ND	ND	ND	ND	NA
PETN	8330	-	ND	ND	ND	ND	3.61368 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
RDX	8330	4.4	0.686737	0.691961	0.625828	0.699377	2.06435	0.81987	0.585869 J	1.02918	2.94037	1.04044	0.450407 J	1.12378	2.55622	3.1504	0.612774 J	1.19549	0.19899 J	NA
Tetryl	8330	-	ND	ND	0.1381 J	ND	0.209092 J	ND	0.535441 J	0.249584 J	ND	0.197291 J	0.1542 J	0.233246 J	ND	0.320851 J	ND	0.157623 J	0.127007 J	NA
Trinitrogycerin	8330	-	ND	ND	ND	ND	10.19427 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA

Note:
Bold = Detected concentration
Gray highlight = A detected concentration above the selected screening level.
mg/kg = milligrams per kilogram
ND = Chemical not detected
J = Reported value is estimated
\- = No screening level available
NA = Sample was not analyzed

TABLE 2-19

Summary of Estimated Carcinogenic Risks and Non-carcinogenic Hazard Indices

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Excess Lifetime Cancer Risk (ELCR)					Non-Carcinogenic Hazard Indices (HIs)				
Exposure Points	Receptor Group & Exposure Scenarios	Ingestion	Dermal Contact	Inhalation	Total ELCR	Carcinogenic COC[c]	Ingestion	Dermal Contact	Inhalation	Screening HI	Non-carcinogenic COC[d]
Onsite Soil (0-2 ft bgs Sitewide)	Industrial Worker Soil (0-2 ft bgs)	3.5E-06	2.3E-06	3.2E-06	**9E-06**	**--**	0.017	0.0017	0.0058	0.02	--
Onsite Soil (0-10 ft bgs Sitewide) and Onsite Groundwater[a]	Construction Worker Onsite Soil (0-10 ft bgs)	8.0E-07	2.8E-07	8.7E-08	1.2E-06	**--**	0.11	0.012	0.0040	0.12	--
	Construction Worker Onsite Groundwater (Excavations Downgradient of Building 220)	NA	1.1E-05	1.1E-06	1.2E-05	--	NA	3.0	0.52	3.5	Carbon tetrachloride, PCE
	Construction Worker Onsite Groundwater and Soil Total				**1E-05**	**--**				**4**	
Offsite Groundwater	Construction Worker Offsite Groundwater (Excavations)	NA	1.0E-06	7.8E-08	**1E-06**	**--**	NA	0.18	0.039	0.2	--
	Residential Child Offsite Groundwater	-	-	-	-	**--**	27	13	177	217	1,2-DCA, Manganese, PCE, TCE
	Residential Adult/Child (Aggregate) Offsite Groundwater	2.7E-02	1.6E-02	7.0E-02	**1E-01**	1,2-DCA, PCE, TCE, Chloroform	-	-	-	-	--
	Residential Adult Offsite Groundwater	-	-	-	-	**--**	12	6	99	117	1,2-DCA, Manganese, PCE, TCE
Soil (0-10 ft bgs) at Unit A and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	0.56	0.0064	0.0089	0.57	--
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**0.7**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.060	0.0010	0.0089	0.070	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.1**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	NA	NA	NA	NA	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit B and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.21	0.064	0.0099	1.3	--
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**1.4**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.13	0.010	0.0099	0.15	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.2**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	3.8E-05	3.6E-06	2.1E-08	4.1E-05		-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**5E-04**						
Soil (0-10 ft bgs) at Unit C and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	0.62	0.0076	0.0098	0.64	--
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**0.7**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.066	0.0012	0.0098	0.077	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.1**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	NA	NA	NA	NA	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						

TABLE 2-19

Summary of Estimated Carcinogenic Risks and Non-carcinogenic Hazard Indices

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Excess Lifetime Cancer Risk (ELCR)					**Non-Carcinogenic Hazard Indices (HIs)**				
Exposure Points	Receptor Group & Exposure Scenarios	Ingestion	Dermal Contact	Inhalation	Total ELCR	Carcinogenic COC[c]	Ingestion	Dermal Contact	Inhalation	Screening HI	Non-carcinogenic COC[d]
Soil (0-10 ft bgs) at Unit D											
and	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.48	0.0093	0.0135	1.5	--
Onsite Groundwater[b]	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**1.6**	
		-	-	-	-	--	0.16	0.001	0.0135	0.17	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.2**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	NA	NA	NA	NA	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit E											
and	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	2.6	0.1	0.0135	2.7	Thallium, Antimony
Onsite Groundwater[b]	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**3**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.28	0.011	0.0135	0.30	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.4**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	3.2E-05	3.1E-06	1.7E-07	3.5E-05		-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**5E-04**						
Soil (0-10 ft bgs) at Unit F											
and	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.52	0.047	0.0125	1.6	--
Onsite Groundwater[b]	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**1.7**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.163	0.0072	0.0125	0.18	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.2**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	2.0E-05	1.9E-06	1.1E-08	2.2E-05		-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit G											
and	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.6	0.017	0.0143	1.7	**--**
Onsite Groundwater[b]	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	**--**
	Residential Child Groundwater and Soil Total					**--**				**1.8**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.177	0.003	0.0143	0.19	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	**--**
	Residential Adult Groundwater and Soil Total					**--**				**0.2**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	9.3E-07	3.8E-07	2.7E-11	1.3E-06	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						

TABLE 2-19

Summary of Estimated Carcinogenic Risks and Non-carcinogenic Hazard Indices

Decision Document – Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Excess Lifetime Cancer Risk (ELCR)					**Non-Carcinogenic Hazard Indices (HIs)**				
Exposure Points	Receptor Group & Exposure Scenarios	Ingestion	Dermal Contact	Inhalation	Total ELCR	Carcinogenic COC[c]	Ingestion	Dermal Contact	Inhalation	Screening HI	Non-carcinogenic COC[d]
Soil (0-10 ft bgs) at Unit H and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	2.0	0.058	0.010	2.0	--
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**2**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.21	0.0089	0.010	0.23	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.3**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	2.5E-05	2.4E-06	1.4E-08	2.8E-05		-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit I and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.64	0.010	0.0142	1.7	Thallium
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**1.8**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.18	0.00	0.0142	0.19	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**					
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	NA	NA	NA	NA	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit J and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	2.8	0.057	0.0122	2.9	Thallium
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**3**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.301	0.01	0.0122	0.32	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.4**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	3.1E-05	3.1E-06	1.7E-08	3.4E-05		-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						
Soil (0-10 ft bgs) at Unit K and Onsite Groundwater[b]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	2.1	0.017	0.0132	2.1	Thallium
	Residential Child Onsite Groundwater	-	-	-	-	--	0.049	0.010	0.054	0.11	--
	Residential Child Groundwater and Soil Total					**--**				**2**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.22	0.003	0.0132	0.24	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	0.021	0.0043	0.030	0.056	--
	Residential Adult Groundwater and Soil Total					**--**				**0.3**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	NA	NA	NA	NA	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	6.7E-06	4.9E-07	4.1E-04	4.2E-04	1,2-DCA, Carbon tetrachloride	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**4E-04**						

TABLE 2-19
Summary of Estimated Carcinogenic Risks and Non-carcinogenic Hazard Indices
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Excess Lifetime Cancer Risk (ELCR)					Non-Carcinogenic Hazard Indices (HIs)				
Exposure Points	Receptor Group & Exposure Scenarios	Ingestion	Dermal Contact	Inhalation	Total ELCR	Carcinogenic COC[c]	Ingestion	Dermal Contact	Inhalation	Screening HI	Non-carcinogenic COC[d]
Soil (0-10 ft bgs) at Unit L and Onsite Groundwater[a]	Residential Child Soil (0-10 ft bgs)	-	-	-	-	--	1.1	0.026	0.019	1.1	
	Residential Child Onsite Groundwater	-	-	-	-	--	433	166	1640	2239	1,2-DCA, Benzene, Carbon tetrachloride, Chloroform, cis-1,2-DCE, Manganese, Naphthalene, PCE, trans-1,2-DCE, TCE
	Residential Child Groundwater and Soil Total									**2240**	
	Residential Adult Soil (0-10 ft bgs)	-	-	-	-	--	0.11	0.0040	0.019	0.14	--
	Residential Adult Onsite Groundwater	-	-	-	-	--	186	74	922	1182	1,2-DCA, Benzene, Carbon tetrachloride, Chloroform, cis-1,2-DCE, Manganese, Naphthalene, PCE, trans-1,2-DCE, TCE
	Residential Adult Groundwater and Soil Total									**1182**	
	Residential Adult/Child (Aggregate) Soil (0-10 ft bgs)	2.2E-06	6.9E-06	3.5E-06	1.3E-05	--	-	-	-	-	--
	Residential Adult/Child (Aggregate) Onsite Groundwater	1.9E-01	1.2E-01	5.6E-01	8.7E-01	1,1,1,2-TeCA, 1,1,2,2-TeCA, 1,1,2-TCA, 1,2-DCA, Benzene, Carbon tetrachloride, Chloroform, Naphthalene, PCE, TCE	-	-	-	-	--
	Residential Adult/Child (Aggregate) Groundwater and Soil Total				**9E-01**						

Notes:
Total ELCRs and HIs are presented in **bold** font to distinguish them from component ELCRs and HIs that comprise the totals.
NA = Not applicable or not available

[a] Groundwater exposures were quantified for groundwater downgradient of Building 220.

[b] Groundwater exposures were quantified for sitewide groundwater, excluding the area downgradient of Building 220.

[c] If the receptor ELCR exceeds 1E-04, risk drivers/COCs were identified as individual chemicals with an ELCR greater than 1E-05 for the environmental medium driving the risk.

[d] If a target organ HI exceeds 1.0, HI drivers/COCs were identified as chemicals with an individual HI greater than 0.1 contributing to the target organ HI exceeding 1.0 for the environmental medium driving the risk.

DCA = dichloroethane, DCE = dichloroethene, PCE = tetrachloroethene, TCA = trichloroethane, TCE = trichloroethene, TeCA = tetrachloroethane

TABLE 2-20
Detailed Evaluation of Remedial Alternatives
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 3 In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 4 Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal and Offsite Disposal
Overall Protection to Human Health and the Environment				
Protection of human health and the environment	St. Louis Ordinance 66777 prohibits the installation of potable water supply wells in the City of St. Louis, which encompasses the site and downgradient offsite properties. Therefore, Alternative 1 protects against potable use of groundwater. Alternative 1 is not protective for RAOs pertaining to potential construction worker risks to groundwater or risks to receptors associated with COC concentrations in soil.	Alternative 2 protects against potable use of groundwater because of St. Louis Ordinance 66777. Treatment would eliminate potential construction worker risk within Plume A TTZ. Groundwater monitoring and inspections of Plume C would be protective of the potential construction worker direct contact risk by verifying that groundwater levels are deeper than 10 feet below ground and notifying hypothetical receptors accordingly, should that assumption be proven invalid during monitoring. Removal of metals and Aroclor 1260 from the soil and sediment meets the ARARs and is protective of receptors.	For the reasons described under Alternative 2, this alternative would be protective.	For the reasons described under Alternative 2, this alternative would be protective.
Compliance with ARARs				
Action-specific ARARs	In compliance.	In compliance.	In compliance.	In compliance.
Chemical-specific ARARs	Not in compliance.	In compliance. Remediation goals eventually would be met.	In compliance. Remediation goals eventually would be met.	In compliance. Remediation goals eventually would be met.
Long-Term Effectiveness and Permanence				
Magnitude of residual risk	No residual risks to potable use receptors because of the existing ordinance. Risks to construction workers would remain.	No residual risks to potable use receptors because of the existing ordinance. Residual risk to the construction worker would be minimal due to treatment and minimal exposure. No residual risk to soil COCs.	No residual risks to potable use receptors because of the existing ordinance. Residual risk to the construction worker would be minimal due to treatment and minimal exposure. No residual risk to soil COCs.	No residual risks to potable use receptors because of the existing ordinance. Residual risk to the construction worker would be minimal due to treatment and minimal exposure. No residual risk to soil COCs.

TABLE 2-20
Detailed Evaluation of Remedial Alternatives
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 3 In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 4 Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal and Offsite Disposal
Adequacy and reliability of controls	Reliable for the potable use exposure. No controls for the other receptors.	Reliable for the potable use exposure. Five-year reviews allow for future evaluations of the exposure pathways associated with potential future risk after the remedial actions.	Reliable for the potable use exposure. Five-year reviews allow for future evaluations of the exposure pathways associated with potential future risk after the remedial actions.	Reliable for the potable use exposure. Five-year reviews allow for future evaluations of the exposure pathways associated with potential future risk after the remedial actions.
Potential environmental impacts of remedial action	Natural attenuation would slowly reduce COC mass, but amount of reduction would remain unknown.	Excavation activities will temporarily impact nearby residents due to noise and roadway traffic.	Soil mixing and excavation activities will temporarily impact nearby residents due to noise and roadway traffic.	Excavation activities will temporarily impact nearby residents due to noise and roadway traffic.
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Treatment processes used and materials treated	None.	Acceptable. Treatment processes will be utilized to reduce VOC concentrations in groundwater and soil.	Acceptable. Treatment processes will be utilized to reduce VOC concentrations in groundwater and soil.	None.
Amount of hazardous material destroyed or treated	Natural attenuation slowly would reduce concentrations of COCs in the groundwater over time, but amount of reduction would remain unknown.	Most mass would be destroyed or treated. Natural attenuation would slowly reduce concentrations of COCs in the groundwater over time. Potentially hazardous material pertaining to VOCs would be treated in soil and groundwater. Sampling would evaluate the amount of reduction.	Most mass would be destroyed or treated. Natural attenuation would slowly reduce concentrations of COCs in the groundwater over time. Potentially hazardous material pertaining to VOCs would be treated in soil and groundwater. Sampling would evaluate the amount of reduction.	Most mass would be removed from the site. Natural attenuation would slowly reduce concentrations of COCs in the groundwater over time.
Expected reduction in toxicity, mobility, or volume of the waste	Little. Natural attenuation would slowly reduce VOC mass, but amount of reduction would remain unknown.	Significant. Natural attenuation would slowly reduce VOC mass and treatment would reduce VOC mass in Plume A TTZ.	Significant. Natural attenuation would slowly reduce VOC mass and treatment would reduce VOC mass in Plume A TTZ.	Significant. Natural attenuation would slowly reduce VOC mass.
Irreversibility of treatment	Not applicable.	Complete. Once VOCs are degraded, they will not recur.	Complete. Once VOCs are degraded, they will not recur.	Not applicable.

TABLE 2-20
Detailed Evaluation of Remedial Alternatives
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 3 In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 4 Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal and Offsite Disposal
Type and quantity of residuals that will remain following treatment	Not applicable.	Ultimately no treatment residuals will remain. Concentrations of VOC daughter products such as vinyl chloride may be generated, but vinyl chloride is expected to biodegrade and not accumulate. Monitoring will evaluate the residuals.	Ultimately no treatment residuals will remain. Concentrations of VOC daughter products such as vinyl chloride may be generated, but vinyl chloride is expected to biodegrade and not accumulate. Monitoring will evaluate the residuals.	Not applicable.
Statutory preference for treatment	Does not satisfy.	Meets preference for treatment.	Meets preference for treatment.	Does not satisfy.
Short-Term Effectiveness				
Protection of workers during remedial action	Not applicable.	Treatment is not expected to create additional risk to industrial workers onsite because of the proximity of workers to the TTZ. Workers implementing the remedy would have limited potential for exposure to PCE, since remediation-derived waste may be generated only as part of monitoring well installation and abandonment activities. The surface soil removal activities were based on residential exposure risk, not industrial workers. Risks associated with heavy machinery use and with intrusive activities on the environment during the remedial action will be addressed through safe work practices and a comprehensive health and safety plan.	Treatment is not expected to create additional risk to industrial workers onsite. Workers implementing the remedy would have potential exposure to PCE, since soil mixing will expose most of the PCE within the TTZ. Risk associated with surface soil removal was based on exposure of residents, not industrial workers. Risks associated with heavy machinery use and with intrusive activities on the environment during the remedial action will be addressed through safe work practices and a comprehensive health and safety plan.	Removal activities are not expected to pose additional risk to industrial workers onsite. Workers implementing the remedy could be exposed to PCE, since excavation and removal would expose the PCE within the TTZ. Risk associated with surface soil removal was based on exposure of residents, not industrial workers. Risks associated with heavy machinery use and with intrusive activities on the environment during the remedial action will be addressed through safe work practices and a comprehensive health and safety plan.

TABLE 2-20
Detailed Evaluation of Remedial Alternatives
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 3 In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 4 Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal and Offsite Disposal
Protection of the community during remedial action	Not applicable.	Implementation of the groundwater TTZ alternative would have little (if any) impact to the community. Excavation and removal work associated surface soil remediation may affect the community by trucks entering and leaving the site.	Implementation of the groundwater TTZ alternative would have little (if any) impact to the community. Excavation and removal work associated surface soil remediation may affect the community by trucks entering and leaving the site.	Excavation and removal work associated with surface soil and groundwater TTZ remediation may affect the community by trucks entering and leaving the site. This alternative would have more trucks entering and leaving the site.
Potential environmental impacts of remedial action	Not applicable.	Treatment would introduce minimal impacts due to construction work, such as excavation and transportation of surface soil.	Treatment would introduce minimal impacts due to construction work, such as excavation and transportation of surface soil.	Treatment would introduce impacts from construction work, such as excavation and transportation of surface and subsurface soil.
Time until protection is achieved	Protection is not achieved.	Due to the existing ordinance and depth to groundwater, protection would be achieved rapidly onsite. Groundwater contamination under Stratford Avenue would not be addressed during the remedial action, therefore protection would not be achieved rapidly offsite.	Due to the existing ordinance and depth to groundwater, protection would be achieved rapidly onsite. Groundwater contamination under Stratford Avenue would not be addressed during the remedial action, therefore protection would not be achieved rapidly offsite.	Due to the existing ordinance and depth to groundwater, protection would be achieved rapidly onsite. Groundwater contamination under Stratford Avenue would not be addressed during the remedial action, therefore protection would not be achieved rapidly offsite.
Implementability				
Technical feasibility	Not applicable.	Feasible, but complex because of thermal treatment application and its design. An additional power source would be required.	Feasible, but complex because application of the chemical reduction amendment and design would be required.	Feasible.
Reliability of technology	Not applicable.	Reliable.	Reliable.	Reliable.
Administrative feasibility	Not feasible.	Feasible.	Feasible.	Feasible.
Availability of equipment, services, and materials	Not applicable.	Additional power sources would be required to operate this remedial action.	Equipment and materials are readily available.	Equipment and materials are readily available.

TABLE 2-20
Detailed Evaluation of Remedial Alternatives
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Groundwater Treatment Using Thermal Technologies, Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 3 In Situ Groundwater Treatment and Soil and Powder Well Sediment Removal and Offsite Disposal	Alternative 4 Groundwater Source Removal by Excavation, Soil and Powder Well Sediment Removal and Offsite Disposal
Cost				
Capital cost	$0	$2,638,000	$1,772,000	$1,971,000
Present worth[a]	$0	$1,116,000	$1,116,000	$1,116,000
Period of analysis (yr)	$0	50[b]	50[b]	50[b]
Capital and present worth	$0	$3,754,000[c]	$2,888,000[c]	$3,087,000[c]
Present Cost Range (-30 / +50)	$0	$2,628,000 to $5,631,000	$2,022,000 to $4,332,000	$2,161,000 to $4,631,000

[a] Present worth of periodic costs (Five-year review, operation and maintenance) are shown.

[b] Based on USEPA, 2000, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 540-R-00-002).

[c] Cost estimate is provided in Appendix A.

TABLE 2-21
Applicable, Relevant, and Appropriate Requirements
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Requirement	Requirement Synopsis
Federal	
Clean Air Act (42 U.S.C. 7401 et seq.)	The Clean Air Act is intended to protect the quality of air and promote public health. Title I of the Act directed the USEPA to publish national ambient air quality standards for “criteria pollutants.” In addition, USEPA has provided national emission standards for hazardous air pollutants under Title III of the Clean Air Act. Hazardous air pollutants are also designated hazardous substances under CERCLA. The Clean Air Act amendments of 1990 greatly expanded the role of National Emission Standards for Hazardous Air Pollutants by designating 179 new hazardous air pollutants and directed USEPA to attain maximum achievable control technology standards for emission sources. Such emission standards are potential ARARs if selected remedial technologies (such as incinerators or air strippers) produce air emissions of regulated hazardous air pollutants. Substantive criteria promulgated pursuant to the Clean Air Act may be considered an ARAR for remedies that involve creation of air emissions, such as excavation activities that might create dust or treatment systems that might emit VOCs.
Toxic Substances Control Act (15 U.S.C. 2601 et seq.)	The Toxic Substances Control Act (TSCA), created in 1976, instituted a range of control measures, primarily record-keeping and reporting requirements, to document the production and use of hazardous chemicals, primarily PCBs. Remedial alternatives involving excavation of soils contaminated with PCBs must meet the substantive requirements of TSCA for disposal such as the requirement for land disposal to be at a TSCA permitted landfill for soils with PCBs > 50 mg/kg.
Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 321 et seq.)	RCRA was passed in 1976. It amended the Solid Waste Disposal Act by including provisions for hazardous waste management. The goals of RCRA are to promote conservation of natural resources while protecting human health and the environment. The statute sets out to control the management of hazardous waste from inception to ultimate disposal. RCRA is linked closely with CERCLA, and the CERCLA list of hazardous substances includes all RCRA hazardous wastes. The Act applies only if soils are considered a hazardous waste. Soils are required to be managed as hazardous waste if they contain listed hazardous waste or have the characteristics of hazardous waste.
State	
Missouri Air Conservation Law	The Air Conservation Law in its present form was passed in 1986. It assigned the Missouri Air Conservation Commission to the authority of the MDNR’s Air and Land Protection Division. The law is an ARAR for remedies that involve creation of air emissions, such as excavation activities that have the potential to create dust.
Departmental Missouri Risk-Based Corrective Action (MRBCA) Technical Guidance (April 2006)	The guidance is to provide a framework for cleanup decisions that facilitate the constructive use of contaminated sites by protecting human health and the environment in the context of current and future site use. This guidance applies to contaminated or potentially contaminated sites and provides a methodology to conduct site-specific characterization; calculate risk-based levels protective of human health, public welfare and the environment; and implement appropriate risk management activities, including long-term stewardship requirements. The guidance document provides a tool for developing cleanup levels. It is a requirement “to be considered” because it is a state guidance document rather than a promulgated requirement.

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions
Confirmation Sampling for Soil Removal Activities						
Laboratory Analysis						
Arsenic Analysis	48	EA	$25	$1,200	Vendor Quote	5 soil borings each at 2 removal areas for collection of 0-6", 6-12", 12-18", and 18-24" intervals; includes QA/QC samples.
Arsenic and Lead Analysis	24	EA	$51	$1,224	Vendor Quote	5 soil borings at 1 removal area for collection of 0-6", 6-12", 12-18", and 18-24" intervals; includes QA/QC samples.
Thallium Analysis	48	EA	$25	$1,200	Vendor Quote	5 soil borings each at 2 removal areas for collection of 0-6", 6-12", 12-18", and 18-24" intervals; includes QA/QC samples.
Lead Analysis	24	EA	$26	$624	Vendor Quote	5 soil borings at 1 removal area for collection of 0-6", 6-12", 12-18", and 18-24" intervals; includes QA/QC samples.
Aroclor 1260 Analysis	24	EA	$26	$624	Vendor Quote	5 soil borings at 1 removal area for collection of 0-6", 6-12", 12-18", and 18-24" intervals; includes QA/QC samples.
Fieldwork Expenses						
Labor	1	LS	$7,200	$7,200	Engineer's Estimate	Fieldwork, office support.
Equipment	1	LS	$725	$725	Engineer's Estimate	Sampling and health and safety equipment.
Travel	1	LS	$288	$288	Engineer's Estimate	Assumes 3 days to complete surface soil delineation.
Subtotal				**$13,085**		
Excavation/Backfill/Transport and Disposal of Soil and Sediment						
Site Preparation						
Preparation	1	LS	$6,540	$6,540	Engineer's Estimate	Subcontractor labor, backhoe, 10-wheel dump truck, private utility locate.
Laboratory Analysis						
Waste Characterization	7	EA	$900	$6,300	Engineer's Estimate	Characterization of soil at each removal area for offsite disposal, sample technician, equipment, and supplies.
Excavation						
Soil Excavation - Arsenic and Lead	245	CY	$70	$17,150	Engineer's Estimate	Arsenic and lead excavation dimensions: 475 sf x 1'; 1,125 sf x 2'; 1,210 sf x 2'; and 1340 sf x 1'
Soil Excavation - Thallium	155	CY	$70	$10,850	Engineer's Estimate	Thallium excavation dimensions: 915 sf x 2' and 1,175 sf x 2'
Soil Excavation - Aroclor 1260	65	CY	$70	$4,550	Engineer's Estimate	Aroclor 1,260 excavation dimension: 875 sf x 2'
IDW Management						
Transportation & Disposal-Special Waste (conversion factor 1.7)	160	TN	$72	$11,520	Engineer's Estimate	Assumes 20% of soil IDW is special waste.
Transportation & Disposal-Hazardous (conversion factor 1.7)	474	TN	$278	$131,772	Engineer's Estimate	Assumes 60% of soil IDW is hazardous.
Transportation & Disposal-Hazardous Pre-treat (conversion factor 1.7)	160	TN	$422	$67,520	Engineer's Estimate	Assumes 20% of soil IDW is hazardous requiring pre-treatment.
Restoration						
Backfill with Imported Fill (conversion factor of 1.6)	744	TN	$41	$30,504	Engineer's Estimate	Subcontractor labor, compactor, backhoe, 10-wheel dump truck.
Seeding and straw	7,115	SF	$0.15	$1,067	Engineer's Estimate	Standard grass seed.

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions
Watering	1	LS	$22,660	$22,660	Engineer's Estimate	Daily watering for 6 weeks - includes water truck services.
Survey Support						
Surveying of Excavation Extents	1	LS	$2,200	$2,200	Vendor Quote	Includes survey of 4 corners at 7 removal areas, data evaluation and report.
Air Monitoring						
Air Monitoring	10	DY	$29	$290	Engineer's Estimate	Breathing zone monitoring during excavation activities.
Fieldwork Expenses						
Labor	1	LS	$10,000	$10,000	Engineer's Estimate	Fieldwork and office support.
Equipment	1	LS	$300	$300	Engineer's Estimate	Sampling and health and safety equipment.
Travel	1	LS	$950	$950	Engineer's Estimate	Assumes 2 weeks to complete surface soil removal and backfill.
Subtotal				**$324,173**		
Powder Well Sediment Removal						
Sediment Removal						
Sediment Removal Services	28	CY	$174	$4,872	Vendor Quote	Removal of 28 yd^3 of sediment from 22 powder wells via vacuum truck.
IDW Management						
Transportation and Disposal - Special Waste (conversion factor of 1.29 for sediment)	18	TN	$70	$1,260	Engineer's Estimate	Disposal of 36 tons of sediment as 50% as special waste.
Transportation and Disposal - Hazardous (conversion factor of 1.29 for sediment)	18	TN	$270	$4,860	Engineer's Estimate	Disposal of 36 tons of sediment as 50% hazardous.
Laboratory Analysis						
Waste Characterization	1	LS	$2,283	$2,283	Vendor Quote	
Fieldwork Expenses						
Labor	1	LS	$6,000	$6,000	Engineer's Estimate	Fieldwork, office support.
Travel Expenses	1	LS	$318	$318	Engineer's Estimate	
Equipment	1	LS	$725	$725	Engineer's Estimate	
Air Monitoring						
Air Monitoring	3	DY	$29	$87	Engineer's Estimate	Breathing zone monitoring during sediment removal activities.
Subtotal				**$20,405**		
Pre-Remedial Design Sampling						
Installation of Groundwater Sampling Points						
Drilling Services	1	LS	$9,500	$9,500	Vendor Quote	Installation of 7 temporary wells, abandonment, drums, mobilization.
Laboratory Analysis						
Analysis of COCs	11	EA	$60	$660	Vendor Quote	Analysis of PCE; includes QA/QC.
Waste Characterization	2	EA	$289	$578	Vendor Quote	
IDW Management						
Transportation and Offsite Disposal	1	LS	$1,700	$1,700	Vendor Quote	Offsite disposal of 4 soil drums. Liquid IDW discharged via sanitary sewer system.
Fieldwork Expenses						
Labor	1	LS	$7,600	$7,600	Engineer's Estimate	Fieldwork, office support, and data validation.
Equipment	1	LS	$1,375	$1,375	Engineer's Estimate	Sampling and health and safety equipment.
Travel Expenses	1	LS	$318	$318	Engineer's Estimate	Assumes 3 days to complete groundwater delineation.

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions
Survey Support						
Survey of Sample Locations	1	LS	$1,630	$1,630	Vendor Quote	Includes survey of 7 groundwater sample points, data evaluation and report.
Subtotal				**$23,361**		
Well Abandonment / Installation						
Well Abandonment and Installation at Plumes A and C						
Abandonment and Installation Services	1	LS	$9,370	$9,370	Vendor Quote	Abandonment of 4 shallow 2" well (MW-105, MW-106, MW-114, MW-111) and 1 deep well (MW-117), and installation of 3 shallow 2" wells (2 at Plume A and 1 at Plume C); includes well development, drums, and mobilization.
IDW Management						
Transportation and Offsite Disposal	1	LS	$4,400	$4,400	Vendor Quote	Offsite disposal of 12 soil drums and discharge of liquid IDW via sanitary sewer system.
Fieldwork Expenses						
Labor	1	LS	$9,200	$9,200	Engineer's Estimate	Fieldwork and office support.
Equipment and Supplies	1	LS	$725	$725	Engineer's Estimate	
Travel Expenses	1	LS	$404	$404	Engineer's Estimate	Assumes 4 days to complete abandonment/installation activities.
Survey Support						
Survey of New Wells	1	LS	$1,470	$1,470	Vendor Quote	Includes survey of 3 wells, data evaluation and report.
Subtotal				**$25,569**		
Soil Mixing at Plume A						
Implementation						
Subcontractor Mobilization and Demobilization	1	LS	$130,000	$130,000	Vendor Quote	Treatment Area: 2,100 ft^2 Target Treatment Zone: 1-29 feet bgs Treatment Zone Volume: 59,000 ft^3 mass of product required: 36,450 lbs, Includes the following: 40' x 40' concrete pad removal, 1-pass trenching machine, decontamination pad, IDW disposal, mobilization / demobilization, installation of sediment and erosion control, placement of topsoil over disturbed areas, seeding, fertilizer, and straw, daily watering for 6 weeks, and site cleanup.
Chemical Reduction Product	1	LS	$57,750	$57,750	Vendor Quote	
Enhanced Reductive Dechlorination Product Preparation	1	LS	$24,750	$24,750	Vendor Quote	
Soil Mixing	1	LS	$300,000	$300,000	Vendor Quote	
Chemical Application	1	LS	$32,850	$32,850	Vendor Quote	
Decontamination of Equipment	1	LS	$12,500	$12,500	Vendor Quote	
IDW Management of Excess Soil	1	LS	$10,425	$10,425	Vendor Quote	
Sewer Line Removal	1	LS	$2,000	$2,000	Engineer's Estimate	
Site Restoration	1	LS	$20,960	$20,960	Vendor Quote	
Project Management	1	LS	$4,600	$4,600	Vendor Quote	
Fieldwork Expenses						
Labor	1	LS	$20,480	$20,480	Engineer's Estimate	Fieldwork, office support.
Equipment	1	LS	$1,500	$1,500	Engineer's Estimate	Sampling and health and safety equipment.
Travel	1	LS	$1,390	$1,390	Engineer's Estimate	Assumes 4 weeks to complete soil mixing.
Subtotal				**$619,205**		

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions
Groundwater Monitoring at Plume A - 2 Events						
Groundwater Monitoring at Plume A						
Laboratory Analysis						
Analysis of COCs	2	EA	$60	$120	Vendor Quote	2 monitoring wells within Plume A to be sampled approximately one month following soil mixing activities (will coincide with the first annual groundwater monitoring event). The second event will occur 12 weeks later.
Soil and Liquid IDW Characterization	1	EA	$289	$289	Vendor Quote	1 Liquid IDW sample/event.
IDW Management						
Transportation and Disposal	1	LS	$2,210	$2,210	Vendor Quote	Disposal of 1 liquid IDW drum via sanitary sewer system/event.
Fieldwork Expenses						
Labor	1	LS	$5,000	$5,000	Engineer's Estimate	Fieldwork, office support, project management.
Equipment	1	LS	$808	$808	Engineer's Estimate	Sampling and health and safety equipment.
Travel	1	LS	$318	$318	Engineer's Estimate	Assumes 4-day rentals to complete soil sampling/event.
Subtotal				**$8,745**		
Remedial Design			6%	**$62,073**		
Work Planning			6%	**$62,073**		
Contingency			25%	**$258,636**		
Subtotal				**$382,781**		
Total Cost of Alternative 3 with Remedial Design and Contingency				**$1,417,324**		
Construction Oversight/Project Management			10%	**$141,732**		
Reporting (Includes RACR and Annual LTM Report)			15%	**$212,599**		
Subtotal				**$354,331**		
TOTAL CAPITAL COST				**$1,771,655**		
Groundwater Monitoring at Plumes A and C - Years 1 and 2						
Laboratory Analysis						
Analysis of COCs	68	EA	$60	$4,080	Vendor Quote	11 monitoring wells sampled per quarterly event for a period of 2 years; includes QA/QC. Annual costs are presented.
Waste Characterization	1	EA	$1,156	$1,156	Vendor Quote	
IDW Management						
Transportation and Disposal	1	EA	$800	$800	Vendor Quote	Disposal of liquid IDW via sanitary sewer system.
Fieldwork Expenses						
Labor	1	EA	$16,000	$16,000	Engineer's Estimate	Fieldwork, office support, data validation for 4 quarterly events.
Equipment and Supplies	1	EA	$2,638	$2,638	Engineer's Estimate	Sampling and health and safety equipment for 4 quarterly events.
Travel Expenses	1	EA	$436	$436	Engineer's Estimate	Assumes 1 day to complete groundwater sampling activities. Costs reflect 4 quarterly events.

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions
Reporting						
Groundwater Monitoring and Inspection Report	1	LS	$12,000	$12,000	Engineer's Estimate	
Data Management	1	LS	$2,400	$2,400	Engineer's Estimate	
Subtotal				**$39,510**		
Contingency			30%	**$11,853**		
Subtotal				**$51,363**		
Project Management			10%	**$5,136**		
Technical Support			20%	**$10,273**		
Total Annual Groundwater Monitoring Cost - Years 1 and 2				**$66,772**		
Groundwater Monitoring at Plumes A and C - Years 3 through 50						
Laboratory Analysis						
Analysis of COCs	17	EA	$60	$1,020	Vendor Quote	11 monitoring wells sampled annually; includes QA/QC.
Waste Characterization	1	EA	$289	$289	Vendor Quote	
IDW Management						
Transportation and Disposal	1	LS	$800	$800	Vendor Quote	Disposal of liquid IDW via sanitary sewer system.
Fieldwork Expenses						
Labor	1	LS	$4,000	$4,000	Engineer's Estimate	Fieldwork, office support, data validation per event.
Equipment	1	LS	$633	$633	Engineer's Estimate	Sampling and health and safety equipment.
Travel Expenses	1	LS	$109	$109	Engineer's Estimate	Assumes 1 day to complete groundwater sampling activities.
Reporting						
Groundwater Monitoring and Inspection Report	1	LS	$12,000	$12,000	Engineer's Estimate	
Data Management	1	LS	$2,400	$2,400	Engineer's Estimate	
Subtotal				**$21,251**		
Contingency			30%	**$6,375**		
Subtotal				**$27,626**		
Project Management			10%	**$2,763**		
Technical Support			20%	**$5,525**		
Subtotal				**$8,288**		
Total Annual Groundwater Monitoring Cost - Years 3 through 50				**$35,914**		
Periodic Costs - Five-year Reviews - Years 5 through 50						
5-year Review	LS	1	$15,000	$15,000	Engineer's Estimate	
Periodic Costs Per Five-year Review - Years 5 through 50				**$15,000**		
			2.7%	Discount Rate		
			0.0%	Inflation Rate		
Present Value Analysis						
Present Worth of GW Monitoring - Years 1 and 2			1.9218	$128,324		
Present Worth of GW Monitoring - Years 3 through 50			25.3403	$910,076		
Present Worth of Periodic Costs in Year 5			0.8753	$13,129		
Present Worth of Periodic Costs in Year 10			0.7661	$11,492		
Present Worth of Periodic Costs in Year 15			0.6706	$10,059		
Present Worth of Periodic Costs in Year 20			0.5869	$8,804		
Present Worth of Periodic Costs in Year 25			0.5137	$7,706		
Present Worth of Periodic Costs in Year 30			0.4497	$6,745		
Present Worth of Periodic Costs in Year 35			0.3936	$5,904		
Present Worth of Periodic Costs in Year 40			0.3445	$5,167		
Present Worth of Periodic Costs in Year 45			0.3015	$4,523		
Present Worth of Periodic Costs in Year 50			0.2639	$3,959		
Total Present Worth Costs				**$1,115,887**		
TOTAL CAPITAL AND PRESENT WORTH COSTS				**$2,887,542**		

TABLE 2-22
Alternative 3—In Situ Groundwater Treatment and
Soil and Powder Well Sediment Removal and Offsite Disposal
Decision Document – Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Description	Qty	Unit	Unit Cost	Total	Source	Assumptions

Note:

1) The estimate above is considered budgetary-level cost estimating, suitable for use in project evaluation and planning. Actual construction costs are expected to vary from these estimates due to market conditions, actual costs of purchased materials, quantity variations, regulatory requirements, and other factors existing at the time of construction.

2) Costs were based on RS Means (2005 edition using a 4% annual increase to 2010), MRK Exploration quote, Environmental Works quote, Summit quote, Capitol Environmental 2008 quote, Ferguson Surveying 2008 quote, PEL 2008 quote, and Engineer's Estimates. Costs are based on present worth. Escalation assumptions were not included in costs.

3) Excavation costs were based on RS Means (2005 edition using a 3% annual increase to 2010). Costs are based on present worth. Escalation assumptions were not included in costs.

4) *Mobilization/Demobilization* costs will include site setup, facilities, utility location, signage, security, decon cell, dust suppression, site teardown/restoration, and demobilization.

5) *Construction Oversight/Project Management* costs include daily oversight, health and safety requirements, project management requirements, subcontractor procurements, and any day to day requirements deemed necessary.

6) *Reporting* costs include development of the work plan and other required planning documents including but not limited to quality control, health and safety, environmental protection, and completion reporting (as-built drawings).

Abbreviations and Acronyms:
EA - Each
LS - Lump Sum
QA/QC - Quality Assurance/Quality control
CY - Cubic Yard
TN - Ton
IDW - Investigation-derived waste
MW - Monitoring Well
PCE - Tetrachloroethene
TCE - Trichloroethene
1,1,1,2-TeCA - 1,1,1,2-tetrachloroethane
1,1,2,2-TeCA - 1,1,2,2-tetrachloroethane

TABLE 2-23

Remediation Goals for Chemicals of Concern

Decision Document - Operable Unit 1

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Cleanup Level	Units	Basis for Cleanup Level
Soil Remediation Goals			
Antimony	31	mg/kg	Regional Screening Level [a] for Residential Soil based on a Noncancer Hazard Index of 1.0
Aroclor 1260 [b]	1	mg/kg	"To be Considered" ARAR (40 CFR 761.61(a)(4)(I)(A))
Arsenic [b]	13.2	mg/kg	Site-specific background value [c]
Lead [b]	400	mg/kg	Regional Screening Level [a] for Residential Soil based on a Noncancer Hazard Index of 1.0
Thallium	7	mg/kg	Regional Screening Level [a] for Residential Soil based on a Noncancer Hazard Index of 1.0
Groundwater Remediation Goals			
CT	3,200	µg/L	Construction Worker Dermal Contact with Excavation Water based on ELCR of 1×10^{-5} and HI of 1.0
PCE	21,000	µg/L	Construction Worker Dermal Contact with Excavation Water based on ELCR of 1×10^{-5} and HI of 1.0
Migration from Soil to Groundwater			
CT [d]	1.19	mg/kg	Site-specific calculations [e]
PCE [d]	9.14	mg/kg	Site-specific calculations [f]

[a] U.S. Environmental Protection Agency. 2009. USEPA Regional Screening Levels. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables /index.htm.

[b] Although remediation goals were developed for arsenic, lead, and Aroclor 1260, the HHRA did not identify those chemicals as COCs. Elevated concentrations of arsenic, lead, and Aroclor 1260 had been excluded from the HHRA, because project stakeholders agreed that areas where these chemical concentrations were elevated would be addressed through a future soil removal action. Remediation goals for arsenic, lead, and Aroclor 1260 will serve as cleanup criteria when the Army performs the removal action. Because the remaining concentrations do not pose unacceptable risk to human health, arsenic, lead, and Aroclor 1260 do not require additional remedial action beyond the soil removal areas previously identified.

[c] Maximum-likelihood-estimate 95/95 upper tolerance limit of onsite arsenic concentrations, after the removal of outliers from the sample population

[d] Although CT and PCE were not identified as soil COCs in the HHRA, their concentrations in soil may affect the RAO for construction worker dermal contact with groundwater. Therefore, remediation goals were developed for unsaturated soil to address potential ongoing sources of groundwater contamination.

[e] Site-specific calculations based on groundwater remediation goal of 3,200 µg/kg for CT and dilution attenuation factor of 1

[f] Site-specific calculations based on groundwater remediation goal of 21,000 µg/kg or PCE and dilution attenuation factor of 1

CT = carbon tetrachloride

PCE = tetrachloroethylene

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

HI = hazard index

FIGURE 2-1
SITE LOCATION MAP
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-1_SITE_LOC_DD.MXD MSCHROCK 11/29/2010 20:41:30

LEGEND

- Monitoring Well
- Powder Well
- Elevation Contour (2-foot interval)
- Site Boundary
- 220 Former Building

0 50 100 Feet

FIGURE 2-2
CURRENT SITE FEATURES
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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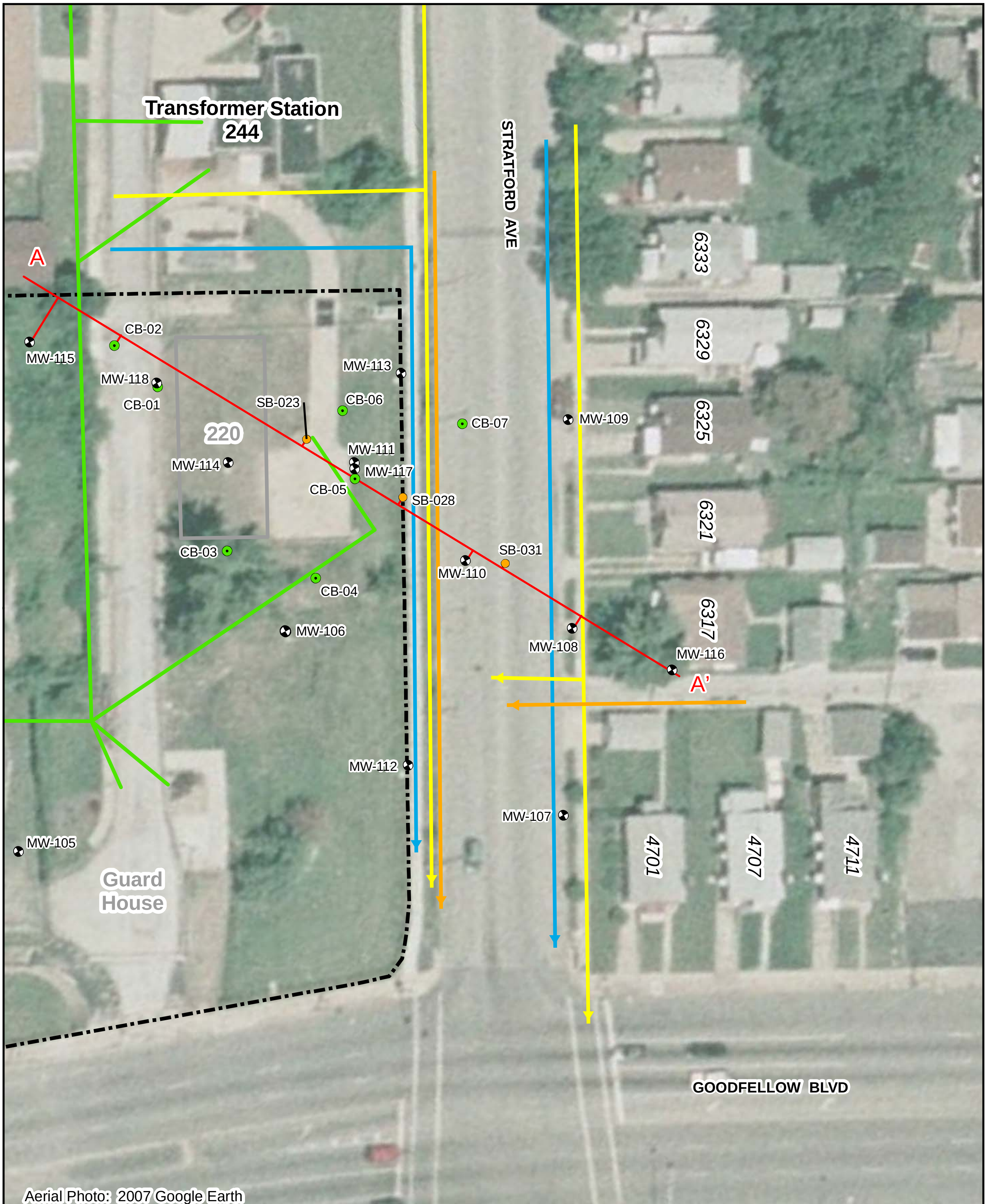
\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-2_SITE_FEATURES_DD.MXD MSCHROCK 11/29/2010 20:42:52



0 30 60 Feet

LEGEND

- Soil Boring
- Confirmation Boring
- Monitoring Well
- Cross Section
- Site Boundary
- 220 Former Building

Approximate Utilities

- Natural Gas
- Sanitary Sewer
- Telephone
- Water

FIGURE 2-3
LOCATION OF CROSS-SECTION A-A'
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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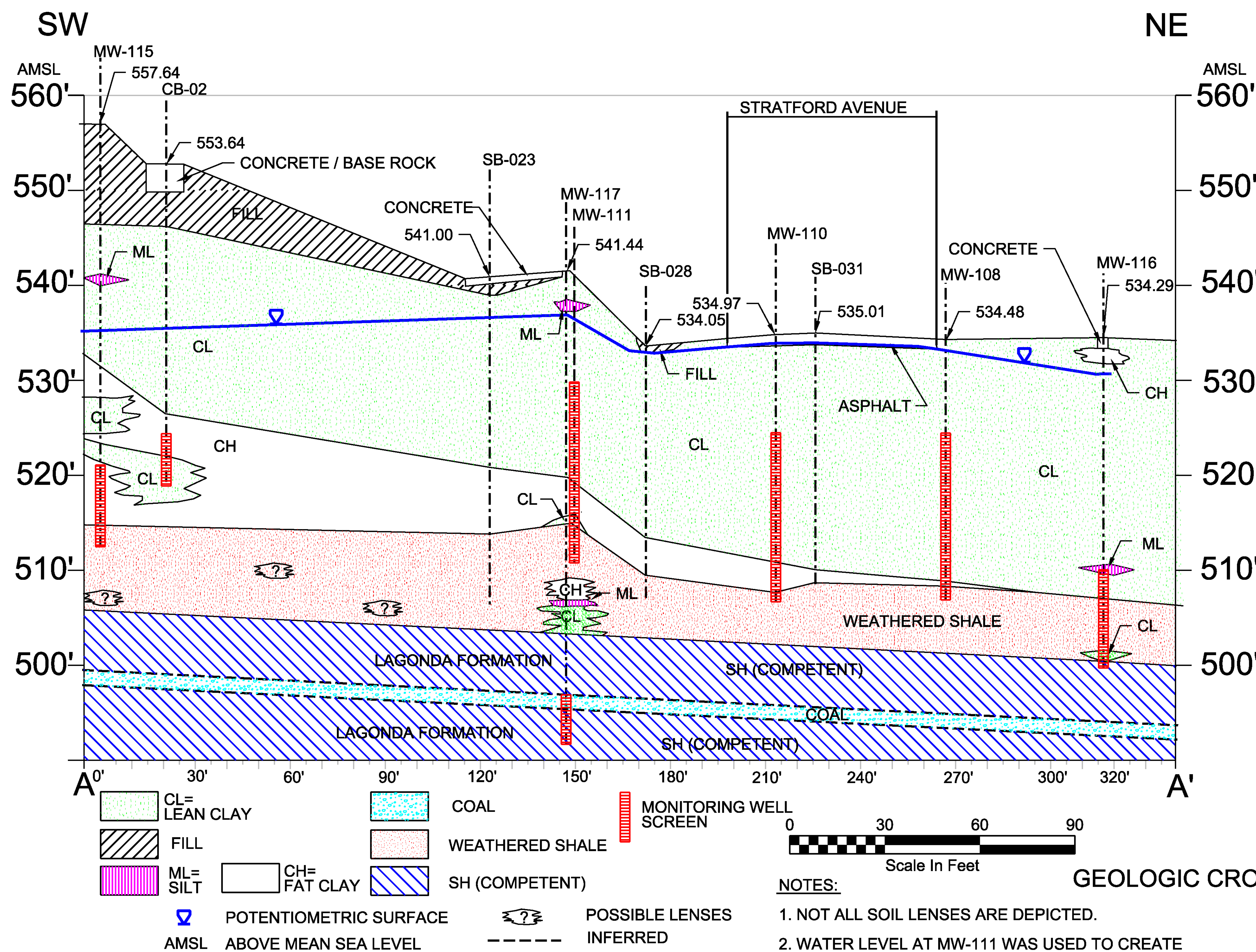
\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-3_CROSSECTION_A_A_DD.MXD MSCHROCK 12/2/2010 13:19:27



NOTES:

1. NOT ALL SOIL LENSES ARE DEPICTED.
2. WATER LEVEL AT MW-111 WAS USED TO CREATE POTENTIOMETRIC SURFACE NEAR MW-117

FIGURE 2-4
GEOLOGIC CROSS - SECTION A-A'

St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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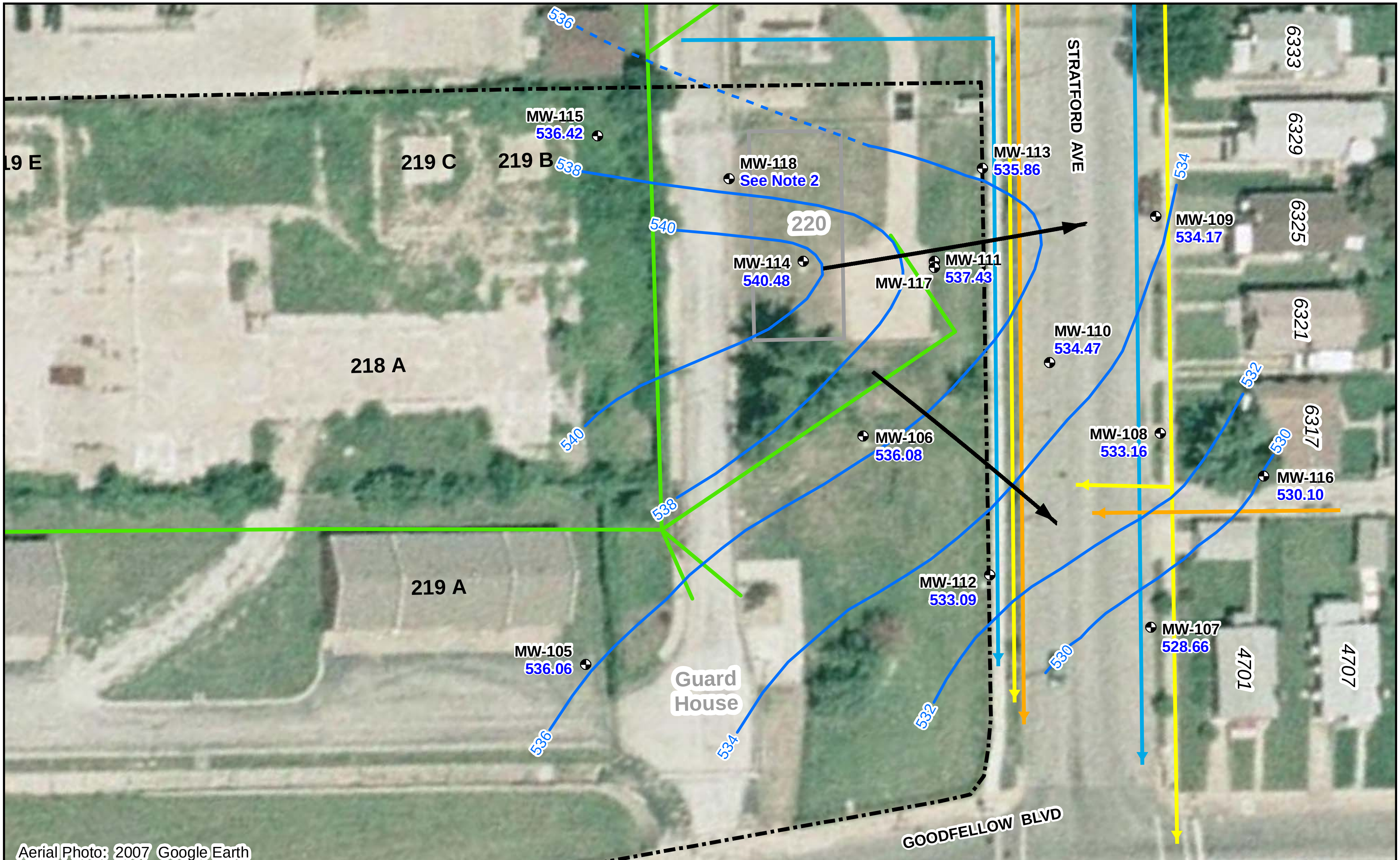

LEGEND

- Monitoring Well with Groundwater Elevation
- Groundwater Flow Direction
- Potentiometric Surface Contour
- 220 Former Building
- Site Boundary

Approximate Utilities
- Natural Gas
- Sanitary Sewer
- Telephone
- Water

0 30 60 Feet

NOTE:
1. Water level measurements were collected on June 2, 2008.
2. MW-118 was not installed in 2008 when water levels were measured.

FIGURE 2-5
POTENTIOMETRIC SURFACE MAP
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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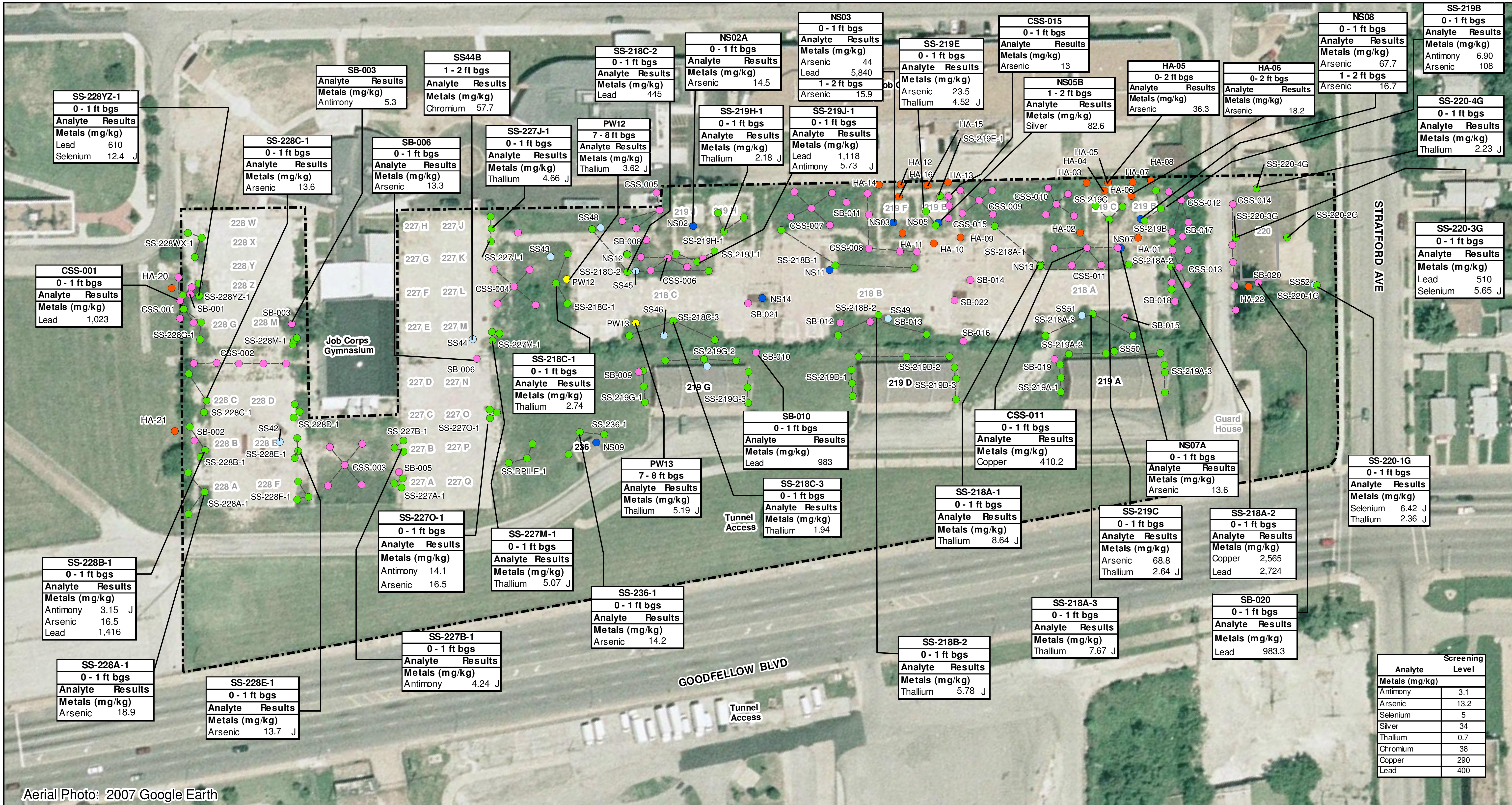
\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-5_POT_SURF_DD.MXD MSCHROCK 11/29/2010 20:47:16



LEGEND

- 2008 Soil Sample
- 2005 Soil Sample
- 2001 Soil Sample
- 1998 Soil Sample Locations
- 1991 Soil Sample
- Composite Sample Portion Line
- Site Boundary
- 220 Former Building

0 50 100 Feet

NOTE:
1. J = Reported value is estimated.
2. mg/kg = milligrams per kilogram
3. ft bgs = feet below ground surface

FIGURE 2-6
METALS IN SURFACE SOIL AT CONCENTRATIONS EXCEEDING SCREENING LEVELS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

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\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-6_SURF_SOIL_METALS_EXCEED_DD.MXD MSCHROCK 11/24/2010 13:36:26

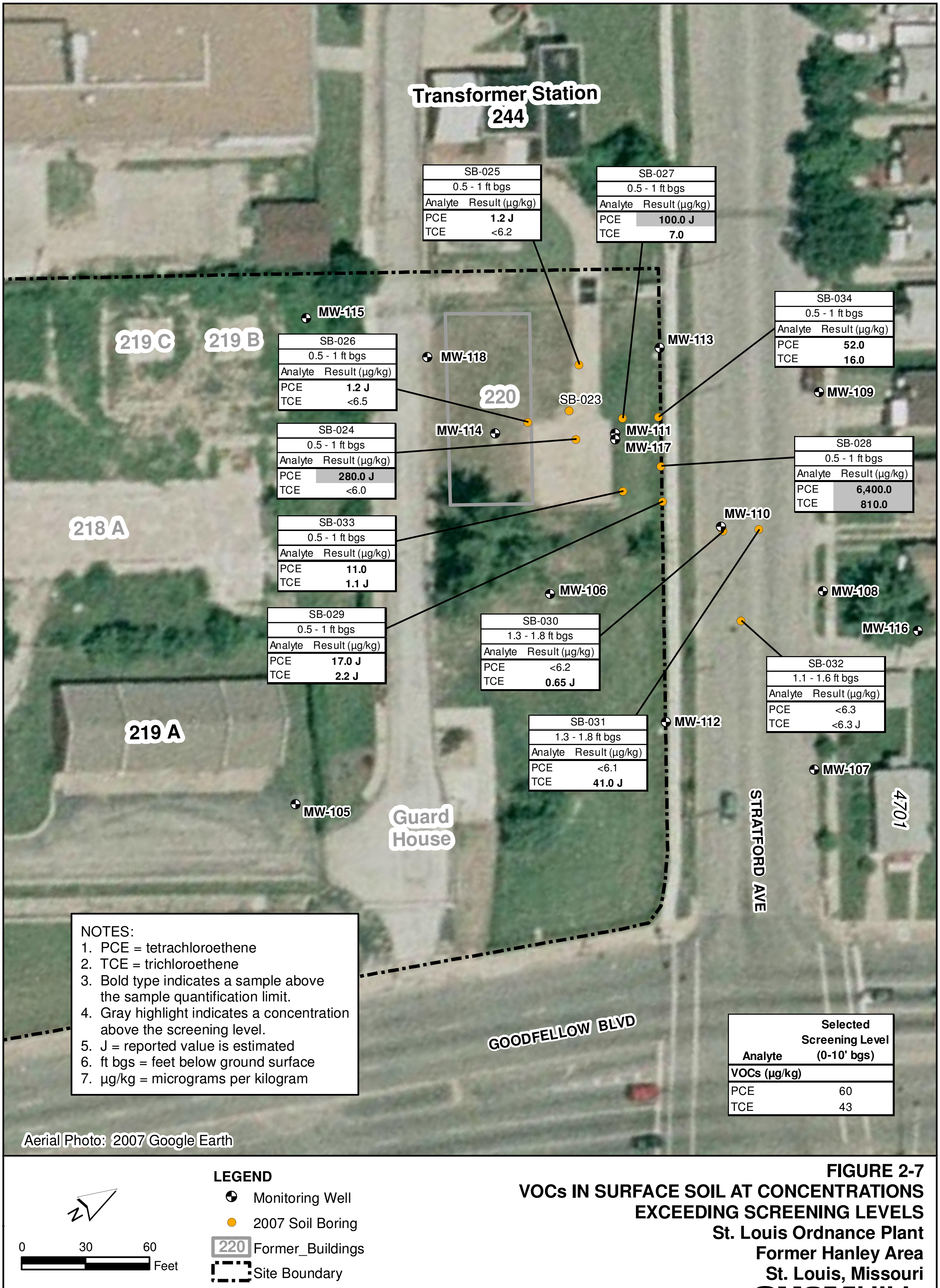


FIGURE 2-7
VOCs IN SURFACE SOIL AT CONCENTRATIONS EXCEEDING SCREENING LEVELS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-7_VOCS_SURF_SOIL_EXCEED_DD.MXD MSCHROCK 1/31/2011 11:37:45

SED-001	
0 - 1 ft bgs	
Analyte	Results
PCBs (mg/kg)	
Aroclor 1260	569

SS55A	
0 - 1 ft bgs	
Analyte	Results
PCBs (mg/kg)	
Aroclor 1260	18,200

SS-001	
0 - 1 ft bgs	
Analyte	Results
PCBs (mg/kg)	
Aroclor 1260	1.44

CSS-009	
0 - 1 ft bgs	
PAHs (µg/kg)	Results
Benzo(b)fluoranthene	766.9

SB-010	
0 - 1 ft bgs	
PAHs (µg/kg)	Results
Benzo(b)fluoranthene	818.6

SB-020	
0 - 1 ft bgs	
Analyte	Results
PAHs (µg/kg)	
Benzo(a)anthracene	245,704
Benzo(a)pyrene	196,359
Benzo(b)fluoranthene	388,878
Benzo(g,h,i)perylene	136,295
Benzo(k)fluoranthene	104,945
Chrysene	328,483
Dibenz(a,h)anthracene	30,616
Fluoranthene	797,026
Ideno(1,2,3-cd)pyrene	131,387
Pyrene	703,713

Analyte	Selected Screening Level (0-10' bgs)
PCBs (mg/kg)	
Aroclor	1[1]
PAHs/SVOCs (µg/kg)	
Benzo(a)anthracene	887
Benzo(a)pyrene	735
Benzo(b)fluoranthene	626
Benzo(g,h,i)perylene	478
Benzo(k)fluoranthene	1,500
Chrysene	15,000
Dibenz(a,h)anthracene	303
Fluoranthene	230,000*
Indeno(1,2,3-cd)pyrene	415
Pyrene	230,000*

Notes:
MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use
SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.
[1] = This is the the TSCA screening level.

0 50 100
Feet

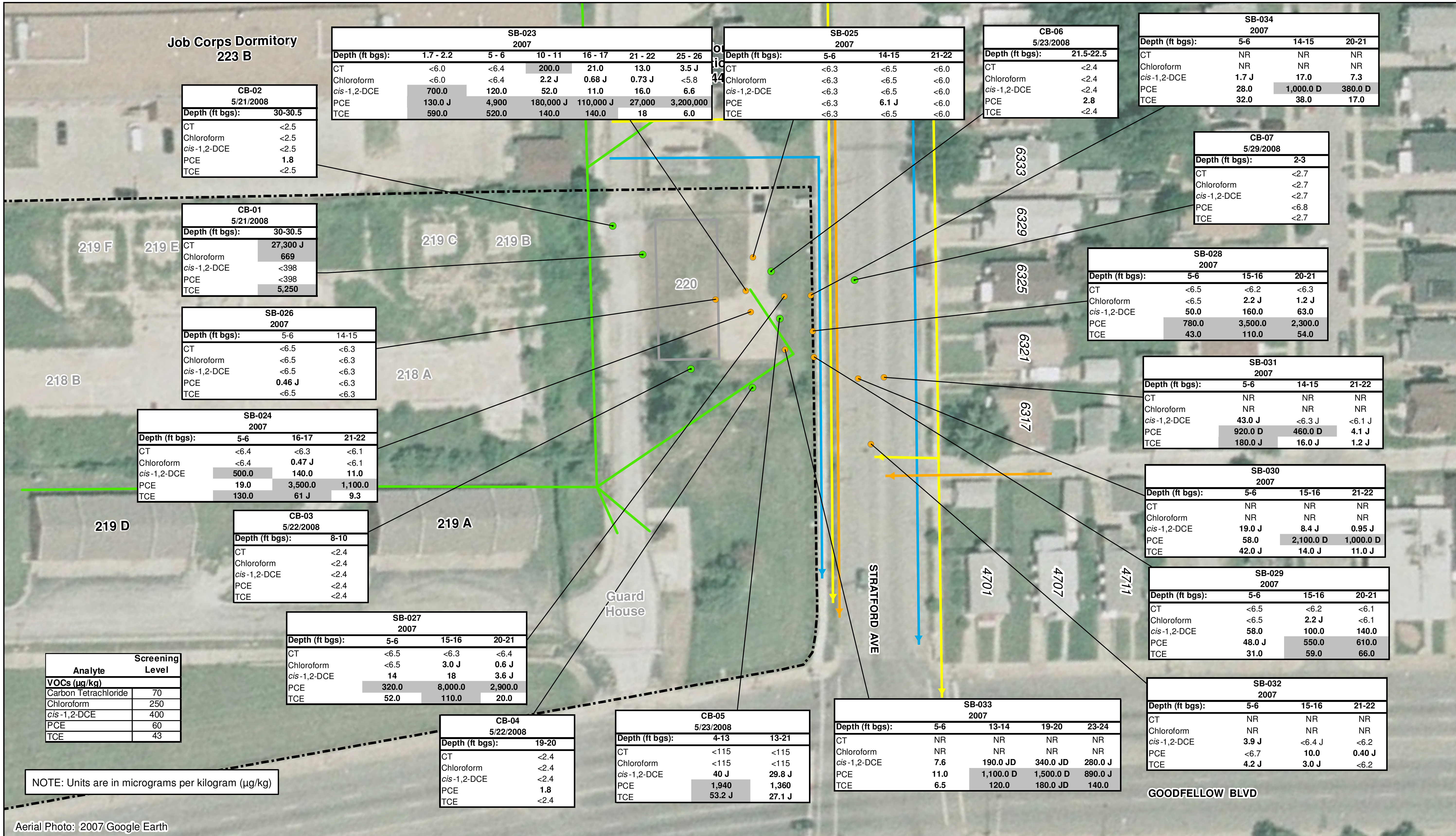
LEGEND
- 2008 Soil Sample
- 2005 Soil Sample
- 1998 Soil Sample Locations
- 1991 Soil Sample
- Composite Sample Portion Line
- Site Boundary
- 220 Former Building

NOTES:
1. PAH = polycyclic aromatic hydrocarbon
2. PCB = polychlorinated biphenyl
3. PCBs were analyzed in SED-001, SS55-A, and SS-001. PAHs were analyzed in all other samples shown.
4. ft bgs = feet below ground surface
5. µg/kg = microgram per kilogram
6. mg/kg = milligram per kilogram

FIGURE 2-8
PAHs AND PCBs IN SURFACE SOIL AT CONCENTRATIONS EXCEEDING SCREENING LEVELS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-8_PAHS_PCBS_SURF_SOIL_EXCEED_DD.MXD MSCHROCK 11/24/2010 14:03:42



SB-023 2007 Depth (ft bgs):	1.7 - 2.2	5 - 6	10 - 11	16 - 17	21 - 22	25 - 26
CT	<6.0	<6.4	**200.0**	**21.0**	**13.0**	**3.5 J**
Chloroform	<6.0	<6.4	**2.2 J**	**0.68 J**	**0.73 J**	<5.8
cis-1,2-DCE	**700.0**	**120.0**	**52.0**	**11.0**	**16.0**	**6.6**
PCE	**130.0 J**	**4,900**	**180,000 J**	**110,000 J**	**27,000**	**3,200,000**
TCE	**590.0**	**520.0**	**140.0**	**140.0**	**18**	**6.0**

SB-025 2007 Depth (ft bgs):	5-6	14-15	21-22
CT	<6.3	<6.5	<6.0
Chloroform	<6.3	<6.5	<6.0
cis-1,2-DCE	<6.3	<6.5	<6.0
PCE	<6.3	**6.1 J**	<6.0
TCE	<6.3	<6.5	<6.0

CB-06 5/23/2008 Depth (ft bgs):	21.5-22.5
CT	<2.4
Chloroform	<2.4
cis-1,2-DCE	<2.4
PCE	**2.8**
TCE	<2.4

SB-034 2007 Depth (ft bgs):	5-6	14-15	20-21
CT	NR	NR	NR
Chloroform	NR	NR	NR
cis-1,2-DCE	**1.7 J**	**17.0**	**7.3**
PCE	**28.0**	**1,000.0 D**	**380.0 D**
TCE	**32.0**	**38.0**	**17.0**

CB-02 5/21/2008 Depth (ft bgs):	30-30.5
CT	<2.5
Chloroform	<2.5
cis-1,2-DCE	<2.5
PCE	**1.8**
TCE	<2.5

CB-07 5/29/2008 Depth (ft bgs):	2-3
CT	<2.7
Chloroform	<2.7
cis-1,2-DCE	<2.7
PCE	<6.8
TCE	<2.7

CB-01 5/21/2008 Depth (ft bgs):	30-30.5
CT	**27,300 J**
Chloroform	**669**
cis-1,2-DCE	<398
PCE	<398
TCE	**5,250**

SB-028 2007 Depth (ft bgs):	5-6	15-16	20-21
CT	<6.5	<6.2	<6.3
Chloroform	<6.5	**2.2 J**	**1.2 J**
cis-1,2-DCE	**50.0**	**160.0**	**63.0**
PCE	**780.0**	**3,500.0**	**2,300.0**
TCE	**43.0**	**110.0**	**54.0**

SB-026 2007 Depth (ft bgs):	5-6	14-15
CT	<6.5	<6.3
Chloroform	<6.5	<6.3
cis-1,2-DCE	<6.5	<6.3
PCE	**0.46 J**	<6.3
TCE	<6.5	<6.3

SB-031 2007 Depth (ft bgs):	5-6	14-15	21-22
CT	NR	NR	NR
Chloroform	NR	NR	NR
cis-1,2-DCE	**43.0 J**	<6.3 J	<6.1 J
PCE	**920.0 D**	**460.0 D**	**4.1 J**
TCE	**180.0 J**	**16.0 J**	**1.2 J**

SB-024 2007 Depth (ft bgs):	5-6	16-17	21-22
CT	<6.4	<6.3	<6.1
Chloroform	<6.4	**0.47 J**	<6.1
cis-1,2-DCE	**500.0**	**140.0**	**11.0**
PCE	**19.0**	**3,500.0**	**1,100.0**
TCE	**130.0**	**61 J**	**9.3**

SB-030 2007 Depth (ft bgs):	5-6	15-16	21-22
CT	NR	NR	NR
Chloroform	NR	NR	NR
cis-1,2-DCE	**19.0 J**	**8.4 J**	**0.95 J**
PCE	**58.0**	**2,100.0 D**	**1,000.0 D**
TCE	**42.0 J**	**14.0 J**	**11.0 J**

CB-03 5/22/2008 Depth (ft bgs):	8-10
CT	<2.4
Chloroform	<2.4
cis-1,2-DCE	<2.4
PCE	<2.4
TCE	<2.4

SB-029 2007 Depth (ft bgs):	5-6	15-16	20-21
CT	<6.5	<6.2	<6.1
Chloroform	<6.5	**2.2 J**	<6.1
cis-1,2-DCE	**58.0**	**100.0**	**140.0**
PCE	**48.0 J**	**550.0**	**610.0**
TCE	**31.0**	**59.0**	**66.0**

SB-027 2007 Depth (ft bgs):	5-6	15-16	20-21
CT	<6.5	<6.3	<6.4
Chloroform	<6.5	**3.0 J**	**0.6 J**
cis-1,2-DCE	**14**	**18**	**3.6 J**
PCE	**320.0**	**8,000.0**	**2,900.0**
TCE	**52.0**	**110.0**	**20.0**

Analyte	Screening Level
VOCs (µg/kg)	
Carbon Tetrachloride	70
Chloroform	250
cis-1,2-DCE	400
PCE	60
TCE	43

SB-032 2007 Depth (ft bgs):	5-6	15-16	21-22
CT	NR	NR	NR
Chloroform	NR	NR	NR
cis-1,2-DCE	**3.9 J**	<6.4 J	<6.2
PCE	<6.7	**10.0**	**0.40 J**
TCE	**4.2 J**	**3.0 J**	<6.2

SB-033 2007 Depth (ft bgs):	5-6	13-14	19-20	23-24
CT	NR	NR	NR	NR
Chloroform	NR	NR	NR	NR
cis-1,2-DCE	**7.6**	**190.0 JD**	**340.0 JD**	**280.0 J**
PCE	**11.0**	**1,100.0 D**	**1,500.0 D**	**890.0 J**
TCE	**6.5**	**120.0**	**180.0 JD**	**140.0**

CB-04 5/22/2008 Depth (ft bgs):	19-20
CT	<2.4
Chloroform	<2.4
cis-1,2-DCE	<2.4
PCE	**1.8**
TCE	<2.4

CB-05 5/23/2008 Depth (ft bgs):	4-13	13-21
CT	<115	<115
Chloroform	<115	<115
cis-1,2-DCE	**40 J**	**29.8 J**
PCE	**1,940**	**1,360**
TCE	**53.2 J**	**27.1 J**

NOTE: Units are in micrograms per kilogram (µg/kg)

LEGEND

- Confirmation Boring
- 2007 Soil Boring
- Site Boundary
- 220 Former Building

Approximate Utilities
- Natural Gas
- Sanitary Sewer
- Telephone
- Water

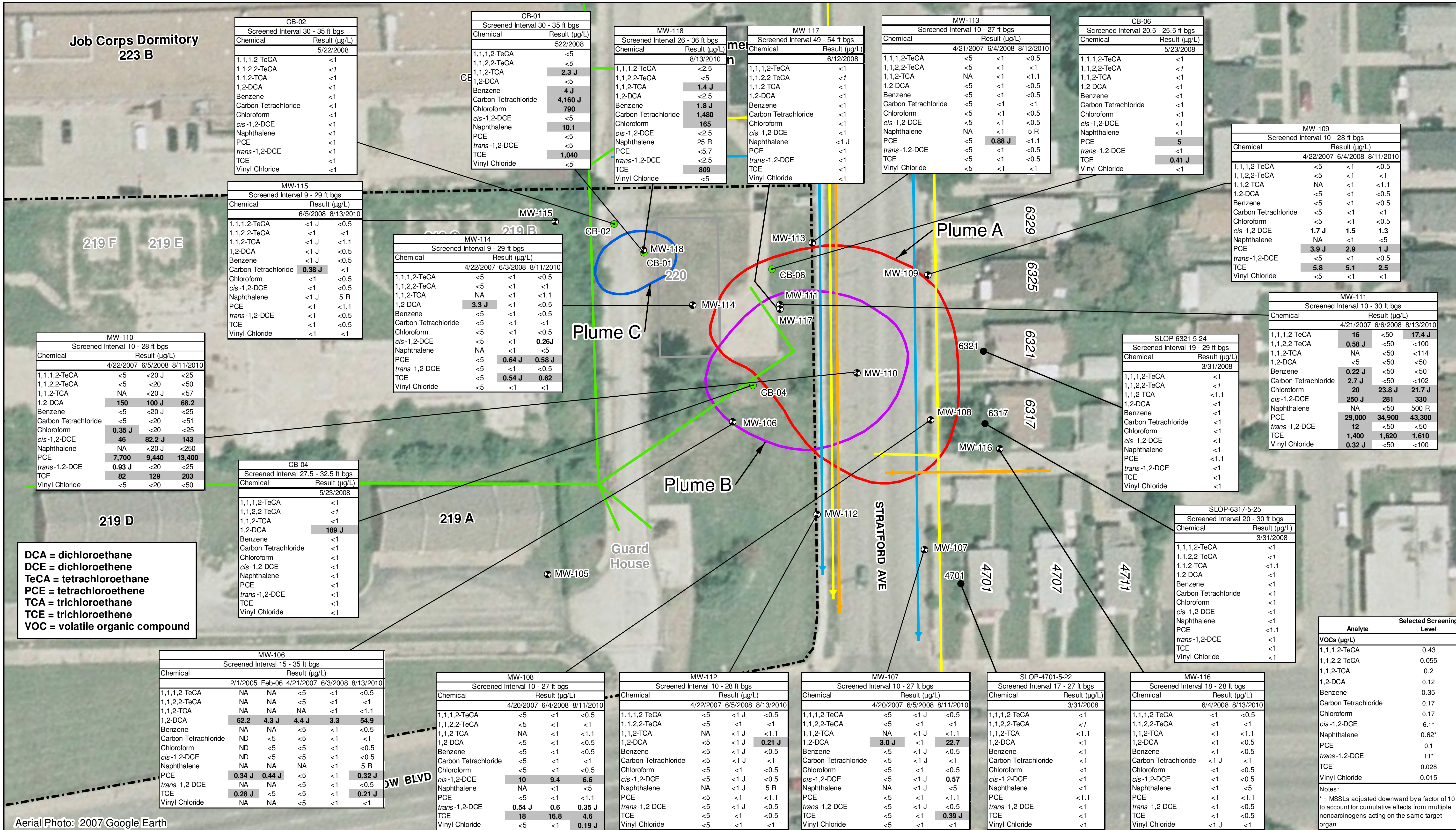
0 30 60 Feet

NOTES:
1. CT = carbon tetrachloride
2. *cis*-1,2-DCE = *cis*-1,2-dichloroethene
3. PCE = tetrachloroethene
4. TCE = trichloroethene
5. DCE = dichloroethene
6. D = Qualified at dilution
7. J - Estimated Concentration
8. NR = Not reported
9. '<' - Chemical not detected above the method detection limit
10. Bold type indicates the chemical was detected
11. Gray highlight indicates a detected concentration above the screening level.
12. ft bgs = feet below ground surface

FIGURE 2-9
VOCs IN SUBSURFACE SOIL AT CONCENTRATIONS EXCEEDING SCREENING LEVELS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-9_VOCS_SUBSURF_SOIL_EXCEED_DD.MXD MSCHROCK 1/26/2011 22:53:36



CB-02 — Screened Interval 30 - 35 ft bgs

Chemical	Result (µg/L) 5/22/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	<1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

CB-01 — Screened Interval 30 - 35 ft bgs

Chemical	Result (µg/L) 522/2008
1,1,1,2-TeCA	<5
1,1,2,2-TeCA	<5
1,1,2-TCA	**2.3 J**
1,2-DCA	<5
Benzene	**4 J**
Carbon Tetrachloride	**4,160 J**
Chloroform	**790**
cis-1,2-DCE	<5
Naphthalene	**10.1**
PCE	<5
trans-1,2-DCE	<5
TCE	**1,040**
Vinyl Chloride	<5

MW-118 — Screened Interval 26 - 36 ft bgs

Chemical	Result (µg/L) 8/13/2010
1,1,1,2-TeCA	<2.5
1,1,2,2-TeCA	<5
1,1,2-TCA	**1.4 J**
1,2-DCA	<2.5
Benzene	**1.8 J**
Carbon Tetrachloride	**1,480**
Chloroform	**165**
cis-1,2-DCE	<2.5
Naphthalene	25 R
PCE	<5.7
trans-1,2-DCE	<2.5
TCE	**809**
Vinyl Chloride	<5

MW-117 — Screened Interval 49 - 54 ft bgs

Chemical	Result (µg/L) 6/12/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1 J
PCE	<1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

MW-113 — Screened Interval 10 - 27 ft bgs

Chemical	4/21/2007	6/4/2008	8/12/2010
1,1,1,2-TeCA	<5	<1	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1	<1.1
1,2-DCA	<5	<1	<0.5
Benzene	<5	<1	<0.5
Carbon Tetrachloride	<5	<1	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	<5	<1	<0.5
Naphthalene	NA	<1	5 R
PCE	<5	**0.88 J**	<1.1
trans-1,2-DCE	<5	<1	<0.5
TCE	<5	<1	<0.5
Vinyl Chloride	<5	<1	<1

Result (µg/L)

CB-06 — Screened Interval 20.5 - 25.5 ft bgs

Chemical	Result (µg/L) 5/23/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	**5**
trans-1,2-DCE	<1
TCE	**0.41 J**
Vinyl Chloride	<1

MW-109 — Screened Interval 10 - 28 ft bgs

Chemical	4/22/2007	6/4/2008	8/11/2010
1,1,1,2-TeCA	<5	<1	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1	<1.1
1,2-DCA	<5	<1	<0.5
Benzene	<5	<1	<0.5
Carbon Tetrachloride	<5	<1	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	**1.7 J**	**1.5**	**1.3**
Naphthalene	NA	<1	<5
PCE	**3.9 J**	**2.9**	**1 J**
trans-1,2-DCE	<5	<1	<0.5
TCE	**5.8**	**5.1**	**2.5**
Vinyl Chloride	<5	<1	<1

Result (µg/L)

MW-115 — Screened Interval 9 - 29 ft bgs

Chemical	6/5/2008	8/13/2010
1,1,1,2-TeCA	<1 J	<0.5
1,1,2,2-TeCA	<1	<1
1,1,2-TCA	<1 J	<1.1
1,2-DCA	<1 J	<0.5
Benzene	<1 J	<0.5
Carbon Tetrachloride	**0.38 J**	<1
Chloroform	<1	<0.5
cis-1,2-DCE	<1	<0.5
Naphthalene	<1 J	5 R
PCE	<1	<1.1
trans-1,2-DCE	<1	<0.5
TCE	<1	<0.5
Vinyl Chloride	<1	<1

Result (µg/L)

MW-114 — Screened Interval 9 - 29 ft bgs

Chemical	4/22/2007	6/3/2008	8/11/2010
1,1,1,2-TeCA	<5	<1	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1	<1.1
1,2-DCA	**3.3 J**	<1	<0.5
Benzene	<5	<1	<0.5
Carbon Tetrachloride	<5	<1	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	<5	<1	**0.26J**
Naphthalene	NA	<1	<5
PCE	<5	**0.64 J**	**0.58 J**
trans-1,2-DCE	<5	<1	<0.5
TCE	<5	**0.54 J**	**0.62**
Vinyl Chloride	<5	<1	<1

Result (µg/L)

MW-110 — Screened Interval 10 - 28 ft bgs

Chemical	4/22/2007	6/5/2008	8/11/2010
1,1,1,2-TeCA	<5	<20 J	<25
1,1,2,2-TeCA	<5	<20	<50
1,1,2-TCA	NA	<20 J	<57
1,2-DCA	**150**	**100 J**	**68.2**
Benzene	<5	<20 J	<25
Carbon Tetrachloride	<5	<20	<51
Chloroform	**0.35 J**	<20	<25
cis-1,2-DCE	**46**	**82.2 J**	**143**
Naphthalene	NA	<20 J	<250
PCE	**7,700**	**9,440**	**13,400**
trans-1,2-DCE	**0.93 J**	<20	<25
TCE	**82**	**129**	**203**
Vinyl Chloride	<5	<20	<50

Result (µg/L)

MW-111 — Screened Interval 10 - 30 ft bgs

Chemical	4/21/2007	6/6/2008	8/13/2010
1,1,1,2-TeCA	**16**	<50	**17.4 J**
1,1,2,2-TeCA	**0.58 J**	<50	<100
1,1,2-TCA	NA	<50	<114
1,2-DCA	<5	<50	<50
Benzene	**0.22 J**	<50	<50
Carbon Tetrachloride	**2.7 J**	<50	<102
Chloroform	**20**	**23.8 J**	**21.7 J**
cis-1,2-DCE	**250 J**	**281**	**330**
Naphthalene	NA	<50	500 R
PCE	**29,000**	**34,900**	**43,300**
trans-1,2-DCE	**12**	<50	<50
TCE	**1,400**	**1,620**	**1,610**
Vinyl Chloride	**0.32 J**	<50	<100

Result (µg/L)

SLOP-6321-5-24 — Screened Interval 19 - 29 ft bgs

Chemical	Result (µg/L) 3/31/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1.1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	<1.1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

CB-04 — Screened Interval 27.5 - 32.5 ft bgs

Chemical	Result (µg/L) 5/23/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1
1,2-DCA	**189 J**
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	<1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

SLOP-6317-5-25 — Screened Interval 20 - 30 ft bgs

Chemical	Result (µg/L) 3/31/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1.1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	<1.1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

DCA = dichloroethane
DCE = dichloroethene
TeCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene
VOC = volatile organic compound

MW-106 — Screened Interval 15 - 35 ft bgs

Chemical	2/1/2005	Feb-06	4/21/2007	6/3/2008	8/13/2010
1,1,1,2-TeCA	NA	NA	<5	<1	<0.5
1,1,2,2-TeCA	NA	NA	<5	<1	<1
1,1,2-TCA	NA	NA	NA	<1	<1.1
1,2-DCA	**62.2**	**4.3 J**	**4.4 J**	**3.3**	**54.9**
Benzene	NA	NA	<5	<1	<0.5
Carbon Tetrachloride	ND	<5	<5	<1	<1
Chloroform	ND	<5	<5	<1	<0.5
cis-1,2-DCE	ND	<5	<5	<1	<0.5
Naphthalene	NA	NA	NA	<1	5 R
PCE	**0.34 J**	**0.44 J**	<5	<1	**0.32 J**
trans-1,2-DCE	NA	NA	<5	<1	<0.5
TCE	**0.28 J**	<5	<5	<1	**0.21 J**
Vinyl Chloride	NA	NA	<5	<1	<1

Result (µg/L)

MW-108 — Screened Interval 10 - 27 ft bgs

Chemical	4/20/2007	6/4/2008	8/11/2010
1,1,1,2-TeCA	<5	<1	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1	<1.1
1,2-DCA	<5	<1	<0.5
Benzene	<5	<1	<0.5
Carbon Tetrachloride	<5	<1	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	**10**	**9.4**	**6.6**
Naphthalene	NA	<1	<5
PCE	<5	<1	<1.1
trans-1,2-DCE	**0.54 J**	**0.6**	**0.35 J**
TCE	**18**	**16.8**	**4.6**
Vinyl Chloride	<5	<1	**0.19 J**

Result (µg/L)

MW-112 — Screened Interval 10 - 28 ft bgs

Chemical	4/22/2007	6/5/2008	8/13/2010
1,1,1,2-TeCA	<5	<1 J	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1 J	<1.1
1,2-DCA	<5	<1 J	**0.21 J**
Benzene	<5	<1 J	<0.5
Carbon Tetrachloride	<5	<1 J	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	<5	<1 J	<0.5
Naphthalene	NA	<1 J	5 R
PCE	<5	<1	<1.1
trans-1,2-DCE	<5	<1 J	<0.5
TCE	<5	<1	<0.5
Vinyl Chloride	<5	<1	<1

Result (µg/L)

MW-107 — Screened Interval 10 - 27 ft bgs

Chemical	4/20/2007	6/5/2008	8/11/2010
1,1,1,2-TeCA	<5	<1 J	<0.5
1,1,2,2-TeCA	<5	<1	<1
1,1,2-TCA	NA	<1 J	<1.1
1,2-DCA	**3.0 J**	<1	**22.7**
Benzene	<5	<1 J	<0.5
Carbon Tetrachloride	<5	<1 J	<1
Chloroform	<5	<1	<0.5
cis-1,2-DCE	<5	<1 J	**0.57**
Naphthalene	NA	<1 J	<5
PCE	<5	<1	<1.1
trans-1,2-DCE	<5	<1 J	<0.5
TCE	<5	<1	**0.39 J**
Vinyl Chloride	<5	<1	<1

Result (µg/L)

SLOP-4701-5-22 — Screened Interval 17 - 27 ft bgs

Chemical	Result (µg/L) 3/31/2008
1,1,1,2-TeCA	<1
1,1,2,2-TeCA	<1
1,1,2-TCA	<1.1
1,2-DCA	<1
Benzene	<1
Carbon Tetrachloride	<1
Chloroform	<1
cis-1,2-DCE	<1
Naphthalene	<1
PCE	<1.1
trans-1,2-DCE	<1
TCE	<1
Vinyl Chloride	<1

MW-116 — Screened Interval 18 - 28 ft bgs

Chemical	6/4/2008	8/13/2010
1,1,1,2-TeCA	<1	<0.5
1,1,2,2-TeCA	<1	<1
1,1,2-TCA	<1	<1.1
1,2-DCA	<1	<0.5
Benzene	<1	<0.5
Carbon Tetrachloride	<1 J	<1
Chloroform	<1	<0.5
cis-1,2-DCE	<1	<0.5
Naphthalene	<1	<5
PCE	<1	<1.1
trans-1,2-DCE	<1	<0.5
TCE	<1	<0.5
Vinyl Chloride	<1 J	<1

Result (µg/L)

Analyte	Selected Screening Level
VOCs (µg/L)	
1,1,1,2-TeCA	0.43
1,1,2,2-TeCA	0.055
1,1,2-TCA	0.2
1,2-DCA	0.12
Benzene	0.35
Carbon Tetrachloride	0.17
Chloroform	0.17
cis-1,2-DCE	6.1*
Naphthalene	0.62*
PCE	0.1
trans-1,2-DCE	11*
TCE	0.028
Vinyl Chloride	0.015

Notes:
* = MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

LEGEND

- Groundwater Sample Point
- Temporary Well
- Monitoring Well
- Site Boundary
- Former Building
- Area Exceeding MCL for PCE, TCE, and cis-1,2-DCE (Plume A)
- Area Exceeding MCL for 1,2-DCA (Plume B)
- Area Exceeding MCL for Carbon Tetrachloride (Plume C)

Approximate Utilities
- Natural Gas
- Sanitary Sewer
- Telephone
- Water

0 30 60 Feet

Notes
1. J = Estimated Concentration
2. '<' = Chemical not detected above the method detection limit
3. Bold type indicates the chemical was detected
4. Gray highlight indicates a detected concentration above the screening level.
5. µg/L = micrograms per Liter
6. R = Sample result rejected due to deficiencies in the ability to analyze the sample and to meet the quality control criteria.

FIGURE 2-10
VOCs IN GROUNDWATER AT CONCENTRATIONS EXCEEDING SCREENING LEVELS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-10_VOCS_GW_EXCEED_DD.MXD MSCHROCK 1/31/2011 19:52:42

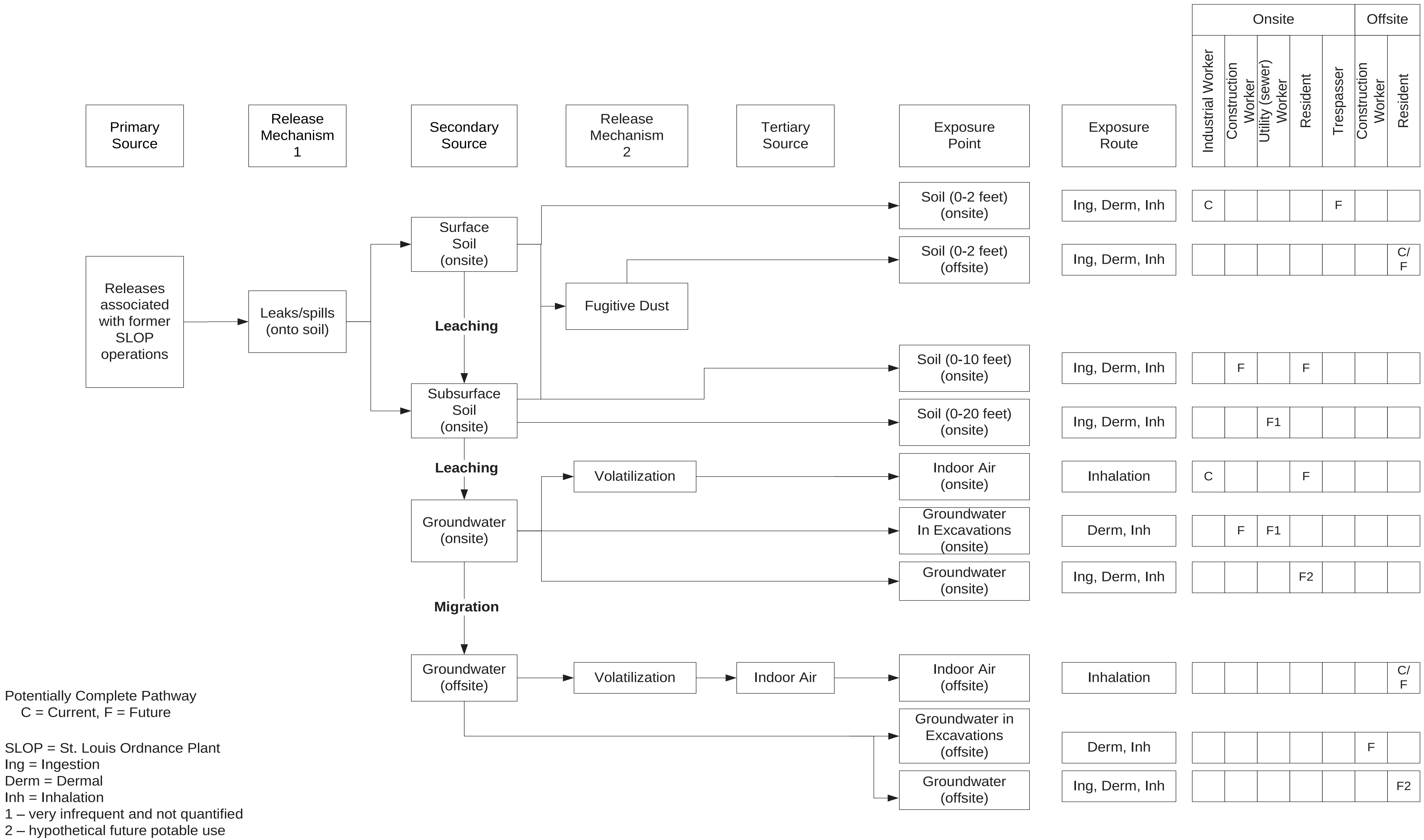
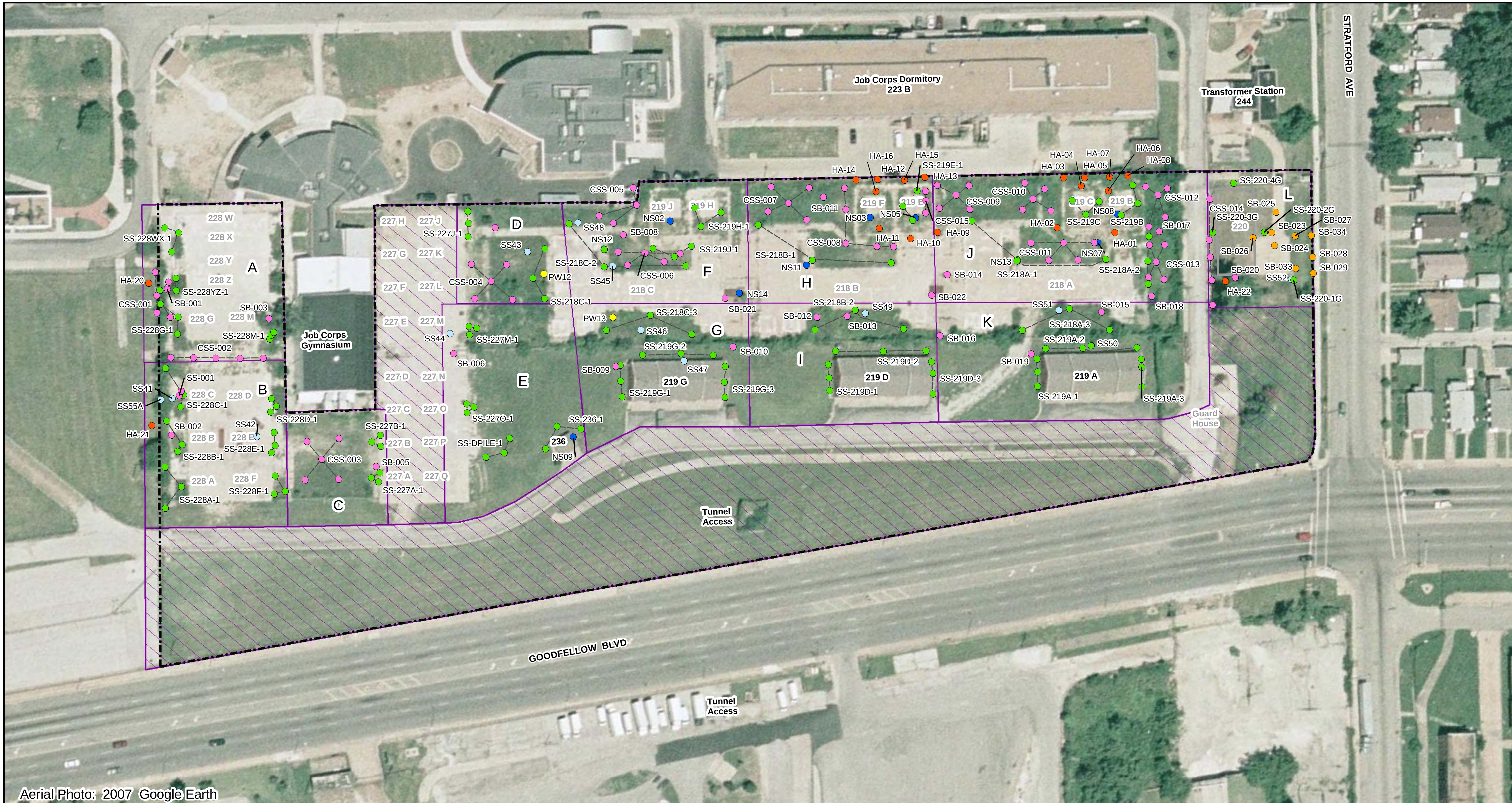


FIGURE 2-11
CONCEPTUAL SITE MODEL
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL



LEGEND

- 2008 Soil Sample
- 2005/2006 Soil Boring
- 2005 Soil Sample
- 2001 Soil Sample
- 2001 Powder Well
- 1998 Soil Sample Locations
- 1991 Soil Sample
- Composite Sample Portion Line
- 220 Former Building
- Exposure Unit
- Non-Exposure Unit
- Site Boundary

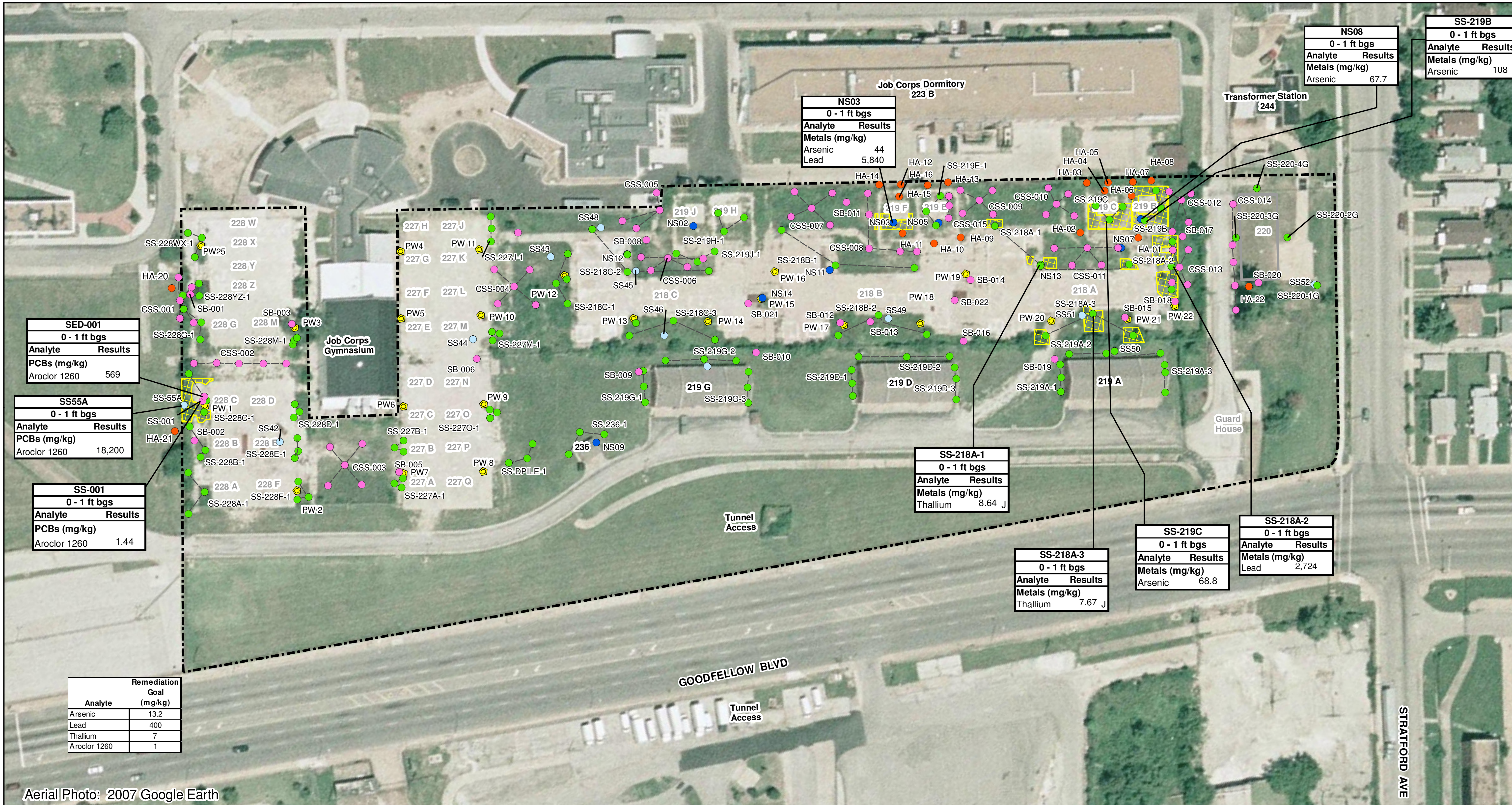
0 50 100
Feet

NOTES:
1. NS03 (0-1' bgs), NS08 (0-1' bgs), SS-001, SS218A-2, SS-219B, SS-219C, and SS55A not included in risk assessment.

FIGURE 2-12
SUBSURFACE SOIL EXPOSURE UNITS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-12_EXPOSURE_UNITS_DD.MXD MSCHROCK 1/26/2011 22:45:32



Analyte	Remediation Goal (mg/kg)
Arsenic	13.2
Lead	400
Thallium	7
Aroclor 1260	1

0 50 100 Feet

LEGEND

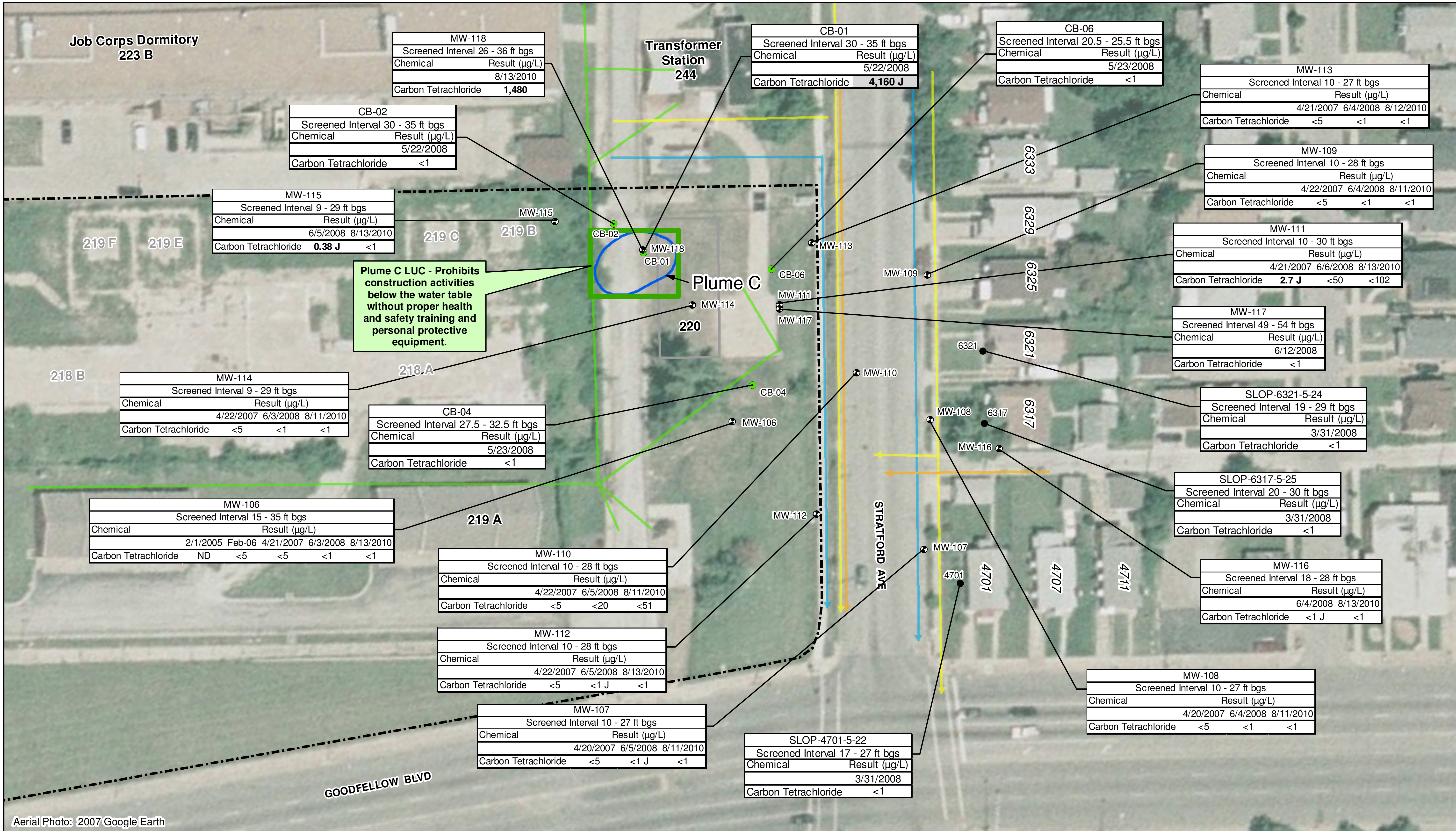
- 2008 Soil Sample
- 2005 Soil Sample
- 2001 Soil Sample
- 1998 Soil Sample
- 1991 Soil Sample
- Powder Well
- Composite Sample Portion Line
- Site Boundary
- 220 Former Building
- Estimated Excavation Limits

NOTES:
1. J = Reported value is estimated.
2. mg/kg = milligrams per kilogram
3. The surface soil remedial action will not include areas covered with concrete.

FIGURE 2-13
SOIL REMOVAL AREAS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

\\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-13_SOIL_REMOVAL_AREAS_DD.MXD MSCHROCK 12/2/2010 13:32:19



LEGEND

- Groundwater Sample Point
- Temporary Well
- Monitoring Well
- Plume C LUC
- Area Exceeding MCL of 5 µg/L for Carbon Tetrachloride (Plume C)
- Site Boundary
- 220 Former Building

Approximate Utilities
- Natural Gas
- Sanitary Sewer
- Telephone
- Water

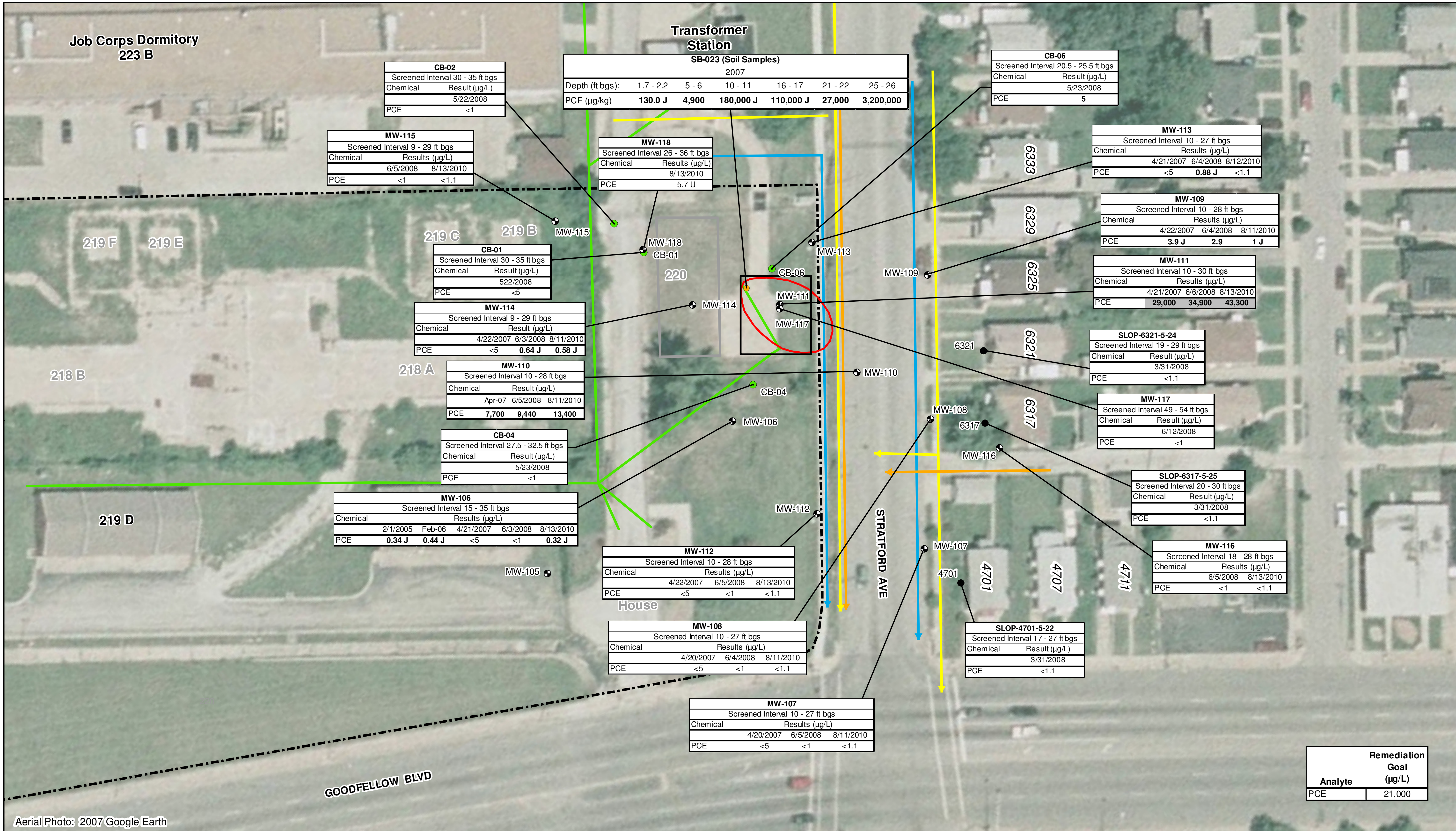
0 30 60 Feet

NOTES:
1. Remediation goal for carbon tetrachloride is 3,200 µg/L.
2. J = Estimated Concentration
3. < = Chemical not detected above the method detection limit.
4. Bold type indicates the chemical was detected.
5. Shading indicates a detected concentration above the remediation goal.
6. Italicized values represent detection limits above screening levels.
7. µg/L = micrograms per liter
8. MCL = Maximum Contaminant Level

FIGURE 2-14
LAND USE CONTROL BOUNDARIES
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

RDD \\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-14_LUC_BOUNDS_DD.MXD MSCHROCK 9/15/2011 7:53:44 PM



LEGEND

- Groundwater Sample Point
- Temporary Well
- Soil Boring
- Monitoring Well

Approximate Utilities
- Natural Gas
- Sanitary Sewer
- Telephone
- Water

- Area Exceeding the Construction Worker PRG
- Target Treatment Zone/ Excavation Extents
- Former Building
- Site Boundary

0 30 60 Feet

NOTES:
1. The remediation goal is protective of construction worker exposure.
2. PCE = tetrachloroethene
3. J = Estimated Concentration
4. < = Chemical not detected above the method detection limit
5. Bold type indicates the chemical was detected.
6. Shading indicates a detected concentration above the construction worker remediation goal.
7. µg/L = micrograms per liter
8. µg/kg = micrograms per kilogram

FIGURE 2-15
PCE IN GROUNDWATER AT CONCENTRATIONS EXCEEDING REMEDIATION GOALS
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri

CH2MHILL

RDD \\BALDUR\PROJ\SLOP_349765\MAPFILES\DEC_DOC\FIG_2-15_PCE_GW_EXCEED_PRG_DD.MXD MSCHROCK 9/15/2011 7:56:05 PM

3. Responsiveness Summary

The public comment period for the former Hanley Area began on November 29, 2010, and ended on December 29, 2010. No comments were received on the Proposed Plan. The public availability session regarding the Proposed Plan was held on December 13, 2010. No comments or questions were received from the public during the public comment period or at the public availability session.

3.1 Stakeholder Comments and Lead Agency Responses

None.

3.2 Technical and Legal Issues

None.

4. References

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Appendix A
Groundwater Yield Estimates

Groundwater Yield Estimates at the Former Hanley Area

Groundwater yield beneath the former Hanley Area was assessed using groundwater drawdown and pumping data collected in August 2010. Low-flow purging preceded groundwater sampling at monitoring wells located within the contaminated zone at the former Hanley Area and in offsite downgradient wells north of the site along Stratford Avenue. Figure 2-10 in the decision document shows the locations of monitoring wells that were purged and sampled in August 2010. Table A-1 presents well construction details for the onsite and offsite monitoring wells.

To perform low-flow purging, the system volume (that is, the volume of water within the entire length of sample tubing and the flow-through cell) was calculated before sampling each monitoring well. On five-minute intervals, the field parameters temperature, specific conductance, dissolved oxygen, pH, oxidation reduction potential, and turbidity were measured and recorded during the low-flow purge cycle. Groundwater depth in the monitoring well was also measured every five minutes. Each monitoring well was purged until groundwater parameters stabilized over three consecutive 5-minute intervals and after a minimum of two system volumes were removed.

Table A-2 displays water quality parameters measured during the purge cycles described above. Pumping rates ranged from 0.033 to 0.056 gallons per minute (gpm), or 48 to 76 gallons per day (gpd). With the exception of MW-114 (purged at a rate of 48 gpm), groundwater drawdowns did not stabilize and reach a steady-state condition during the purge cycle.

Based on the information above, groundwater yield beneath the former Hanley Area and in downgradient offsite areas is on the order of 48 to 76 gpd. This range may be an overstatement of actual yield, because steady-state drawdowns were not observed in most monitoring wells, meaning that the cited yields may not be sustainable.

Groundwater yields of 48 to 76 gpd fall below 150 gpd, which the U.S. Environmental Protection Agency (USEPA) considers as the minimum yield required to supply the needs of an average-sized household (USEPA 1988). In their review of data presented in Table A-2, USEPA classified groundwater within and downgradient of the former Hanley Area as Class IIIA—not a source of drinking water due to insufficient yield (USEPA 2011).

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TABLE A-1
Permanent Monitoring Well Construction Summary
Decision Document-Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Well / Piezometer	Date Installed	Well Diameter (inches)	Total Depth (ft bgs)	Surface Elevation (feet)	Riser Elevation (feet)	Screened Interval (ft bgs)	Filter Pack Interval (ft bgs)	Bentonite Interval (ft bgs)	Grout Interval (ft bgs)
MW-101[a]	2001	2	35	563.16	562.65	15.0-35.0	13.0-35.0	10.0-13.0	0.0-10.0
MW-102[a]	2001	2	35	558.86	558.58	15.0-35.0	13.0-35.0	0.0-13.0	--
MW-103[a]	2001	2	35	555.49	555.25	15.0-35.0	13.0-35.0	10.0-13.0	0.0-10.0
MW-104[a]	2001	2	35	557.56	557.06	15.0-30.0	13.0-35.0	10.0-13.0	0.0-10.0
MW-105[a]	2001	2	35	553.66	556.58	15.0-35.0	13.0-35.0	10.0-13.0	0.0-10.0
MW-106	01/22/05	2	35	545.26	544.93	15.0-35.0	12.0-35.0	7.0-12.0	3.0-7.0
MW-107	01/25/07	2	27	532.11	531.76	10.0-27.0	8.0-27.0	5.0-8.0	3.0-5.0
MW-108	01/25/07	2	27	534.48	534.17	10.0-27.0	8.0-27.0	5.0-8.0	3.0-5.0
MW-109	01/26/07	2	28	536.65	536.35	10.0-28.0	8.0-28.0	5.0-8.0	3.0-5.0
MW-110	01/25/07	2	28	534.97	534.67	10.0-28.0	8.0-28.0	5.0-8.0	3.0-5.0
MW-111	01/24/07	2	30	541.57	541.22	10.0-30.0	7.0-30.0	2.0-7.0	--
MW-112	01/25/07	2	28	534.22	533.49	10.0-28.0	8.0-28.0	5.0-8.0	3.0-5.0
MW-113	01/26/07	2	27	537.75	537.25	10.0-27.0	8.0-27.0	5.0-8.0	3.0-5.0
MW-114	03/20/07	2	29	543.75	543.41	9.0-29.0	7.5-29.0	5.5-7.5	2.0-5.5
MW-115	05/19/08	2	43	557.64	560.66	33.0-43.0	31.0-43.0	29.0-31.0	0.0-29.0
MW-116	05/16/08	2	28	534.29	533.91	18.0-28.0	16.0-28.0	14.0-16.0	0.0-14.0
MW-117[a]	06/05/08	2	54	541.44	541.18	49.0-54.0	45.0-54.0	--	0.0-45.0
MW-118[b]	08/11/10	2	36	553.55	553.31	26.0-36.0	24.0-36.0	22.0-24.0	1.0-22.0

Notes:

[a] Monitoring well was not sampled in August 2010.

[b] Monitoring well not used in yield estimate because static water level had not yet been reached when purging of other wells was conducted in August 2010.

MW-106 completed with concrete from 0.0-3.0 feet bgs; MW-107 through MW-110, MW-112, and MW-113 completed with concrete from 0.0-2.5 feet bgs and fine sand from 2.5-3.0 feet bgs; MW-111 and MW-114 completed with concrete from 0.0-2.0 feet bgs.

-- = Interval not completed with the specified material.

ft bgs = feet below ground surface

TABLE A-2
Field Parameters Measured During Groundwater Purging - August 2010
Decision Document-Operable Unit 1
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	Water Quality Parameters Measured During Purging - August 2010										Summary Information						
Well Name	**Begin / End Purge**	**Time**	**Volume Removed (liters)**	**pH**	**Specific Conductance (mS/cm)**	**Temperature (degrees C)**	**Oxidation / Reduction Potential (mV)**	**Depth to Water (ft below top of casing)**	**D.O. (mg/L)**	**Turbidity (NTU)**	**Well Name**	**Elapsed Purge Time (minutes)**	**Volume Purged (liters)**	**Purge Rate (L/min)**	**Purge Rate (gal/min)**	**Purge Rate (gal/day)**	**Drawdown in 2-inch-diameter well[a] (ft)**
MW-106	Begin	7:31	0.00	6.77	0.714	16.68	217.8	10.11	3.73	1.43							
MW-106	End	7:56	3.75	6.32	0.699	16.06	236.3	12.64	3.06	0.64	MW-106	25	3.75	0.15	0.040	57	2.53
MW-107	Begin	14:24	0.00	6.66	0.919	22.97	104.9	3.31	7.88	2.68							
MW-107	End	14:44	4.00	6.30	0.884	22.23	125.6	6.14	6.77	2.07	MW-107	20	4.00	0.20	0.053	76	2.83
MW-108	Begin	10:31	0.00	6.73	0.930	21.46	196.5	2.71	2.01	1.95							
MW-108	End	11:16	7.13	5.88	0.921	20.52	383.2	6.1	2.01	1.67	MW-108	45	7.13	0.16	0.042	60	3.39
MW-109	Begin	12:09	0.00	5.99	0.607	21.55	106.3	4.02	1.85	32.00							
MW-109	End	12:34	4.38	5.16	0.596	21.41	218.7	5.32	1.82	28.50	MW-109	25	4.38	0.17	0.046	67	1.30
MW-110	Begin	11:55	0.00	6.56	0.716	23.04	74.8	1.82	6.76	5.43							
MW-110	End	12:20	5.00	6.37	0.697	21.94	130.4	4.46	5.64	1.77	MW-110	25	5.00	0.20	0.053	76	2.64
MW-111	Begin	8:48	0.00	6.17	0.628	19.78	278.5	5.16	1.73	6.20							
MW-111	End	9:18	6.00	5.01	0.620	19.38	451.9	9.98	1.24	3.29	MW-111	30	6.00	0.20	0.053	76	4.82
MW-112	Begin	7:23	0.00	6.29	0.718	18.67	195	2.41	1.49	9.04							
MW-112	End	7:58	6.00	5.80	0.692	18.31	378.8	6.58	1.04	1.75	MW-112	35	6.00	0.17	0.045	65	4.17
MW-113	Begin	8:50	0.00	5.69	0.672	19.23	235.2	2.32	1.66	7.87							
MW-113	End	9:40	8.75	4.98	0.662	18.98	298.8	7.35	1.14	3.42	MW-113	50	8.75	0.18	0.046	67	5.03
MW-114	Begin	8:41	0.00	7.08	0.554	18.56	145.8	4.48	1.9	1.28							
MW-114	End	9:46	8.19	5.61	0.467	18.71	287.9	8.94	1.16	0.97	MW-114	65	8.19	0.13	0.033	48	4.46[b]
MW-115	Begin	9:11	0.00	7.84	0.357	18.34	167.7	24.8	7.15	2.86							
MW-115	End	9:36	3.75	8.11	0.320	19.46	170.2	26.72	7.93	0.99	MW-115	25	3.75	0.15	0.040	57	1.92
MW-116	Begin	14:18	0.00	6.01	1.329	19.37	76.2	4.58	2.41	2.66							
MW-116	End	14:38	4.00	5.79	1.366	19.31	98.7	8.2	2.14	6.51	MW-116	20	4.00	0.20	0.053	76	3.62

[a] Monitoring well depths range from 27 to 43 feet below ground surface
[b] Steady-state drawdown was only achieved at MW-114 during purging; drawdown at other wells continued to increase throughout the purge cycle.
degrees C = degrees Celcius
mS/cm = millisiemens per centimeter
mV = microvolt
ft = feet
gal/min = gallons per minute
gal/day = gallons per day
L/min = liters per minute
mg/L = milligrams per liter
NTU = nephelometric turbidity units