U.S. ENVIRONMENTAL PROTECTION AGENCY
SUPERFUND PROGRAM

PROPOSED PLAN

For

RIVERFRONT SUPERFUND SITE
OPERABLE UNITS 2 AND 6
NEW HAVEN, MISSOURI

July 2010

EPA ANNOUNCES PROPOSED PLAN

This Proposed Plan (Plan) identifies the preferred alternative for addressing the contamination at the Riverfront Superfund Site (Site), Operable Units (OUs) 2 and 6, and provides the rationale for this preference. In addition, this Plan includes summaries of other alternatives evaluated for possible implementation at OUs 2/6.

This document is issued by the U.S. Environmental Protection Agency (EPA), the lead agency for the Site, and the Missouri Department of Natural Resources (MDNR), the support agency. EPA, in consultation with MDNR, will select a final remedy for OUs 2/6 after reviewing and considering all information submitted during the 30-day public comment period. EPA, in consultation with MDNR, may modify the preferred alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all of the alternatives presented in the Plan.

EPA is issuing this Plan as part of its public participation responsibilities under section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This Plan summarizes information that can be found in greater detail in the remedial investigation (RI) and feasibility study (FS) prepared for OUs 2/6 as well as other documents contained in the Administrative Record file for OUs 2/6. EPA and MDNR encourage the public to review these documents to gain a more comprehensive understanding of OUs 2/6 and the Superfund activities that have been conducted at OUs 2/6.

Dates to remember:
MARK YOUR CALENDAR

PUBLIC COMMENT PERIOD:

EPA will accept written comments on this Plan during the public comment period of August 4, 2010, through September 3, 2010.

PUBLIC MEETING:

EPA will hold a public meeting to explain this Plan and all of the alternatives presented in the Feasibility Study. Oral and written comments will be accepted at the meeting. The meeting will be held on August 10, 2010, at the Trinity Lutheran Church from 7:00 to 9:00 p.m.

For more information, see the Administrative Record at the following locations:

New Haven Scenic Regional Library
109 Maupin
New Haven, MO 63068

U.S. EPA R7 Records Center
901 N 5th Street
Kansas City, KS 66101

SITE HISTORY

The Site is located in Franklin County, Missouri, in the town of New Haven. New Haven (population 2,029) is located on the southern bank of the Missouri River approximately 50 miles west of St. Louis, Missouri (Figure 1). The Site encompasses six OUs. Each OU is briefly described below and depicted on Figure 2:

- OU 1, also referred to as the Front Street Site, involves soil and groundwater contamination located in the Front Street/Cottonwood Street area of downtown New Haven. EPA issued a Record of Decision (ROD) for OU 1 on September 30, 2003.
- OU 2 involves a contaminant source area located at and near the former Kellwood Company (Kellwood) facility located at 202 Industrial Drive in south New Haven.
- OU 3, also referred to as the Old City Dump, involves soil and groundwater contamination located on approximately three acres on the north side of Highway 100 in the southeastern part of New Haven. EPA issued a ROD for OU 3 on September 30, 2003.
- OU 4, also referred to as the Maiden Lane Area, involves soil, groundwater, and surface water contamination in an area located south of downtown between Maupin Avenue and Miller Street. EPA issued a ROD for OU 4 on March 26, 2009.
- OU 5, also referred to as the Old Hat Factory, involves groundwater contamination in an area located just south of downtown near the corner of Maupin Avenue and Wall Street. EPA issued a ROD for OU 5 on December 7, 2006.
- OU 6 involves the groundwater contamination emanating from and migrating to the south of OU 2.

The Comprehensive Environmental Response, Compensation, and Liability Information System Identification Number for the Site, which includes OUs 1 through 6, is MOD981720246.

During routine public water supply well testing in 1986, MDNR detected the volatile organic compound (VOC), tetrachloroethene (PCE), in two public supply wells in the northern part of New Haven. Several environmental investigations were conducted by EPA over the next 13 years to find the contaminant source areas and determine the extent of contamination. Following the completion of an Expanded Site Inspection/RI by EPA in early 2000, the PCE-contaminated areas in New Haven were proposed to be included on the National Priorities List[1], and the contaminated areas collectively became known as the Riverfront Superfund Site.

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[1] The National Priorities List is EPA's list of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response.

From approximately 1973 until September 1985, Kellwood operated a tube mill at 202 Industrial Drive in New Haven, Missouri. During this period, PCE was used as a cleaning solvent in the tube mill's operations to remove oils from fabricated parts. Kellwood sold the facility in 1985 and ceased operation of the tube mill. The former Kellwood facility is currently owned by Metalcraft Industries, a subsidiary of Tubular Steel, Incorporated.

Investigations of VOCs in the area of the former Kellwood facility and the land farm area immediately north of the facility began in 1989. In 1990, the state of Missouri informed Kellwood that there were reports of the disposal of cleaning solvents containing PCE or trichloroethylene (TCE) on the land farm area adjacent to the former Kellwood facility (Figure 3).

In April 1994, Kellwood and MDNR entered into an agreement whereby Kellwood agreed to implement a remedial cleanup and groundwater monitoring plan to address PCE contamination in soils adjacent to Kellwood's former facility. Kellwood, with MDNR's oversight, implemented the plan and sent soils known to be contaminated with PCE at levels equal to or in excess of 380,000 micrograms per kilogram (µg/kg) to an off-site incinerator for thermal treatment and disposal. Pursuant to this agreement, the remaining contaminated soils were to be "land farmed until individual levels of PCE and each of its degradation products are reduced to [1,000 µg/kg] or below."

From 1994 to 1996, soil remaining in the land farm area was tilled to maximize the volatilization of residual PCE. However, dense nonaqueous phase liquid (DNAPL) remains present in subsurface areas of the land farm. Since March 2008, approximately six liters of DNAPL have been removed through periodic recovery operations.

EPA and Kellwood have entered into two Administrative Orders on Consent to address contamination at OUs 2/6. The first Administrative Order on Consent[2] required the provision by Kellwood of whole-house water treatment systems to residents whose domestic wells had been contaminated with hazardous substances resulting from Kellwood's former operations at OU 2. The second Administrative Order on Consent[3] provided for the performance by Kellwood of: (1) an RI to determine the nature and extent of the contamination resulting from Kellwood's former operations at OUs 2/6, and (2) a FS to determine and evaluate remedial action alternatives for responding to such contamination. Kellwood has submitted an RI and FS to EPA for review and approval.

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[2] EPA Docket No. CERCLA-07-2002-0091, effective date March 25, 2002.

[3] EPA Docket No. CERCLA-07-2004-0078, effective date March 16, 2004.

OU 2/OU 6 CHARACTERISTICS

Surface Features

New Haven is part of the Salem Plateau physiographic subprovince of the Ozark Plateau. The physiographic setting of New Haven is moderate to rugged terrain formed with steep valleys and thin soils characteristic of the Ozark Plateau. In the upland areas, there are loess (wind-blown particle) deposits as thick as 15 feet overlying the typical Salem Plateau's cherty, silty clay material. Topography in the New Haven area caused by the gradual uplift of the Ozark Dome and erosion of the uplifted rocks by precipitation, runoff, and stream flow, is accentuated because of its location along the Missouri River. The land surface elevation ranges from 470 feet above mean sea level (AMSL) to 920 feet AMSL. An east-west trending ridge along State Highway 100 lies about one mile to the south of the Missouri River and divides the Missouri River valley to the north and the Boeuf Creek valley to the south.

Surface Water Hydrology

The major body of water in New Haven is the Missouri River which borders the northern edge of the city. There are a number of small creeks and tributaries in the area including Boeuf Creek which lies to the south of OU 2.

A surface water divide between small tributaries that flow north to the Missouri River and tributaries that flow into Boeuf Creek lies along and north of Highway 100. Surface water in the area of OUs 2/6 flows south via unnamed tributaries to Wildcat Creek and to Boeuf Creek, which flows to the east before turning north to empty into the Missouri River. The small tributaries that drain the area of OUs 2/6 and feed Wildcat Creek and Boeuf Creek typically have low flows except following a precipitation event. The upper reaches of these drainages flow seasonally (high rainfall or snow).

Surficial Geology

New Haven is covered by several unconsolidated surficial deposits including Quaternary-Age loess, residual soil deposits of the Buffalo Series, Quaternary-Age alluvium, and Quaternary-Age terrace deposits. The youngest of these is the loess consisting of uniform silt with locally small amounts of clay. The loess is located primarily at topographic highs in the area and ranges from 0 to greater than 20 feet thick.

The Buffalo Series deposits are residual deposits from the weathering of the underlying Powell and Cotter Dolomites and are divided into two subunits—the Buffalo A subunit and the Buffalo O subunit. The Buffalo Series deposits are generally found on slopes along the bluff of the Missouri River valley and, therefore, are not likely to be found In OU 2 and OU 6 to any great extent.

The Quaternary-Age alluvium is found in the flood plains of the streams and tends to consist of organic-rich deposits of silt and clay. The area around Boeuf Creek and its tributaries, including Wildcat Creek, contains large alluvial deposits (from running water) with chert gravel. The Quaternary-Age terrace deposits are also found near Boeuf Creek and are similar to the alluvial deposits but are at a higher altitude and were deposited in an earlier stream deposition event.

Bedrock Geology

New Haven is underlain by the geologic units of the Ozark Aquifer, a marine sedimentary, primarily carbonate rock formation. The Ozark Aquifer is composed of eight lithological units from top to bottom (Figure 4)—the St. Peter Sandstone, Powell Dolomite, Cotter Dolomite, Jefferson City Dolomite, Roudiboux Formation, Gasconade Dolomite, Eminence Dolomite, and the Potosi Dolomite. These formations, based on published literature and observations from the RI, are cherty dolostones of Cambrian and Ordovician Age and can be described as follows:

St. Peter Sandstone

The St. Peter Sandstone is less than 40 feet thick where present. It is exposed approximately one-third mile to the west of OU 2; and it can be recognized as a fine-grained, cemented quartz sandstone that is generally tan, reddish-tan, or white in color.

Powell Dolomite

The Powell dolomite where present consists of a dolostone with medium to thick bedding which is tan in color and finely crystalline containing little or no chert. The Powell Dolomite contains greenish-gray mudstone/shale beds that are as much as two feet thick in the lower 50 to 70 feet of the formation. The Powell and Cotter Dolomites are the bedrock units most commonly exposed in the New Haven area.

Cotter Dolomite

The upper-most bedrock unit beneath OUs 2 and 6 is the Cotter Dolomite. The thickness of the Cotter Dolomite is variable because of erosion. The Cotter Dolomite also contains scattered, fine-grained, well-cemented sandstone beds that usually are less than two feet thick. Two thicker sandstone beds in the Cotter Dolomite—the upper sandstone and the Swan Creek sandstone—are used as marker beds in the subsurface and at surface exposures. The upper sandstone consists of approximately four to five feet of massively bedded, fine-grained sandstone. It consistently outcrops at an altitude of about 550 feet AMSL in many of New Haven's creeks. The Swan Creek sandstone lies approximately 60 feet below the upper sandstone. It is generally an eight to ten-foot layer of fine-grained, well-cemented sandstone within a layer of 15 to 20-foot thick sandy dolostone. The Swan Creek sandstone does not outcrop except to the southeast along

Boeuf Creek. The Swan Creek sandstone member is present at 36 feet below ground surface (bgs) at monitoring well MW-2SW and at 99 feet bgs at MW-1SW. A distinguishing characteristic of the sandstone beds of the Cotter Dolomite is that they are thicker than sandstone beds in the Powell Dolomite and the Jefferson City Dolomite and contain greater quantities of chert.

Jefferson City Dolomite

Beneath the Cotter Dolomite is the Jefferson City Dolomite which is generally undifferentiated from the overlying Cotter Dolomite. Because of their lithologies, they are grouped together. The Jefferson City Dolomite is a tan to light gray, fine to medium, crystalline dolostone or argillaceous dolostone containing greenish-gray mudstone/shale beds and several chert-rich zones. It varies between 150 and 165 feet thick in the New Haven area and does not outcrop as a surface feature.

Roubidoux Formation

The Roubidoux Formation is frequently used for domestic water supply wells in the New Haven area. It is an approximately 115-foot layer consisting of sandstone, sandy dolomite, dolostone, mudstone, chert, and cherty dolostone. It can be easily differentiated from the Jefferson City Dolomite by an increase in chert and a change in a more weathered orange-brown color at the top of the formation. The Roubidoux Formation contains a 20 to 30-foot interval of fine-grained, poorly cemented, well-sorted quartzose sandstone approximately 20 to 40 feet from the top of the unit.

These shallow bedrock formations are part of a local groundwater flow system controlled by local topography that is superimposed on the regional groundwater flow system. The shallow flow system in the New Haven area exists primarily within the Cotter-Jefferson City Dolomites.

The shallow groundwater divide is located north of OUs 2/6 in the vicinity of State Highway 100. South of State Highway 100, shallow groundwater flows south, opposite the regional groundwater flow direction. North of State Highway 100, shallow groundwater flows north/northeast beneath the Maiden Lane area and the topographic divide toward the Missouri River.

Hydrogeology

Groundwater in the Ozark Aquifer is unconfined throughout most of southern Missouri. In the New Haven area, there are two general flow systems within the Ozark

Aquifer: (1) a deep "regional" flow system controlled by regional topography within southern Missouri, and (2) a "local" or shallow (less than 300 to 400 feet deep) flow system controlled by the topography within the New Haven area (Figure 5).

The regional groundwater flow movement generally is from upland areas between major rivers and streams toward valleys where it discharges as base flow into streams. From New Haven, the regional flow system extends for tens of miles and generally is from upland areas more than 90 miles south of New Haven northward toward the Missouri River. The regional flow system generally occurs in the deeper parts of the aquifer (Roubidoux Formation and deeper units) except near regional recharge or discharge areas where flow enters or leaves the aquifer.

Shallow groundwater south of this divide flows south, opposite the regional flow and toward Boeuf Creek. Shallow groundwater north of the divide flows north in the direction of the regional flow toward the Missouri River. Along the shallow groundwater divide near State Highway 100, a downward gradient exists between the shallow and deeper flow systems.

Nature and Extent of Contamination

The results of the RI found that the chemicals of concern (COCs) include PCE; TCE; 1,2,-dichloroethene (1,2,-DCE); and vinyl chloride (VC). For OU 2, the COCs are present in the soil, fractured bedrock, and groundwater. For OU 6, the COCs are present in the groundwater. PCE was the chemical that was disposed of on the open lot north of the former Kellwood facility. Through reductive dechlorination, PCE can degrade to TCE; 1,2,-DCE; and VC. Detailed descriptions of sampling locations and results of those sampling activities are respectively shown on Figures 2.2a – 2.2c and Figures 2.3 – 2.16 of the RI. Figures 2.17 and 2.18 show the distribution of COCs from all available data including data collected prior to the RI.

Distribution of Dense Nonaqueous Phase Liquid (DNAPL)

PCE was detected as a free-phase liquid—DNAPL—in five core holes drilled at OU 2 as part of the DNAPL investigation phase of the RI. Three of the core holes were located on the land farm area immediately north of the former Kellwood facility. DNAPL was detected in two core holes outside the northwest portion of the former Kellwood facility. DNAPL was detected at depths ranging from 4 feet to 22 feet bgs. There is no indication that DNAPL is present outside of the land farm area. (See Figure 3.3 of the FS.)

DNAPL located under the land farm area is considered to be a principal threat waste because it is considered a mobile source material that can continue to migrate into the groundwater. In addition, subsurface soils contain high concentrations of COCs that can migrate through the soils to impact groundwater.

WHAT IS A "PRINCIPAL THREAT"?

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable [40 C.F.R. § 300.430(a)(1)(iii)(A)]. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that acts as a reservoir for migration of contamination to groundwater, surface water, or air or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material, however, nonaqueous phase liquids in groundwater may be viewed as source material.

Chemicals of Concern in Groundwater

Precipitation infiltrating soil and bedrock that may contain DNAPL as well as groundwater migrating past areas with DNAPL have caused PCE; TCE; and 1,2-DCE to move into the groundwater. These contaminants have mobilized into the groundwater from the land farm area located to the north of the former Kellwood facility and have migrated, and will continue to migrate, into the groundwater in the unconsolidated material above the bedrock to the west and south (OU 6) of the former Kellwood facility.

PCE; TCE; and 1,2-DCE have been detected in the following four laterally extensive, transmissive intervals: unconsolidated deposits above the bedrock, the upper sandstone marker bed of the Cotter Dolomite, the Swan Creek sandstone member of the Cotter Dolomite, and in the lower Jefferson City Dolomite/Roubidoux Formation.

The distribution of PCE is widest in the upper sandstone marker bed/upper bedrock permeable zone with PCE present above the 5 micrograms per liter (μg/L) screening criterion to the west at MW-14US and to the south at MW04A (Figure 6a). Samples collected from the unconsolidated deposits at MW-14US and at MW-04A did not contain PCE. PCE is present at concentrations in the hundreds to low thousands of μg/L in the unconsolidated deposits throughout the southern portion of the Industrial Park area and southwest of the former Kellwood facility as seen in the direct push borings and in MW-1S. The distribution of PCE in the Swan Creek sandstone member is much more limited with concentrations generally much lower and below EPA's screening level. PCE in the lower Jefferson City Dolomite/Roubidoux Formation is limited to those locations where private water wells have become contaminated with PCE (Figure 6b). Section 4.4.2 of the RI provides details on the PCE distribution in each of these intervals.

Chemicals of Concern in Sediment and Surface Water

PCE was detected in surface water in several stream segments in OU 6, south and west of the former Kellwood facility (Figures 2.14a-d of the FS). PCE was detected at concentrations up to19 µg/L at three locations along the 600 tributary, west of Wildcat Creek Estates. PCE was also detected below EPA's screening level at the Boeuf Lutheran Road crossing of the 500 tributary. This creek receives runoff from the northwestern portion of the Industrial Park including the former Kellwood facility and the Industrial Park's retention basin as well as the area of the New Haven High School and the city park. Samples from the upper portion of the drainage basin did not contain detectable concentrations of PCE.

PCE was detected at a concentration below EPA's screening level in one sediment sample (Figure 2.13 of the FS). No other sediment samples contained PCE.

Chemicals of Concern in Soils

Analytical results of soil samples collected as part of the RI along with prior sampling by EPA, the U.S. Geological Survey, and others indicate that the extent of the PCE; TCE; and 1,2-DCE soil contamination is limited to the land farm area north of the former Kellwood facility, beneath the former Kellwood facility, beneath Industrial Drive, and at the vacant lot northwest of the former Kellwood facility across Industrial Drive (Figure 4.1 of the RI). Analytical results for compounds detected in the samples are presented in Tables 2.3 and 3.2 of the RI.

Soil Vapor Investigation

Based on the detection of PCE in shallow groundwater near the southeastern corner of the New Haven High School building, soil vapor sampling was conducted. The purpose of the sampling was to evaluate whether soil vapors from VOCs detected in the groundwater within the unconsolidated deposits might impact the school building. The locations of the monitoring points are on Figure 3.23 in the RI. This sampling detected no elevated levels of VOCs in building.

Subslab soil vapor sampling will be conducted under the former Kellwood facility to determine whether the DNAPL source area located under the building presents an indoor air risk.

SCOPE AND ROLE OF OUs 2/6

OUs 2/6 are part of the overall cleanup for the Site that includes four other separate OUs in combination with removal actions—typically short-term response measures taken to respond to the release or threat of release of a hazardous substance into the environment—performed under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority.

Removal actions conducted at the Site have included:

- A time-critical removal action was conducted by EPA at OU 1 to replace a PCE-contaminated water line that ran beneath Front Street through a PCE source area. The water line was made of polyethylene which is permeable to PCE. The contamination at OU 1 infiltrated the water supply line in this segment and contaminated the water. The polyethylene water line was replaced with a steel line. In addition, as part of this action, approximately 300 cubic yards of PCE-contaminated soil was removed from this area and disposed.

- A time-critical removal action was conducted by Kellwood at OU 6 which involved the installation of whole-house water treatment units at four residences whose water wells had been contaminated by PCE.

- A time-critical removal action was conducted by EPA at OU 4 which involved the injection of a chemical oxidant as a measure to address a PCE source area.

OUs 2/6 are discrete areas of contamination that do not affect and are not affected by other OUs at the Site. OUs 1, 3, and 5 have remedial actions in place while OU 4 is in the remedial design phase.

This Plan proposes EPA's preferred alternative to address soil and groundwater contamination resulting from releases of hazardous substances that have occurred, and are occurring, at and from the former Kellwood facility on Industrial Drive. These releases have resulted in localized areas of soil contamination—at the land farm area and beneath the facility—and have contaminated groundwater that flows to the south-southwest contaminating private wells.

SUMMARY OF SITE RISKS

CECRLA and NCP require that CERCLA remedial actions provide permanent solutions to protect human health and the environment from hazardous substances. These solutions provide for the removal, treatment, or containment of hazardous substances, pollutants, and contaminants so that any remaining contamination does not pose an unacceptable health risk to anyone that might come in contact with them.

As part of the RI/FS, a baseline risk assessment was conducted to determine the current and future effects of OU 2/6 contaminants on human health and the environment.

The following two subsections—Human Health Risk Assessment and Ecological Risk Assessment—summarize and present the conclusions of the baseline risk assessment.

Human Health Risk Assessment

Step 1: Chemicals of Concern

The COCs for soils are: PCE; TCE; 1,2-DCE (total); and VC. The COCs for groundwater are: PCE; TCE; and 1,2-DCE. VC is not a COC for groundwater. The common contaminant for both soil and groundwater is PCE.

WHAT IS A HEALTH RISK AND HOW IS IT CALCULATED?

A Superfund human health risk assessment estimates the "baseline risk." This is an estimate of the likelihood of health problems occurring if no cleanup action is taken at a site. To estimate the risk, the process undertakes four steps:

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

In Step 1, comparisons are made between site-specific concentrations and health-based standards to determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, different ways people might be exposed to contaminants are identified. Concentrations, frequency, and duration of exposure are used to calculate the "reasonable maximum exposure" which portrays the highest level of exposure that could reasonably be expected to occur.

In Step 3, information from Step 2 is combined with toxicity information for each chemical to assess potential health risks. EPA considers two types of risk: cancer and noncancer. The likelihood of any kind of cancer resulting from exposure to hazardous substances at a site is generally expressed as an upper bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people exposed, one extra cancer may occur. For noncancer effects, a "hazard index" is calculated. The key concept here is that a hazard index less than one predicts no noncancer effects.

In Step 4, the results of the three previous steps are combined, evaluated, and summarized into a total site risk. EPA then determines if the site risks require action to prevent exposures to the contaminants.

Step 2: Estimate Exposure

The exposure assessment uses the site description and contaminant characterization to identify potentially exposed human receptor populations, identify potential exposure pathways, and calculate estimated daily intakes of the chemicals of potential concern (COPC). Behavioral and physiological factors influencing exposure frequency and levels are presented in a series of exposure scenarios as a basis for quantifying contaminant intake levels by receptor populations for each identified exposure pathway.

Site-specific information such as climate, geology, soils, groundwater, surface water, population demographics, land use, water use, agricultural practices, etc., will be incorporated to predict the contaminant levels to which receptors would be exposed. Once these exposure levels are determined, they will be compared with the appropriate health effects criteria to characterize human health risks.

Steps 3 and 4: Assess and Characterize Risk

Risk characterization integrates the results of the exposure and toxicity assessments to derive quantitative and qualitative estimates of the potential cancer risk and noncancer hazards that may occur due to exposure to site-related contaminants.

The following are the primary conclusions of the Human Health Risk Assessment associated with each contaminated medium at OUs 2/6:

- The total cancer risk and total hazard index (HI) exceed target ranges for potential future residents in OU 2 where DNAPL is present and near the former Kellwood facility through incidental ingestion, inhalation, dermal contact with impacted soil, inhalation of indoor air (volatilizing from either soil or groundwater), and ingestion of groundwater from a future drinking water well.

- The total cancer risk and total HI exceed target ranges for residents in OU 6 using groundwater as tap water prior to any treatment. The risk is primarily driven from the ingestion of PCE. Therefore, the whole-house water treatment units must be maintained at the affected residences.

- The total cancer risk is within the target risk range for residents living near the former Kellwood facility breathing indoor air which may contain contaminants volatilizing from the groundwater. The total HI for this exposure pathway is below target levels.

For a more detailed discussion on the conclusions of the Human Health Risk Assessment, see Section 8, Appendix K.

Ecological Risk Assessment

A Baseline Ecological Risk Assessment (BERA) for the Site was conducted in 2002. The assessment included OUs 1, 3, and 4. The study area of the BERA was defined as all water sheds potentially affected by the Site based on a review of surficial topography. Thus the area of study, evaluated in the 2002 BERA, included OU 6 as shown in Figure 3-2 of the aforementioned report. Aquatic habitats in the study area consisted of the Missouri River (adjacent to OU 1) and several small streams that originate within the study area. The streams in OUs 3 and 4 flow directly into the Missouri River. For OU 2, one small stream flows southward into Boeuf Creek, which flows for approximately eight miles until it discharges into the Missouri River. Most terrestrial habitats within the study area were developed residentially or commercially; however, there was some undeveloped land that included forest areas adjacent to streams or flood plains and some agricultural fields. Although there are several state and federal threatened and endangered species reported as occurring in Franklin County, Missouri, none of the species are known to occur within the study area.

Constituents evaluated in the BERA included PCE and related VOCs based on the history and known discharges at the Site. Specifically, the constituents of potential ecological concern (COPECs) were: PCE; TCE; 1,2-DCE (total); VC; and benzene. The exposure pathways evaluated included soil and contaminated food ingestion for terrestrial receptors and groundwater discharging to surface waters for aquatic receptors. Media evaluated included flood plain surface soil, sediment, surface water, and plant tissue. None of the COPECs are considered to be bioaccumulative.

Since no site-related COPECs were detected at frequencies or concentrations likely to pose a risk to ecological receptors, the 2002 BERA concluded that no further ecological investigations or assessments were recommended. A more detailed discussion on the Ecological Risk Assessment can be found in Appendix J of the RI.

Ecological Risk Assessment Update

After the 2002 BERA was prepared, additional samples were collected from the streams and tributaries in the study area. In addition, soil, surface water, and sediment samples were collected in association with the RI for OUs 2/6.

The BERA update included the review of applicable screening levels. In the 2002 BERA, a Preliminary Remediation Goal (PRG) of 8.9 µg/L for PCE was established for surface water. This concentration was based on the ecological data quality level (EDQL) developed by EPA Region 5. However in 2003, EPA Region 5 updated the EDQLs to ecological screening levels (ESLs); and a new level of 45 µg/L was established for PCE. EPA Region 3 updated its surface water screening benchmarks in 2006 and established a level of 111 µg/L for PCE. This updated EPA Region 3 Biological Technical Assistance Grant (BTAG) screening benchmark is now proposed for general EPA use as the new PRG for PCE in surface water.

Ecological Risk Assessment Conclusion

The updated BERA reaffirmed the conclusion of the 2002 assessment that since no Site-related COPECs were detected at frequencies or concentrations likely to pose a risk to ecological receptors, no further ecological investigations or assessments were recommended.

REMEDIAL ACTON OBJECTIVES

Remedial Action Objectives (RAOs) consist of medium-specific goals and/or site-specific goals for protecting human health and the environment. RAOs aimed at protecting human health and the environment should specify:

- COCs
- Exposure route(s) and receptor(s)
- An acceptable level or range of levels for COCs and each exposure route (i.e., a PRG)

RAOs for protecting human receptors should express both COC levels and an exposure route, rather than COC levels alone, because protectiveness may be achieved by reducing exposure (such as capping an area, limiting access, or providing an alternate water supply) as well as reducing COC levels. Because RAOs for protecting environmental receptors typically seek to preserve or restore a resource (e.g., groundwater), environmental objectives should be expressed in terms of the medium of interest and target cleanup levels whenever possible.

RAOs at OUs 2/6 are required for the media of soil, groundwater, and DNAPL (See Tables 3.1 and 3.2) with the associated target concentrations. All of the RAOs are summarized below:

- Protect human health by eliminating exposure (i.e., inhalation, incidental ingestion, dermal contact) to soil in the land farm area with concentrations of COCs in excess of risk-based concentrations (i.e., PCE at 550 μg/kg for a residential scenario).
- Protect human health by eliminating exposure (i.e., inhalation) to indoor air containing COCs (as vapors) due to the migration of vapors from soil or shallow groundwater in excess of risk-based concentrations (i.e., PCE at 272 μg/kg or 423 μg/L for an industrial scenario and 35.9 μg/kg or 44.1 μg/L for a residential scenario) on the land farm area and under the former Kellwood facility.
- Protect human health by preventing exposure (ingestion) to groundwater containing contaminants at concentrations greater than their respective maximum contaminant levels[4] (MCLs). MCLs for COCs are: PCE - 5 μg/L; TCE - 5 μg/L; cis-1,2-DCE - 70μg/L; and VC - 2 μg/L.
- Protect human health and the environment by minimizing further migration of groundwater containing COCs.

[4] MCLs are maximum permissible levels of contaminants in water which are delivered to a user of public water system. MCLs are promulgated by EPA pursuant to the Safe Drinking Water Act.

- Protect the environment by reducing the COC concentrations in soil or eliminating or mitigating the soil to the groundwater pathway.

- Protect the environment by minimizing the movement of DNAPL into the groundwater system.

- Protect the environment by mitigating exposure of wildlife to surface water, sediment, and surface soils with concentrations of COCs in excess of ecological risk-based standards and compliance with the Applicable or Relevant and Appropriate Requirements (ARARs) for ecological protection such as the Region 3 BTAG freshwater benchmarks. All detected concentrations in surface water and sediment at the Site were below current risk-based standards.

SUMMARY OF REMEDIAL ALTERNATIVES

The remedial alternatives considered for use at OUs 2/6 combine various technologies to address the DNAPL source and soil and groundwater impacts which result in the RAOs not being achieved. EPA's goals in evaluating the preliminary remedial alternatives are to provide both a range of cleanup options and sufficient detail to adequately compare alternatives. The following list identifies the main components of each alternative. Additional elements of the alternatives may be included and are noted in the detailed descriptions in Section 5 of the FS. The alternatives evaluated in the FS and considered by EPA were:

1: No Action.
2a: DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units*, institutional controls (ICs), and groundwater monitoring.
2b: DNAPL recovery followed by in situ chemical oxidation, alternative water supply, whole-house water treatment units (interim**), ICs, and groundwater monitoring.
2c: DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, in situ groundwater remediation, and groundwater monitoring.
2d: DNAPL recovery followed by in situ chemical oxidation, alternative water supply, whole-house water treatment units (interim**), ICs, in situ groundwater remediation, and groundwater monitoring.
3a: Thermally enhanced vapor extraction for the DNAPL source area in the land farm area, whole-house water treatment units, ICs, and groundwater monitoring.
3b: Thermally enhanced vapor extraction for the DNAPL source area in the land farm area, whole-house water treatment units (interim**), alternative water supply, ICs, and groundwater monitoring.

* Whole-house water treatment units would consist of point-of-entry carbon filtration systems.
** Interim whole-house water treatment units would be used until the alternate water supply is connected to the affected residence.

4a: Thermally enhanced vapor extraction for contaminated soil and the DNAPL source area in the land farm area, whole-house water treatment units, ICs, and groundwater monitoring.

4b: Thermally enhanced vapor extraction for contaminated soil and the DNAPL source area in the land farm area, bioremediation of groundwater, whole-house water treatment units, ICs, and groundwater monitoring.

4c: Thermally enhanced vapor extraction for contaminated soil and the DNAPL source area in the land farm area, in situ chemical oxidation for groundwater, whole-house water treatment units, ICs, and groundwater monitoring.

4d: Thermally enhanced vapor extraction for contaminated soil and the DNAPL source area in the land farm area, in situ chemical reduction for groundwater, whole-house water treatment units, ICs, and groundwater monitoring.

5: In situ chemical oxidation of the DNAPL source area located under the former Kellwood facility (Area 3-A) and the groundwater, whole-house water treatment units, ICs, and groundwater monitoring.

6: In situ chemical reduction of the DNAPL source area located under the former Kellwood facility (Area 3-A) and the groundwater, whole-house water treatment units, ICs, and groundwater monitoring

Alternatives 2b, 2d, and 3b would provide a permanent alternative water supply. However, the absence of an agreement to extend the water supply to the unincorporated area to the south of New Haven renders these options unavailable. Alternatives 2a, 2c, 3a, 4a-4d, 5, and 6 require ongoing operation and maintenance (O&M) of the whole-house water treatment units at residences with wells contaminated by COCs at levels exceeding their MCLs. Such systems have been operated successfully in four residences for almost eight years.

Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6 include implementation of groundwater treatment wells in an area of the upper water bearing zone where the highest concentrations of COPCs have been detected outside of the land farm area.

Common Elements

Except for the "no action" alternative (Alternative 1), all alternatives require the use of ICs[5] to reduce exposure to contaminated soils and/or groundwater. OUs 2/6 are within a Special Area designation put in place by MDNR pursuant to the Missouri Well Drillers' Act (Figure 7). The Special Area designation results in the imposition of enforceable, stringent well construction standards throughout the OUs 2/6 area. This provides a reliable and durable IC on the groundwater exposure pathway. In the event that soil ICs are required, it is expected that they can readily be implemented through informational or educational devices (i.e., notices to area residents) through the imposition of activity and use limitations through environmental covenants or other appropriate mechanisms.

[5] ICs are nonengineered controls, such as administrative and/or legal controls, that are intended to help minimize the potential for human exposure to contamination.

For all alternatives, section 121(c) of CERCLA requires that EPA review remedies every five years to assure that they continue to be protective of human health and the environment. This five-year review would be a site-wide review with the review for OUs 2/6 being conducted at the same time as the other Site's OUs are reviewed. The intent of the review is to evaluate the remedial action to assure that human health and the environment are being protected by the remedial action being implemented. Depending on the results of the evaluation, additional remedial actions could be required.

For cost-estimating purposes, each alternative was standardized to a 30-year time period. All alternatives are required to attain the RAOs. A complete and detailed description of each alternative can be found in Section 5 of the FS.

ALTERNATIVE 1: NO ACTION

Estimated Capital Cost:	*NONE*
Present Worth O&M Cost:	*$152,000*
Total Present Worth Cost:	*$152,000*
Estimated Time to Achieve RAOs:	*Never*

Alternative 1 would not involve any remedial actions, and OUs 2/6 would remain in their present condition. This alternative, required by NCP and CERCLA, is a baseline alternative against which the effectiveness of the other alternatives can be compared. Under this "no action" alternative, no funds would be expended for monitoring, control, or cleanup of the remaining contamination. However, funds would need to be expended to properly abandon all existing groundwater monitoring wells. Also, a five-year review would be required under CERCLA so funds would have to be expended to conduct the review.

ALTERNATIVE 2a: DNAPL RECOVERY followed by IN SITU CHEMICAL OXIDATION TREATMENT, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$990,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$3,480,000*
Estimated Time to Achieve RAOs:	*>30 years*

Alternative 2a would consist of the following:

- DNAPL recovery would continue in existing wells in the land farm area, and additional DNAPL recovery wells would be installed in the north and west (north end) of the former Kellwood facility. The use of these wells for continued DNAPL recovery would continue until recovery becomes impractical.

- Once physical DNAPL recovery efforts are complete, DNAPL recovery wells may be utilized for in situ chemical oxidation treatment of the residual contamination within the bedrock on the land farm area. Chemical oxidation treatment will be repeated periodically as needed in the land farm area until nearby and downgradient monitoring wells indicate that COC levels have reached the RAOs or monitoring indicates that further treatment will not continue to effectively reduce the concentrations of COCs.

- Monitoring wells will be installed in the vicinity of the treatment area to evaluate the effectiveness of the treatment.

- Whole-house water treatment units will be provided and maintained for residences with groundwater contaminated with a COC above the MCL.

- ICs will consist of the well construction restrictions described in 10 CSR 23-3.100, and the Special Area 3 Designation.

- Groundwater monitoring will be conducted to monitor the changes in the concentration of COCs over time within OUs 2/6. This includes the monitoring of residential wells.

ALTERNATIVE 2b: DNAPL RECOVERY followed by CHEMICAL OXIDATION TREATMENT, ALTERNATE WATER SUPPLY, WHOLE-HOUSE WATER TREATMENT UNITS (Interim), ***INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING***

Estimated Capital Cost:	*$2,610,000*
Present Worth O&M Cost:	*$2,000,000*
Total Present Worth Cost:	*$4,610,000*
Estimated Time to Achieve RAOs:	*> 30 years*

Alternative 2b consists of the same components as Alternative 2a with the addition of an alternate water supply.

Alternate water supply lines would be installed to provide potable water from the local public water supply system to OU 6 residences where whole-house water treatment units are currently in use. The existing private wells would need to be abandoned upon connection to the public water supply.

ALTERNATIVE 2c: DNAPL RECOVERY followed by IN SITU OXIDATION TREATMENT, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, IN SITU GROUNDWATER REMEDIATION, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$3,430,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$5,920,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components that are part of Alternative 2a, Alternative 2c would include the following:

- Treatability testing would be preformed to determine the most effective in situ groundwater treatment technology for a line of treatment wells that would be installed in the unconsolidated deposits/upper sandstone marker bed at the southern end of Industrial Drive. The treatability testing is to match subsurface conditions with the most effective technology. Technologies that would be evaluated to address the dissolved phase PCE would include bioremediation, chemical oxidation, and chemical reduction.

- Based on the results of the treatability testing, the most effective in situ groundwater treatment technology will be selected. Phase 2 of this alternative would involve the implementation of a pilot test for the recommended alternative followed by the design and implementation of full-scale treatment.

ALTERNATIVE 2d: DNAPL RECOVERY followed by IN SITU CHEMICAL OXIDATION, ALTERNATE WATER SUPPLY, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, IN SITU GROUNDWATER REMEDIATION, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$5,050,000*
Present Worth O&M Cost:	*$2,000,000*
Total Present Worth Cost:	*$7,050,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components that are part of Alternative 2b, Alternative 2d would include the additional component from Alternative 2c, in situ groundwater remediation. In this alternative, in situ chemical oxidation will be used to treat the residual DNAPL and groundwater in the land farm area. Chemical oxidation may be accomplished by the injection of persulfate into the bedrock. Multiple injections may be required as the impacted groundwater from OU 2 moves past the area of injection.

ALTERNATIVE 3a: THERMALLY ENHANCED VAPOR EXTRACTION for DNAPL SOURCE, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$2,120,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$4,610,000*
Estimated Time to Achieve RAOs:	*> 30 years*

Alternative 3a consists of the following:

- Thermally enhanced vapor extraction would be conducted in the land farm area. This treatment may also treat the impacted soil above the area being treated to remediate DNAPL.

- Residences with groundwater supplies with COC concentrations above their MCLs would be provided with whole-house water treatment units. If a treatment unit is required at a new residence based on groundwater monitoring, the well would also be inspected to determine if repairs are required to stop migration of impacted groundwater from the upper sand to the lower Jefferson City Dolomite/Roubidoux Formation.

- ICs, potentially in the form of an environmental covenant pursuant to the Missouri Environmental Covenants Act, will be implemented to impose activity and use limitations on the land farm property. This soil was not shown to present a risk except for a hypothetical residential exposure scenario. This type of exposure is highly unlikely as the area is currently zoned for commercial/ industrial use, the surrounding properties are currently used for commercial/ industrial purposes, and the reasonably anticipated future land use for the area is commercial/industrial. Well construction restrictions, codified at 10 CSR 23-3.100, proscribe well construction in the area of OUs 2/6 and should effectively prevent the installation of wells or other vertical conduits that may allow contamination in the shallow aquifer to migrate into deeper uncontaminated aquifers.

- Groundwater monitoring would assess changes in COC concentrations within OUs 2/6. This would include the monitoring of residential wells.

ALTERNATIVE 3b: THERMALLY ENHANCED VAPOR EXTRACTION for DNAPL SOURCE, WHOLE-HOUSE WATER TREATMENT UNITS, ALTERNATE WATER SUPPLY, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$3,740,000*
Present Worth O&M Cost:	*$2,000,000*
Total Present Worth Cost:	*$5,740,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components listed in Alternative 3a, Alternative 3b includes the following:

- The installation of an alternate water supply that would provide potable water from the local public water supply system to residences whose domestic wells have been contaminated with COCs above MCLs.

ALTERNATIVE 4a: THERMALLY ENHANCED VAPOR EXTRACTION for SOIL and DNAPL, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$2,310,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$4,800,000*
Estimated Time to Achieve RAOs:	*> 30 years*

Alternative 4a consists of the following:

- Thermally enhanced vapor extraction would be conducted in the land farm area to remediate DNAPL. This treatment may also secondarily treat the contaminated soil above the area being treated to remediate DNAPL. Any DNAPL observed during installation of vapor recovery wells would be recovered prior to starting the thermally enhanced vapor recovery operation.

- Thermally enhanced vapor extraction would be conducted on the contaminated soil at Area A-3 below the former Kellwood facility building slab. A predesign investigation may be required to further delineate the extent of soil contamination in this area.

- Residences with groundwater supplies with COC concentrations above MCLs would be provided with whole-house water treatment units. If groundwater monitoring indicates that a treatment unit is required at a residence, the well would also be inspected to determine if repairs are required to stop migration of impacted groundwater from the upper sand to the lower Jefferson City Dolomite/ Roubidoux Formation.

- The contaminated soil in the land farm area would remain in place, and ICs will be implemented to prevent residential use of the property.

- Well construction restrictions (10 CSR 23-3.100, Special Area 3 designation) are in place for new wells constructed within the area of OUs 2/6 to prevent the installation of new vertical conduits that may allow contamination in the shallow aquifers to migrate to the deeper zones via improperly installed wells.

- Groundwater monitoring would assess the changes in COC concentrations over time within OUs 2/6. This will include the monitoring of residential wells.

- Treatability testing would be performed to determine the most effective in situ groundwater treatment technology for a line of treatment wells that would potentially be installed approximately at the southern end of Industrial Drive. Technologies that would be evaluated would include bioremediation, chemical oxidation, and chemical reduction.

ALTERNATIVE 4b: THERMALLY ENHANCED VAPOR EXTRACTION for SOIL and DNAPL, BIOREMEDIATION of GROUNDWATER, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$4,030,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$6,520,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components listed for Alternative 4a, Alternative 4b, if selected based on the treatability testing, would include the following:

- A line of treatment wells would be installed at the southern end of Industrial Drive. Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by bioremediation using these treatment wells.

ALTERNATIVE 4c: THERMALLY ENHANCED VAPOR EXTRACTION for SOIL and DNAPL, IN SITU CHEMICAL OXIDATION for GROUNDWATER, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$4,720,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$7,210,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components listed for Alternative 4a, Alternative 4c, if selected based on the treatability testing, would include the following:

- A line of treatment wells would be installed at the southern end of Industrial Drive. Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical oxidation using these treatment wells.

ALTERNATIVE 4d: THERMALLY ENHANCED VAPOR EXTRACTION for SOIL and DNAPL, IN SITU CHEMICAL REDUCTION for GROUNDWATER, WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$3,550,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$6,040,000*
Estimated Time to Achieve RAOs:	*> 30 years*

In addition to the components listed for Alternative 4a, Alternative 4d, if selected based on the treatability testing, would include the following:

- A line of treatment wells would be installed at the southern end of Industrial Drive. Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical reduction using these treatment wells.

ALTERNATIVE 5: IN SITU CHEMICAL OXIDATION (DNAPL, Area 3-A. GROUNDWATER), WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL CONTROLS, and GROUNDWATER MONITORING

Estimated Capital Cost:	*$3,680,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$6,710,000*
Estimated Time to Achieve RAOs:	*> 30 years*

Alternative 5 would consist of the following:

- The land farm area would be treated to a depth of approximately 20 feet using in situ chemical oxidation to reduce DNAPL mass.

- The contaminated soil from the area under the former Kellwood facility building (Area A-3) would be treated by in situ chemical oxidation.

- A line of treatment wells would be installed at the southern end of Industrial Drive. Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical oxidation using these treatment wells.

- Residences with groundwater wells having COC concentrations above their MCLs would be provided with whole-house water treatment units. If a treatment unit is required at a new residence based on groundwater monitoring, the well would also be inspected to determine if repairs are required to stop migration of contaminated groundwater from the upper sand to the lower Jefferson City Dolomite/Roubidoux Formation.

- The contaminated soil in the land farm area would remain in place, and ICs would be implemented to prevent residential use of the property.

- Well construction restrictions (10 CSR 23-3.100, Special Area 3 designation) are in place for new wells constructed in OUs 2/6 and should be effective to prevent the installation of new vertical conduits that may allow contamination in the shallow aquifers to migrate to the deeper zones via improperly installed wells.

- Groundwater monitoring would assess the changes in COC concentrations over time within OUs 2/6. This will include the monitoring of residential wells.

ALTERNATIVE 6: IN SITU REDUCTION (DNAPL, Area -3, GROUNDWATER), WHOLE-HOUSE WATER TREATMENT UNITS, INSTITUTIONAL COMTROLS, GROUNDWATER MONITORING

Estimated Capital Cost:	*$2,230,000*
Present Worth O&M Cost:	*$2,490,000*
Total Present Worth Cost:	*$4,720,000*
Estimated Time to Achieve RAOs:	*> 30 years*

- The land farm area would be treated to a depth of approximately 20 feet using in situ chemical reduction to reduce DNAPL mass.

- The contaminated soil from the area under the former Kellwood facility building (Area A-3) would be treated by in situ chemical reduction.

- A line of treatment wells would be installed at the southern end of Industrial Drive. Treatment of the groundwater in the unconsolidated deposits and the top of the bedrock would be conducted by in situ chemical reduction using these treatment wells.

- Residences with groundwater supplies with COC concentrations above their MCLs would be provided with whole-house water treatment units. If a treatment unit is required at a new residence based on groundwater monitoring, the well would also be inspected to determine if repairs are required to stop migration of contaminated groundwater from the upper sand to the lower Jefferson City Dolomite/Roubidoux Formation.

- The contaminated soil in the land farm area would remain in place, and ICs would be implemented to prevent residential use of the property.

- Well construction restrictions (10 CSR 23-3.100, Special Area 3 designation) are in place for new wells constructed in OUs 2/6 to prevent the installation of new vertical conduits that may allow contamination in the shallow aquifer to migrate to the deeper zones via improperly installed wells.

- Groundwater monitoring would assess the changes in concentrations over time within OUs 2/6. This will include the monitoring of residential wells.

EVALUATION OF ALTERNATIVES

In this section, the remedial alternatives developed through the FS process are evaluated in detail to provide enough relevant information about each alternative so that an appropriate remedial action(s) may be selected. Under CERCLA and NCP, nine criteria are used to evaluate remedial alternatives. The first two criteria, referred to as "threshold criteria," are requirements that an alternative must meet to be selected as the preferred alternative. The next five criteria, referred to as "balancing criteria," are used to weigh major trade-offs among the alternatives. The last two criteria, referred to as "modifying criteria," will be fully evaluated only after public comment is received on this Plan. Because Alternative 1 (No Action) does not meet any of the nine criteria, it was eliminated from consideration for further evaluation.

Overall Protection of Human Health and the Environment – *does the alternative adequately protect human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site by eliminating, reducing, or controlling exposures?*

Alternatives 2 through 6 are all protective of human health and the environment. The contaminated soil in the land farm area (A-1) (Figure 8) would remain in place and ICs would be implemented to prevent residential use of the property. The soil was not shown to pose a risk except for a hypothetical future resident exposure which would require a change in zoning for the land farm area which is highly unlikely. After remedial activities are completed in the land farm area and the recovery and treatment wells are abandoned, the area will be regraded with top soil and reseeded. There is a contaminant area (Area A-3) located under the former Kellwood facility that is believed to provide a continuing source for the migration of contaminants into the groundwater. That source area (and Area A-1 if the existing building was to be expanded to the north, see Figure 8) also provides a potential contaminant source for vapor intrusion into the former Kellwood facility. This exposure route is currently being investigated by Kellwood through subslab sampling and an evaluation of the building infrastructure and operating procedures to determine if the theoretical risk correlates to an actual risk. Groundwater samples obtained from the Lower Jefferson City Dolomite/Roubidoux Formation zone, which is the drinking water source for OUs 2/6, have shown the existence of isolated locations of COCs. These localized areas correlate to existing wells which presumably provided the vertical conduit for the downward migration of DNAPL. However, these isolated areas of contamination are being addressed through the installation of liners in the affected wells and the provision of whole-house water treatment systems at these locations. This drinking water zone has no discernable hydraulic connectivity with the upper nondrinking water zones. The upper nondrinking water zones contain COCs at levels in excess of MCLs. DNAPL recovery/treatment will minimize the dispersion of DNAPL compounds into the groundwater system.

The Alternatives 2c, 2d, 4b, 4c, 5, and 6 that include a line of groundwater treatment wells in the unconsolidated material at the southern end of Industrial Drive (Area A-4) (Figure 9) will shorten the time period that contaminated water remains in this shallow groundwater zone that could potentially discharge to surface waters above the Missouri surface water standards (but below the risk-based criteria) by approximately 10 years.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)[6] – *do the alternatives attain ARARs under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking a waiver of such requirement?*

ARARs are set forth in Section 3.3 of the FS. Alternatives 2 through 6 are expected to achieve ARARs through DNAPL source removal and/or treatment. Alternatives 2 through 6 all provide drinking water meeting MCLs to the residences in OUs 2/6 through either treatment or an alternate water supply. The isolated locations of contaminated groundwater in the Lower Jefferson City Dolomite/Roubidoux Formation will be cleaned up over time as the water is extracted through domestic water wells and treated by the whole-house water treatment units; or for the alternatives with an alternate water supply, the wells would be abandoned and the contamination would achieve levels below MCLs before it reached another potential receptor.

Alternatives 2 through 6 would accelerate the improvement of the groundwater quality in the upper, nondrinking water zones due to the treatment of the DNAPL source and for Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6 due to accompanying treatment of groundwater in the unconsolidated material in Area A4 located at the southern end of Industrial Drive. It is unknown whether any of the alternatives, however, will be effective in reducing groundwater contaminant concentrations in the upper, nondrinking water zones to levels below MCLs throughout all areas of OUs 2/6 because none of the treatment alternatives are expected to eliminate all DNAPL located in the fractured bedrock, which provides a continuing source of contaminants to this water-bearing zone. The addition of the groundwater treatment wells would lower the concentrations in the upper aquifer sooner than what would occur through DNAPL recovery/treatment alone.

Long-term Effectiveness and Permanence – *each alternative must be assessed for the long-term effectiveness that they afford, along with the degree of certainty that the alternative will prove to be successful.*

Alternatives 2 through 6 would provide similar long-term effectiveness as they all include DNAPL recovery and/or treatment. Future monitoring will be required to assess whether the selected alternative is able to attain RAOs throughout OUs 2/6. Regardless of the alternative selected, achieving RAOs will present a near and long-term technical challenge due to the nature of DNAPL and its presence in a fractured bedrock geologic setting.

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[6] There are three types of ARARs: (1) Chemical-specific ARARs are health- or risk-based values or methodologies that establish the acceptable amount or concentration of a hazardous substance that may be found in or discharged to the ambient environment, (2) Location-specific ARARs are restrictions placed on the concentration of a hazardous substance or activity solely because they occur in a specific location, and (3) Action-specific ARARs are technology or activity-based requirements pertaining to the treatment or management of hazardous substances.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment – *the degree to which each alternative employs recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site.*

Alternatives 2 through 6 utilize treatment technologies (identified in the Summary of Remedial Alternatives section of this Plan) which result in the reduction but not total elimination of the volume of DNAPL in the land farm area and, therefore, a reduction but not total elimination of mobility and toxicity of COCs as they dissolve into the groundwater. Alternatives 4a, 4d, 4c, 4d, 5, and 6 also provide a reduction in the toxicity and volume of the impacted soil underneath the former Kellwood facility. Alternatives 2c, 2d, 4b, 4c, 5, and 6 provide a reduction in the toxicity and volume of contamination in the upper groundwater at the treatment zone located at the southern end of Industrial Drive. The reduction in the toxicity and volume in the upper groundwater at the treatment zone at the southern end of Industrial Drive would have been observed within approximately 10 years due to the recovery and/or treatment of DNAPL at the land farm area without the additional groundwater treatment provided in Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6.

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

DNAPL recovery would begin within three to six months with Alternatives 2a, 2b, 2c, or 2d. The full-scale in situ chemical oxidation component of these alternatives would start in year five. In Alternatives 5 and 6, DNAPL treatment would start midway through year two. The shortest estimated time frame for completion of DNAPL recovery/treatment would be 27 months with Alternatives 3 and 4 utilizing thermal treatment in the land farm area.

Alternatives 2 through 6 provide immediate effectiveness for groundwater users as there are already whole-house water treatment units in place at the residences with groundwater sources with COCs above MCLs. Alternative 2a has the shortest predesign investigation, design, and implementation time.

Alternatives 2c, 2d, 4b, 4c, 5, and 6 require installation of treatment wells on a 10-foot center which would require up to three and one-half years for the predesign investigation, treatability testing, pilot testing, design, and installation of the injection wells and an estimated five years for full-scale operation of the system.

Thermal treatment (Alternatives 2c, 2d, 4b, 4c, 4d, 5, and 6) requires a 480 volt power supply, but the individual voltage of the electrodes is low to provide a "step and touch" voltage of less than 15 volts, well below the Occupational Health and Safety Administration standard. Typically, the area would be fenced off to prevent trespassers into the treatment area. The treatment zone is approximately 8 to 20 feet below grade.. Therefore, the heat generated by the treatment system should dissipate before the reaching the surface. As a security measure, the system is designed to shutdown if unauthorized personnel enter the area. The system is operated under a vacuum to prevent the release of vapors to the atmosphere.

Alternative 4b includes the use of hydrogen (as part of the liquid mixture that will release hydrogen in situ). If containerized hydrogen gas is utilized, there would be safety concerns due to the presence of pressured gas cylinders on-site.

The oxidizing chemical—sodium persulfate—and its associated activation compound that are part of Alternatives 4c and 5 require careful attention to various aspects of handling and use.

Implementability - *considers the technical and administrative feasibility of implementing each alternative, including factors such as the relative availability of needed services and materials.*

Alternative 2a would be the easiest and fastest alternative to implement. Certain components of this alternative are already in place (whole-house water treatment units in the only residential wells known to contain COCs above MCLs, well construction restrictions on new wells, and groundwater monitoring). DNAPL recovery well installation and operation could begin as soon as a work plan is approved by EPA. After DNAPL recovery is complete, a pilot test for in situ chemical oxidation would be conducted to aid in the design of the injection wells, chemical selection, and chemical injection rate for the full-scale operation. This alternative would be least intrusive and would be the easiest to obtain access agreements to implement.

Alternative 2b would, in addition to the Alternative 2a remedy components, require the design and installation of a water distribution line. The design process of the water line and obtaining approval from the appropriate parties could be time-consuming. Water distribution systems are also part of Alternatives 2d and 3b. However, given Kellwood's inability to obtain the legal right to access an alternative public water supply for OU 6, the alternate water supply option in Alternatives 2b and 2d appears to be unavailable and will be dropped from further consideration.

Alternatives 2c and 2d are similar to Alternatives 2a and 2b, respectively, with the addition of groundwater treatment wells. Alternatives 4b, 4c, and 4d include groundwater treatment wells and would be subject to the same procedures for selection, design, installation, and operation. The treatment wells would not be installed until a predesign investigation and treatability testing are conducted to select a preferred treatment method. A pilot test would then be conducted using this treatment technology prior to proceeding with full-scale installation and operation. The proposed location for the treatment wells crosses Industrial Drive, and multiple injection wells are anticipated to be required to be installed within the roadway. This would require some coordination of traffic, but the injection wells would be installed flush to grade and would not interfere with traffic except during construction and during the injection of chemical events.

Alternatives 3a, 3b, 4a, 4b, and 4c require installation of thermal treatment wells for the treatment of DNAPL in the land farm area. These wells would be installed on 15 to 20-foot centers for the collocated electrodes and vapor recovery wells. The time required for installation of the wells is estimated to be approximately 180 days. The system could be installed with the wells completed above grade except where it would interfere with vehicular traffic just west of the north end of the former Kellwood facility.

Alternatives 5 and 6 include installation of DNAPL treatment (Alternative 5 using chemical oxidation, Alternative 6 using chemical reduction) wells in the land farm area and at Area A-3 within the former Kellwood facility. The time required for installation of these wells is estimated to be approximately 180 days. These alternatives also include installation of the groundwater treatment wells. The installation of these wells (following a pilot test) is estimated to take 180 days. Roads would remain open during the operation of the treatment system. The below-grade wells would take longer to install and would require temporary shutdown or limited traffic on Industrial Drive. The installation of treatment wells within the former Kellwood facility would need to be coordinated with the facility owner/operator and may require installation over weekends. This work is estimated to take 10 days for well installation.

The alternatives that require treatability testing for groundwater treatment technology (Alternatives 2c, 2d, 4a, 4c, and 4d) involve the most extensive and longest remedial activity. Alternatives 5 and 6 would be almost as long to implement except treatability testing is not included as the specific treatment technology is specified. It is expected that the alternatives that include groundwater treatment, which will require land owner approval, will be the most difficult to implement.

Cost - *includes estimated capital and annual O&M costs as well as present net worth cost. Present net worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.*

The alternatives with lowest to highest estimates of total costs are as follows:

Alternative		Total Cost
2a:	DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, groundwater monitoring	$ 3,480,000
3a:	Thermal treatment for DNAPL, whole-house treatment units, ICs, groundwater monitoring	$ 4,610,000
2b:	DNAPL recovery followed by in situ chemical oxidation, alternate water supply, whole-house water treatment units (interim), ICs, groundwater monitoring	$ 4,610,000

6:	In situ chemical reduction (DNAPL, Area A-3, and groundwater), whole-house water treatment units, ICs, groundwater monitoring	$ 4,720,000
4a:	Thermal treatment for DNAPL source and soils at Area A-3, whole-house water treatment units, ICs, groundwater monitoring	$ 4,800,000
3b:	Thermal treatment of DNAPL source, whole-house treatment units (interim), alternate water supply, ICs, groundwater monitoring	$ 5,740,000
2c:	DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, in situ groundwater remediation, groundwater monitoring	$ 5,920,000
4d:	Thermal treatment of DNAPL and soil at Area A-3, in situ chemical reduction of groundwater, whole-house treatment units, ICs, groundwater monitoring	$ 6,040,000
5:	In situ chemical oxidation (DNAPL, Area A-3, and groundwater), whole-house water treatment units, ICs, groundwater monitoring	$ 6,170,000
4b:	Thermal treatment for DNAPL and soil at Area A-3, bioremediation of groundwater, whole-house water treatment units, ICs, groundwater monitoring	$ 6,520,000
2d:	DNAPL recovery followed by in situ chemical oxidation, alternate water supply, whole-house water treatment units (interim), ICs, in situ groundwater remediation, groundwater monitoring	$ 7,050,000
4c:	Thermal treatment for DNAPL and soil at Area A-3, in situ chemical oxidation of groundwater, whole-house treatment units, ICs, groundwater monitoring	$7,210,000

The alternatives with the lowest to highest estimates of capital costs are as follows:

Alternative		Capital Costs
2a:	DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, groundwater monitoring	$ 990,000
3a:	Thermal treatment for DNAPL, whole-house treatment units, ICs, groundwater monitoring	$ 2,120,000
6:	In situ chemical oxidation (DNAPL, Area A-3, and groundwater), whole-house water treatment units, ICs, groundwater monitoring	$ 2,230,000
4a:	Thermal treatment for DNAPL source and soils at Area A-3, whole-house water treatment units, ICs, groundwater monitoring	$ 2,310,000
2b:	DNAPL recovery followed by in situ chemical oxidation, alternate water supply, whole-house water treatment units (interim), ICs, groundwater monitoring	$ 2,610,000
2c:	DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, in situ groundwater remediation, groundwater monitoring	$ 3,430,000
4d:	Thermal treatment of DNAPL and soil at Area A-3, in situ chemical reduction of groundwater, whole-house treatment units, ICs, groundwater monitoring	$ 3,550,000
5:	In situ chemical oxidation (DNAPL, Area A-3, and groundwater), whole-house water treatment units, ICs, groundwater monitoring	$ 3,680,000
3b:	Thermal treatment of DNAPL source, whole-house treatment units (interim), alternate water supply, ICs, groundwater monitoring	$ 3,740,000
4b:	Thermal treatment for DNAPL and soil at Area A-3, bioremediation of groundwater, whole-house water treatment units, ICs, groundwater monitoring	$ 4,030,000
4c:	Thermal treatment for DNAPL and soil at Area A-3, in situ chemical oxidation of groundwater, whole-house treatment units, ICs, and groundwater monitoring	$ 4,720,000

2d: DNAPL recovery followed by in situ chemical oxidation, alternate water supply, whole-house water treatment units (interim), ICs, in situ groundwater remediation, and groundwater monitoring $ 5,050,000

The cost for the treatment technologies involving DNAPL and groundwater treatment wells could vary significantly from what is estimated based on the number and frequency of injections and the volume of chemicals injected. Estimates were made based on the best available information obtained from the RI and preliminary engineering judgments about the efficacy of in situ treatment approaches for groundwater and soil. Information gathered as part of a predesign investigation and from treatability testing would result in a better estimate of the cost. Even following treatability testing, the actual costs may increase substantially if multiple injections are required in an attempt to reduce groundwater contaminant concentrations below MCLs.

O&M costs have a first year annual cost estimate at $200,000. Certain of the annual cost elements are included for a limited number of years for some of the alternatives. O&M cost total is calculated using the net present worth for 30 years based on a seven percent discount rate. The total O&M cost for the alternatives with only interim operation of whole-house water treatment units (Alternatives 2b, 2d, and 3b) is $1,193,000. The total O&M cost for the alternatives where the whole-house water treatment units are assumed to operate the full 30 years is $2,482,000.

A complete breakdown of costs for the preferred alternative is shown in Table 3.3. The costs for all other alternatives can be found in Appendix B, Cost Estimate Summary of the FS.

State Acceptance

The state of Missouri is currently reviewing the information regarding the preferred alternative.

Community Acceptance

Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the Responsive Summary section of EPA's ROD for OUs 2/6.

SUMMARY OF THE PREFERRED ALTERNATIVE

EPA's preferred alternative for addressing OUs 2/6 is Alternative 2c which includes DNAPL recovery followed by in situ chemical oxidation, whole-house water treatment units, ICs, in situ groundwater remediation, and groundwater monitoring.

Alternative 2c was selected over the other alternatives as it meets the requirements for protecting human health and the environment and provides a safe and acceptable drinking water source for affected groundwater users. This alternative includes DNAPL recovery followed by in situ chemical oxidation to address the source area PCE. It also addresses dissolved phase PCE downgradient from the source by the implementation of in situ groundwater remediation. The groundwater treatment technology would be selected following treatability testing. Implementation of the line of treatment wells would be a second phase to Alternative 2c, implemented upon selection of a treatment technology that would be effective in achieving the remediation goals.

The preferred alternative can change in response to public comment or new information.

Based on the information currently available, EPA believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. EPA expects the preferred alternative to achieve the RAOs, address source materials constituting principal threats, and satisfy the statutory requirements of CERCLA § 121(b). The preferred alternative will also: (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost effective, (4) utilize permanent solutions and alternate treatment technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element.

COMMUNITY PARTICIPATION

EPA and MDNR will continue to provide information regarding the cleanup of OUs 2/6 at the Site through public meetings, the Administrative Record for the Site, and announcements published in the *New Haven Leader* Newspaper. EPA and MDNR encourage the public to gain a more comprehensive understanding of the Site and the Superfund activities that have been conducted at the Site.

The dates for the public comment period, the date, location, time of the public meeting, and the locations of the Administrative Record file are provided on the front page of this Plan.

GLOSSARY OF TERMS

Specialized terms used in this Plan are defined below:

Administrative Record (AR): The body of documents that "forms the basis" for selection of a particular response at a site. An AR is available at or near the site to permit interested individuals to review the documents and to allow meaningful public participation in the remedy selection process.

Aquifer: An underground layer of rock, sand, or gravel capable of storing water within cracks and pore spaces or between grains. When water contained within an aquifer is of sufficient quantity and quality, it can be used for drinking or other purposes. The water contained in the aquifer is called groundwater.

Applicable or Relevant and Appropriate Requirements (ARARs): The federal and state environmental laws that a selected remedy will meet.

Capital Costs: Expenses associated with the initial construction of a project.

Chemical Oxidation Treatment: The use of chemicals called "oxidants" to destroy pollution in soil and groundwater. Oxidants help change harmful chemicals into harmless ones.

Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA): The law enacted by Congress in 1980 to evaluate and clean up abandoned, hazardous waste sites. EPA was charged with the mission to implement and enforce CERCLA.

Groundwater – Underground water that fills pores in soils or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells.

Groundwater Divide: A ridge in the water table, from which groundwater moves away in both directions.

Maximum Contaminant Levels (MCLs): The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

Monitoring: Continued collection of information about the environment that helps gauge the effectiveness of a cleanup action.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The federal regulations that guide the Superfund program.

Operable Unit (OU): Term for each of a number of separate activities undertaken as part of a Superfund site cleanup.

Operation and Maintenance (O&M): Activities conducted at a site after the construction phase to ensure that the cleanup continues to be effective.

Plume: A body of contaminated groundwater flowing from a specific source.

Present Worth Analysis: A method of evaluation of expenditures that occurs over different time periods. By discounting all costs to a common base year, the costs for different remedial actions can be compared on the basis of a single figure for each alternative.

Record of Decision (ROD): The decision document in which EPA selects the remedy for a Superfund site.

Superfund: The nickname given by the press for CERCLA because the program was well funded in the beginning.

Toxicity: A measure of degree to which a substance is harmful to human and animal life.

Volatile Organic Compounds (VOCs): Carbon compounds, such as solvents, which readily volatilize at room temperature and atmospheric pressure. Most are not readily dissolved in water, but their solubility is above health-based standards for potable use. Some VOCs can cause cancer.

Figures

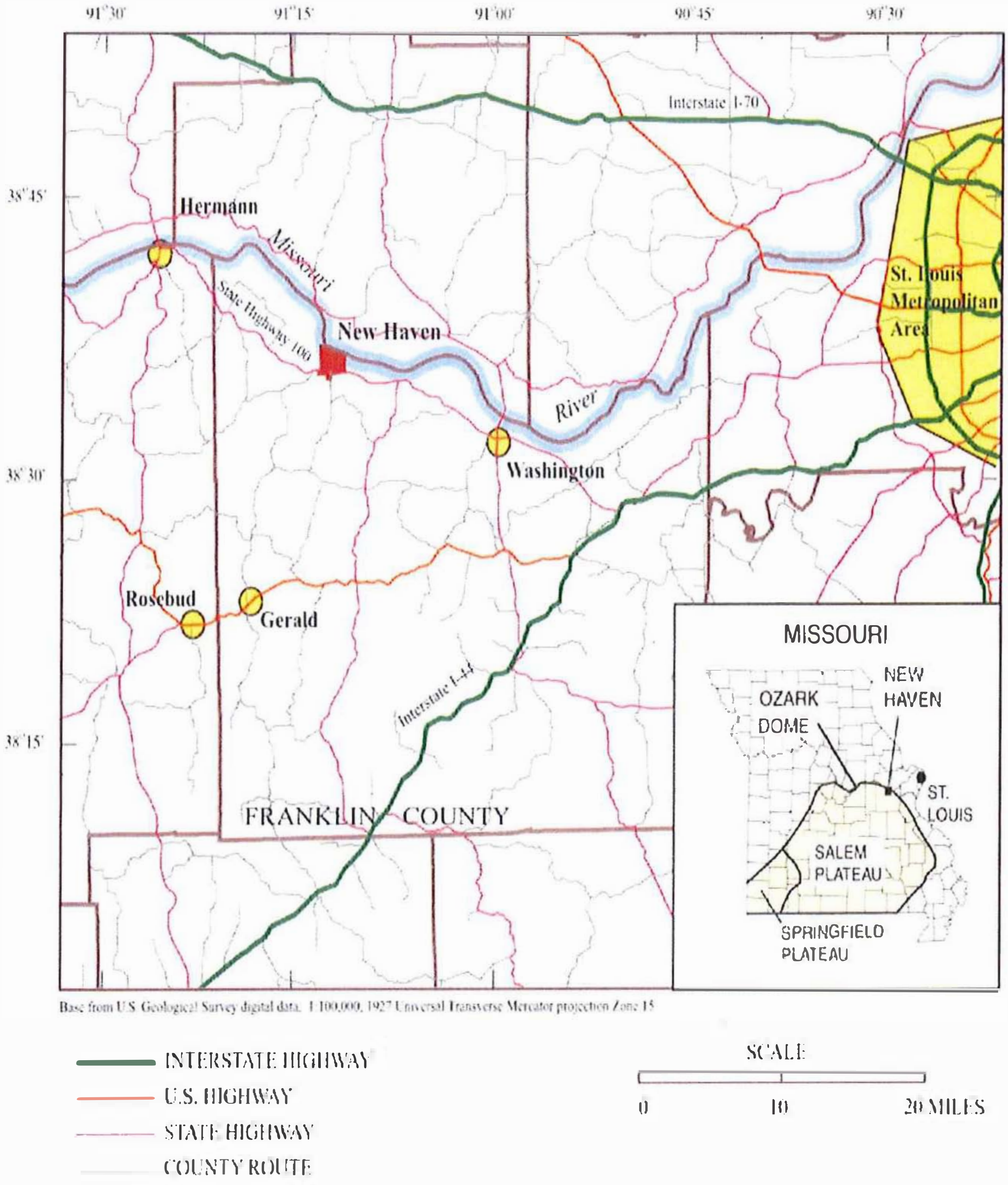


Figure 1: Location of Riverfront Superfund Site, New Haven, Missouri.

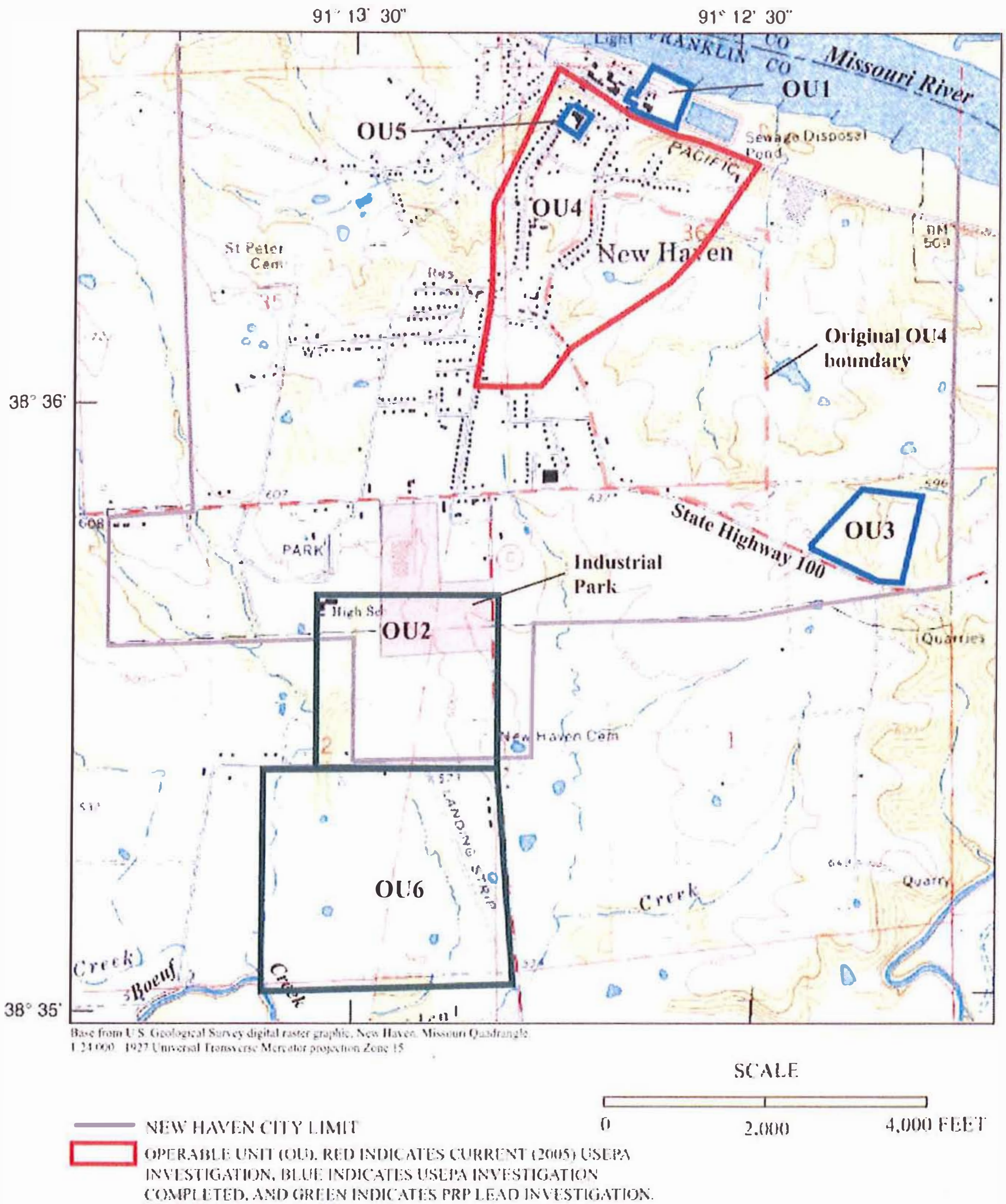


Figure 2: Operable Units of the Riverfront Superfund Site.

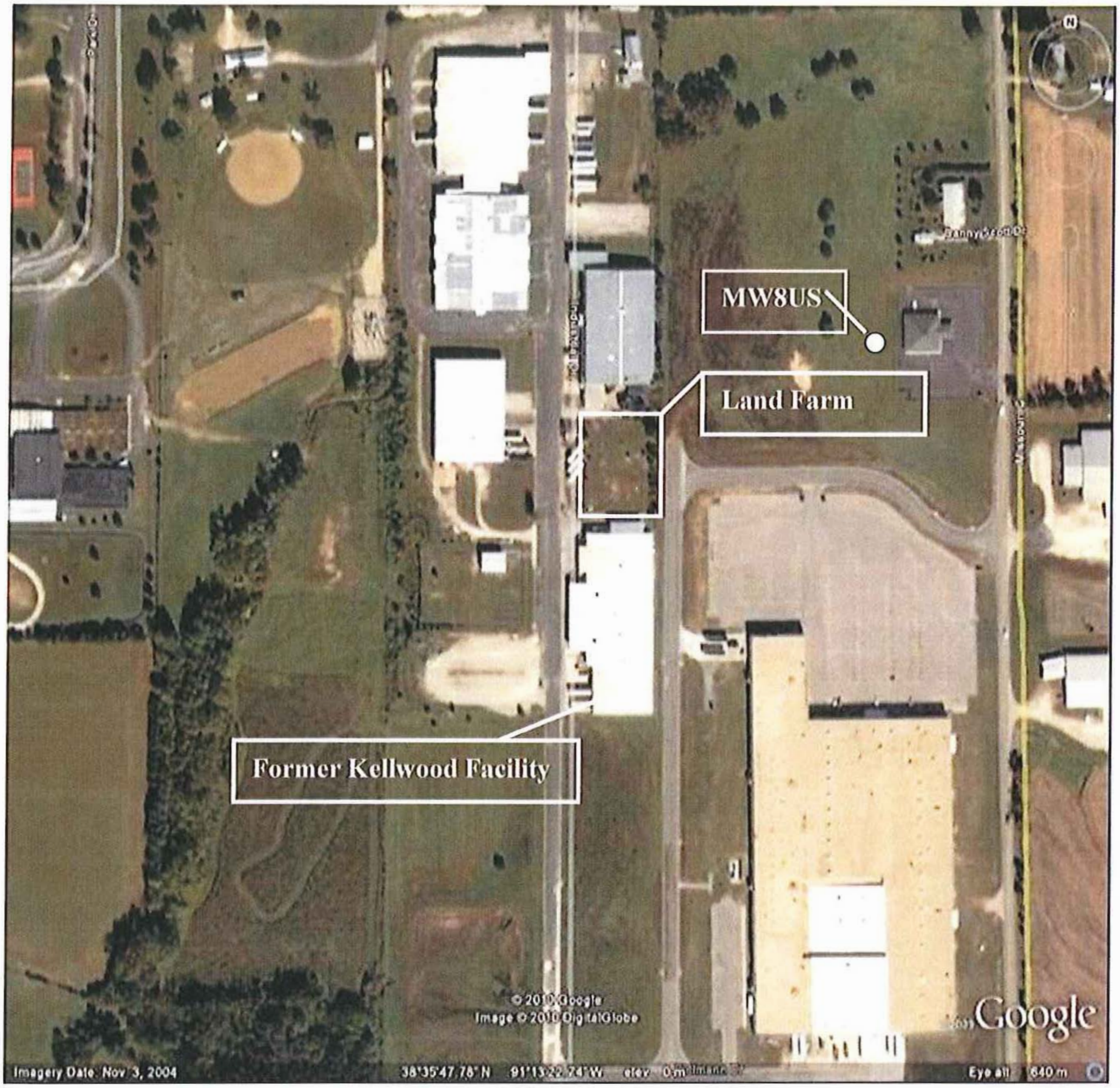


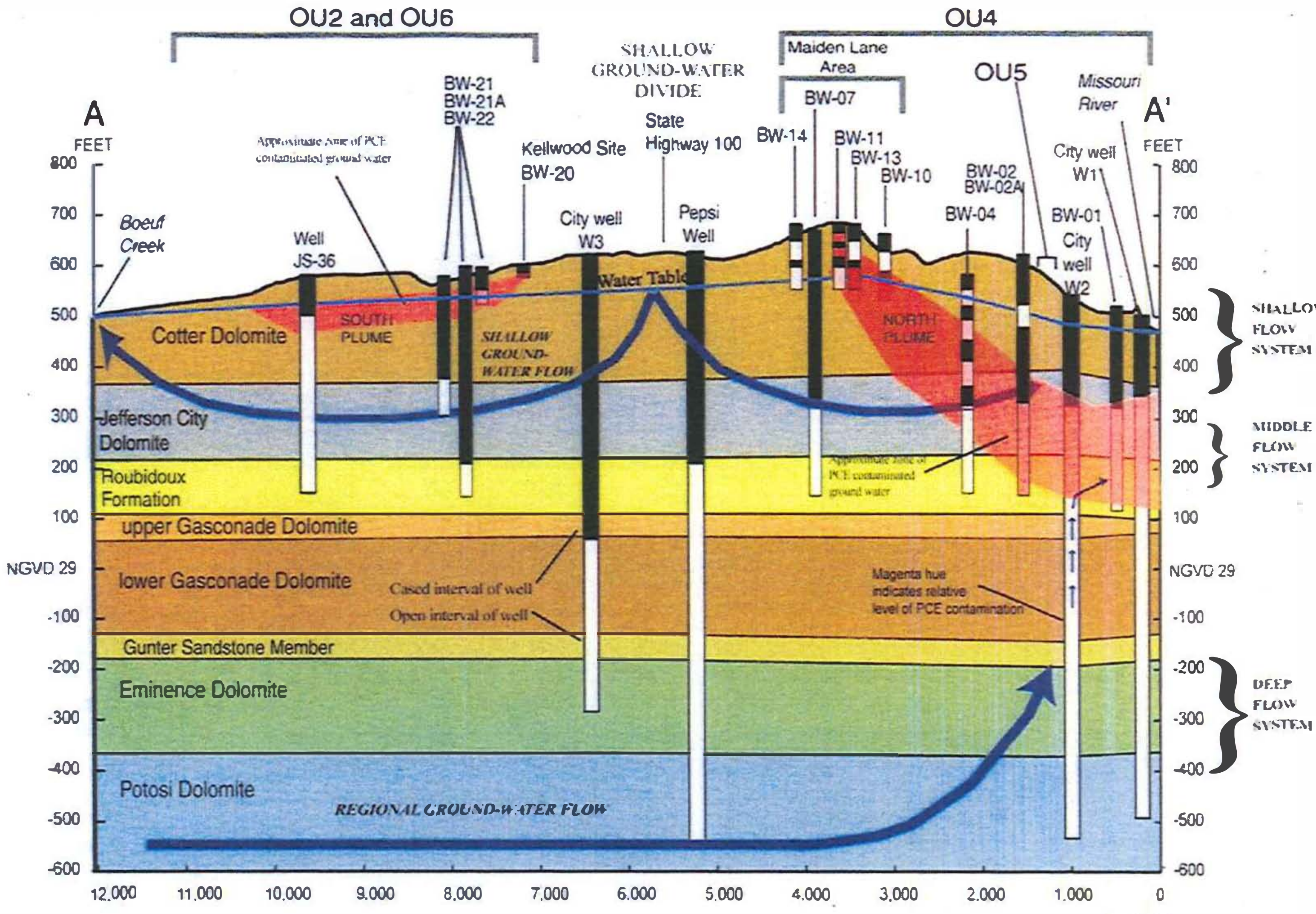
Figure 3: Former Kellwood Facility and Land Farm area.

[ft, feet; gal/min, gallons per minute; thickness data from geologic logs of production wells in New Haven on file at the Missouri Department of Natural Resources Division of Geology and Land Survey and from Starbuck (2002)]

System	Formation	Approximate thickness (ft)	General lithology	General hydrologic properties
Ordovician	St. Peter Sandstone	less than 40	Fine-grained cemented quartz sandstone.	Yields of 10 to 50 gal/min where moderately thick.
	Powell Dolomite	0 to 95	Difficult to differentiate. Crystalline cherty dolostone with abundant thin shale partings and occasional thin sandstone beds. Thicker (2 to10 ft thick) sandstone beds in Cotter.	Adequate for small domestic supply. Yields of 5 to 10 gal/min locally. Less permeable than surrounding units and impedes downward water movement.
	Cotter Dolomite	85 to 280		
	Jefferson City	150 to 165		
	Roubidoux Formation	110 to 120	Cherty, sandy dolostone. Middle 20 to 30 ft is clean sandstone.	Normal yields of 15 to 50 gal/min. Target unit for newer domestic wells.
	upper Gasconade Dolomite	35 to 50	Massively bedded, crystalline dolostone.	Lower permeability than surrounding units.
	lower Gasconade Dolomite	200 to 240	Cherty dolostone with massive chert beds.	Combined yields of upper and lower units range from 50 to 75 gal/min.
	Gunter Sandstone Member of Gasconade Dolomite	35 to 50	Dolostone with less than 10 percent sand.	Normal yield of 40 to 50 gal/min, may exceed 200 gal/min in some locations.
Cambrian	Eminence Dolomite	145 to 180	Crystalline dolostone with less than 5 percent chert and sand.	Yields of 75 to 250 gal/min.
	Potosi Dolomite	greater than 170	Crystalline dolostone with abundant small solution cavities and quartz druse.	Target zone of most high capacity wells. Yields 200 to 1,000 gal/min.

Modified from Miller and Vandike (1997).

Figure 4: Bedrock Geology



*Note: pink shading indicates probable area of tetrachloroethene (PCE) contamination. Degree of shade indicates relative PCE concentration.

Figure 5: Groundwater Divide

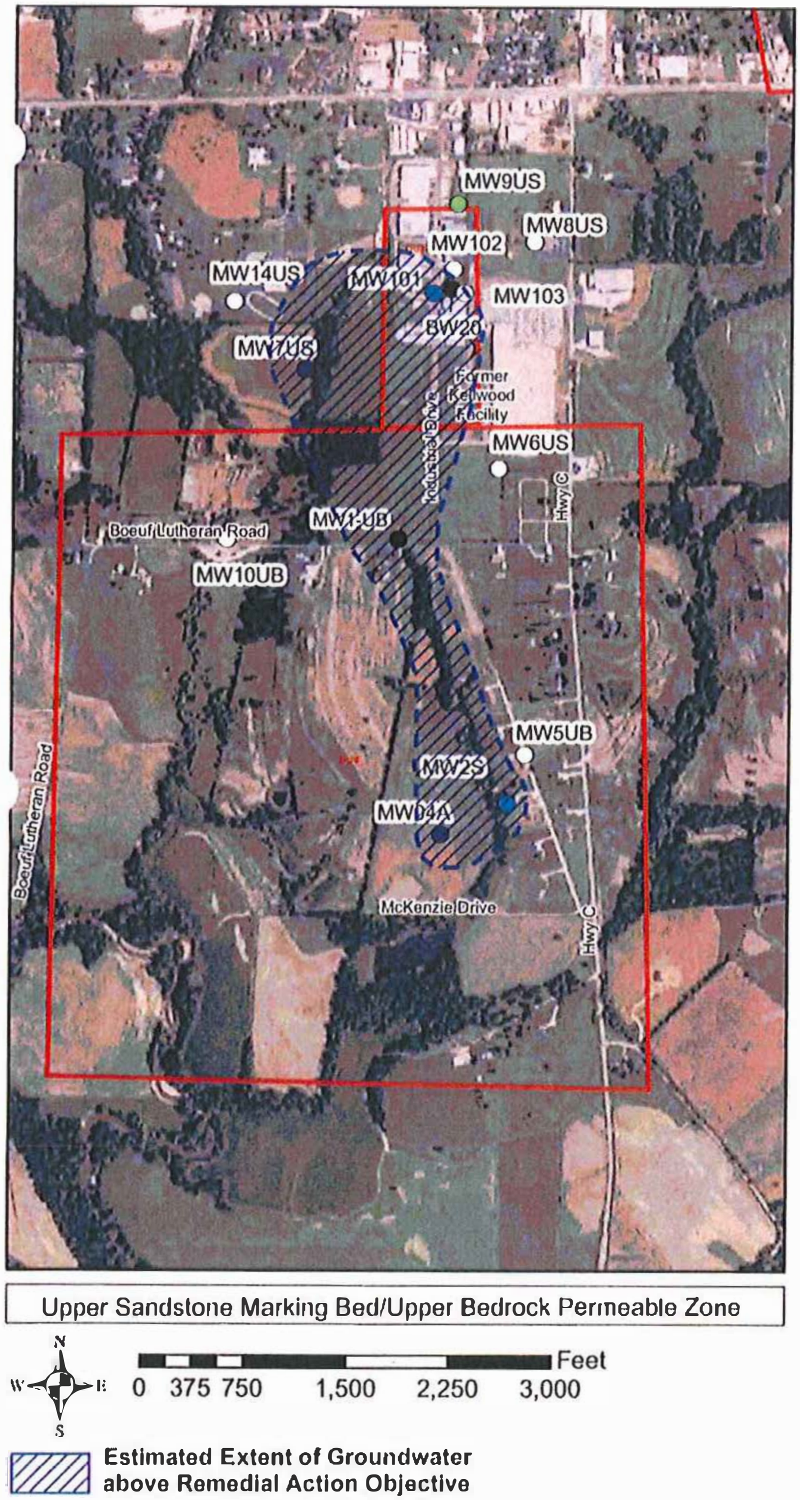


Figure 6a: Extent of Groundwater Contamination in Upper Sandstone/Upper Bedrock.

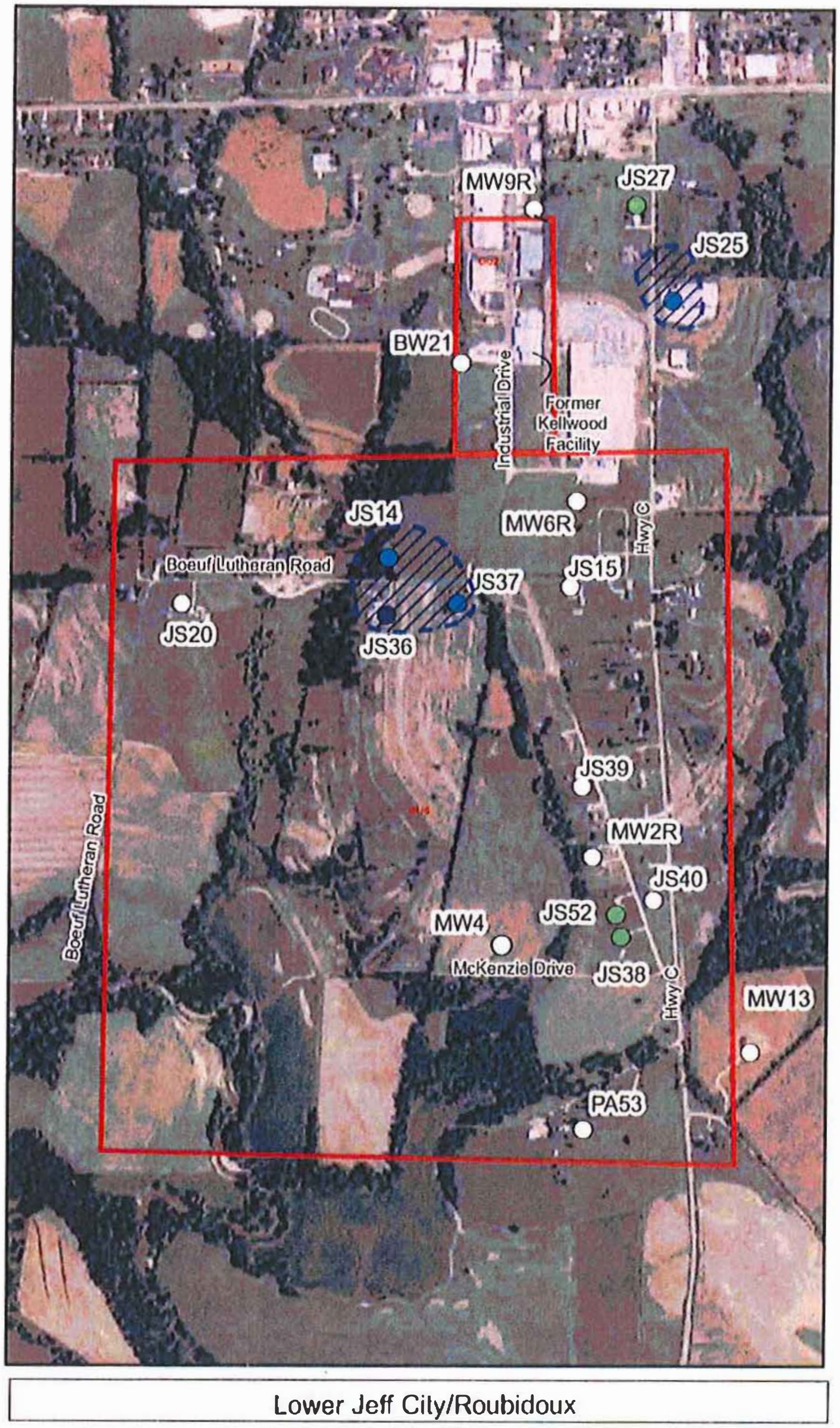


Figure 6b: Extent of Groundwater Contamination in Lower Jefferson City Dolomite/Roubidoux Formations.

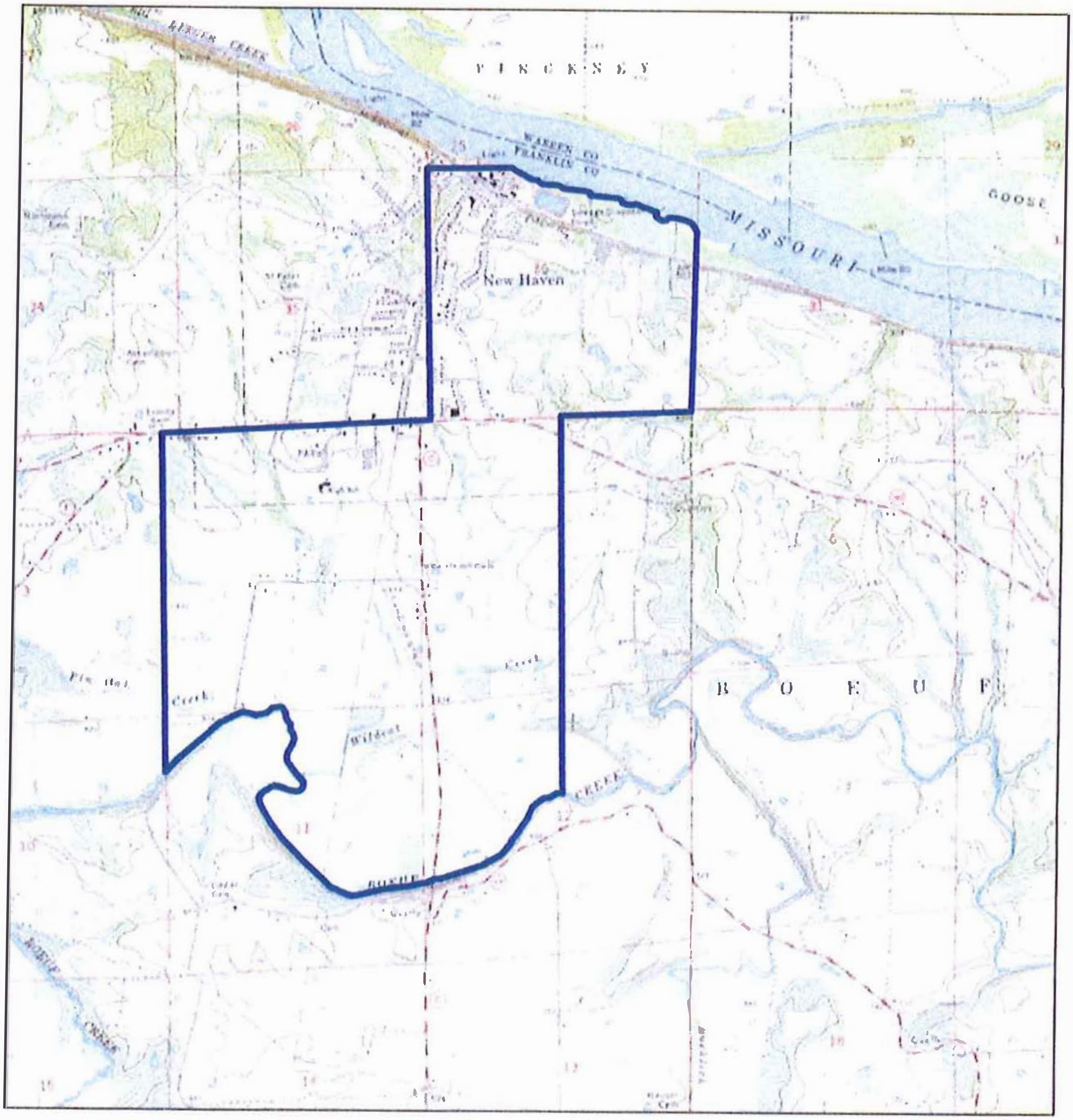


Figure 7: Special Area 3 Boundary

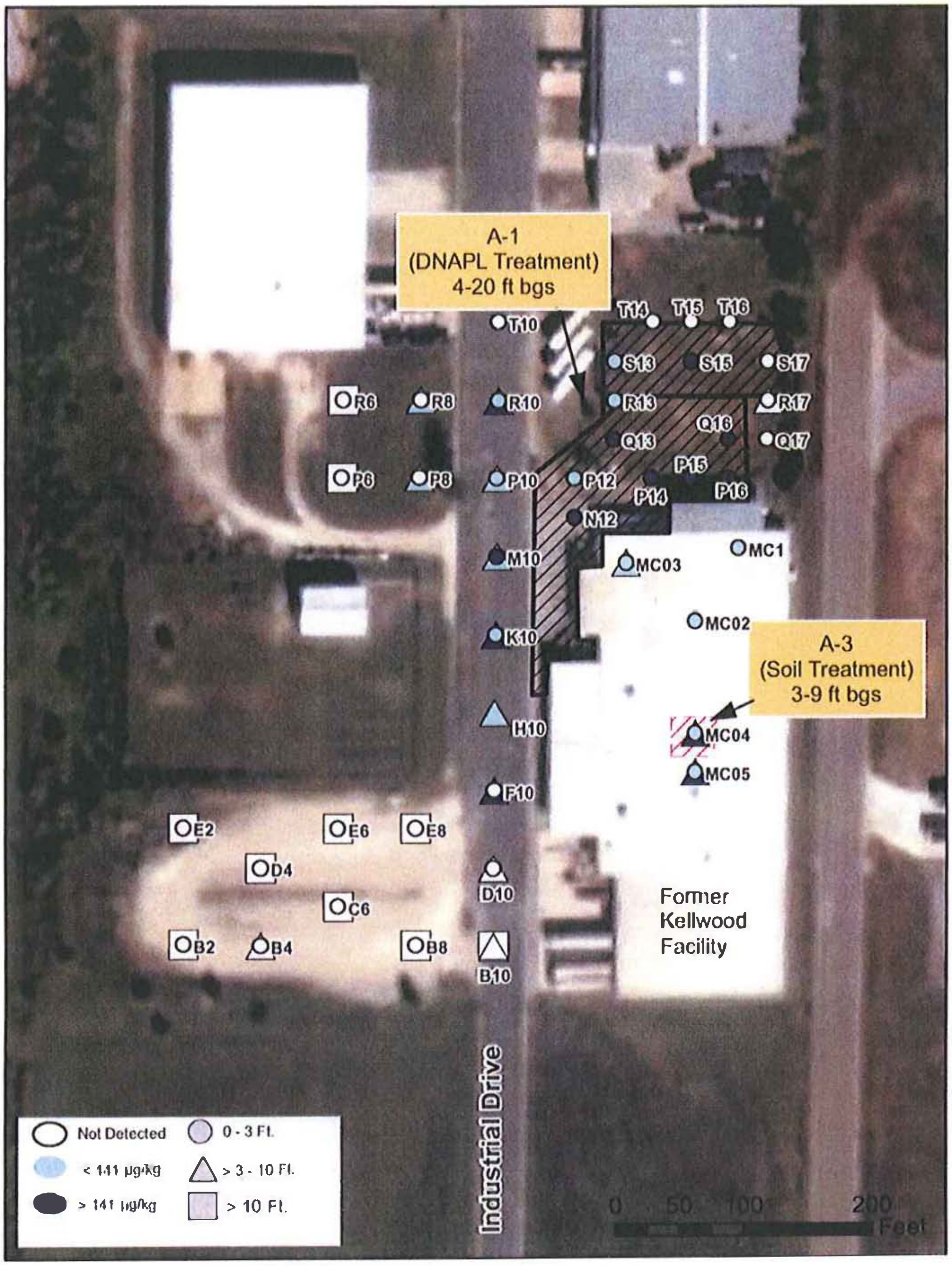


Figure 8: DNAPL Treatment Area (A-1) and Soil Treatment Area Under the Former Kellwood Facility (A-3).

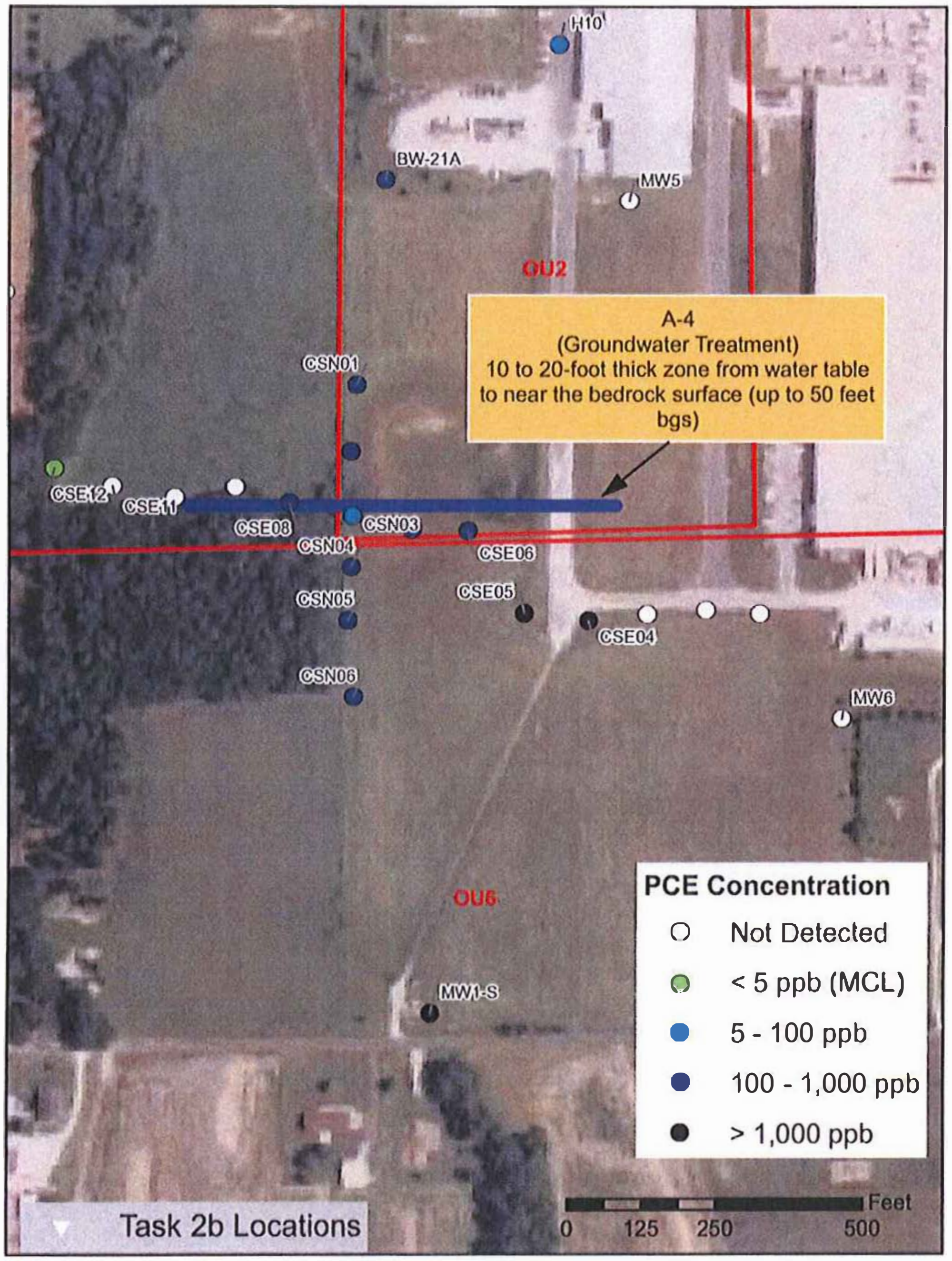


Figure 9: Proposed Location of Groundwater Treatment Wells - Remedial Alternatives 4a, 4b, 4c, 4d, 5, and 6 groundwater treatment wells.

Tables

TABLE 3.1
REMEDIAL ACTION OBJECTIVES FOR HUMAN RECEPTORS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Objective and Pathway	Applicable Com-pounds	Calculated Human Health Level	Calculated Site Background Level	Ground-water MCL	Target Concen-tration	Units	Basis
Protect human health by eliminating exposure (i.e. direct contact)[2] to **soil** [3] with concentrations of COPCs above risk-based values.	PCE [1]	550	N/A	N/A	550	ug/kg	Calculated using target risk of 1 x 10^{-6} (carcinogen) under a **future hypothetical residential scenario**.
Protect human health by eliminating exposure (i.e. inhalation)[2] to vapors volatilizing from **soil** [3] to indoor air with concentrations of COPCs above risk-based values	PCE [1]	35.9	N/A	N/A	35.9	ug/kg	Calculated using target risk of 1 x 10^{-6} (carcinogen) **future hypothetical residential scenario.**
Protect human health by eliminating exposure (i.e. inhalation)[2] to vapors volatilizing from **soil** [3] to indoor air with concentrations of COPCs above risk-based values	PCE [1]	272	N/A	N/A	272	ug/kg	Calculated using target risk of 1 x 10^{-6} (carcinogen) under a **current/future industrial scenario.**
Protect human health by eliminating exposure (i.e. inhalation) to vapors volatilizing from **groundwater** to indoor air with concentrations of COPCs above risk-based values.	PCE [1]	51.5	N/A	N/A	51.5	ug/L	Calculated using target risk of 1 x 10^{-6} (carcinogen) under a **future hypothetical residential scenario**.

TABLE 3.1
REMEDIAL ACTION OBJECTIVES FOR HUMAN RECEPTORS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Objective and Pathway	Applicable Com-pounds	Calculated Human Health Level	Calculated Site Background Level	Ground-water MCL	Target Concen-tration	Units	Basis
Protect human health by eliminating exposure (i.e. inhalation) to vapors volatilizing from **groundwater** to indoor air with concentrations of COPCs above risk-based values	PCE [1]	423	N/A	N/A	423	ug/L	Calculated using target risk of 1 x 10^{-6} (carcinogen) under a **current/future industrial scenario.**
Protect human health by eliminating exposure (i.e. ingestion) to **groundwater** with concentrations of chemicals of COPCs above risk-based values	PCE [1]	< MCL	N/A	5	5	ug/L	Calculated using target risk of 1 x 10^{-6} (carcinogen) and target hazard level of 1 (non-carcinogen) under a **future hypothetical residential scenario.**

[1] PCE is tetrachloroethylene

[2] Direct contact pathway evaluated soils in the 0 to 3 feet depth range. Inhalation pathway evaluated 0 to 10 feet.

[3] Limited to Areas A-1 and A-3 (see Figure 3.1)

N/A – Not Applicable

TABLE 3.2
REMEDIAL ACTION OBJECTIVES FOR ECOLOGICAL RECEPTORS
RIVERFRONT SUPERFUND SITE OU2/OU6
NEW HAVEN, MISSOURI

Applicable Compounds	Target Concentration (ug/kg)	Basis
SURFACE SOILS – Pathway: Prevent direct contact with impacted surface soils and consumption of impacted food		
PCE	9,920	Region 5 ESL
Applicable Compounds	**Target Level (ug/L)**	**Basis**
SURFACE WATER – Pathway: Prevent direct contact with impacted surface water		
PCE	111	Region 3 BTAG
(Note: detected concentrations of PCE at OU2 and OU6 were below the Region 3 BTAG target level.)		
Applicable Compounds	**Target Level (ug/kg)**	**Basis**
SEDIMENT – Pathway: Prevent direct contact with impacted sediment		
PCE	468	Region 3 BTAG
(Note: detected concentrations of PCE at OU2 and OU6 were below this target level.)		

PCE = Tetrachloroethylene
ESL = Ecological Screening Level

Feasibility Study Cost Estimate for Alternative 2c:

DNAPL Recovery followed by *In Situ* Chemical Oxidation Treatment, Whole House Water Treatment, Bench-Scale and Pilot Testing of *In Situ* Groundwater Treatment Technologies, Full Scale Implementation of *In Situ* Groundwater Treatment Technology (A-4), Institutional Controls, Groundwater Monitoring

Job No.: 445737 PARSONS

Riverfront Superfund Site OU2 / OU6 ESTIMATE WORK SHEET

Location: New Haven, Missouri

Item	Description	Ref.	Quant.	Unit	Unit Cost	Total
	Mobilization and Demobilization of Equipment and Personnel		1	LS	$25,000	$25,000
	Temporary Facilities and Equipment (During Drilling & Construction Activities)					
	Temporary Construction Trailers		1	LS	$5,000	$5,000
	Temporary Decontamination Equipment		1	LS	$5,000	$5,000
	Emergency Spill Equipment		1	LS	$2,000	$2,000
	Sediment and Erosion Controls		1	LS	$2,000	$2,000
	Temporary Work Zone Fencing and Signs		1	LS	$2,000	$2,000
	Health and Safety Air Monitoring and Preparation of H&S Records		1	LS	$10,000	$10,000
	Construction Surveys and Final Record Drawings		1	LS	$10,000	$10,000
	Preparation of Plans and Schedules					
	Preparation of H&S Plan / Spill and Emission Control Plan		1	LS	$5,000	$5,000
	Preparation of a Sediment and Erosion Control Plan		1	LS	$5,000	$5,000
	Preparation of a General Earthwork Plan		1	LS	$5,000	$5,000
	Preparation of the Construction Schedule		1	LS	$3,000	$3,000
	DNAPL Recovery (A-1)					
	Install Wells (Estimate 24)		1	LS	$204,000	$204,000
	Install Monitoring Wells (Estimate 3)		1	LS	$25,500	$25,500
	Quarterly DNAPL Recovery (1 Year)		4	LS	$2,000	$8,000
	DNAPL Disposal (Annually)		1	LS	$10,000	$10,000
	Enhanced Quarterly DNAPL Recovery (1 Year)		4	LS	$3,000	$12,000
	DNAPL Disposal (Annually)		1	LS	$10,000	$10,000
	Impacted Water Disposal (Annually)		2	LS	$5,000	$10,000
	DNAPL Treatment (A-1)					
	Pilot Test in existing wells (10% full scale)		1	LS	$26,000	$26,000
	Install Additional Wells (Estimate 14)		1	LS	$112,000	$112,000
	In situ Chemical Oxidation Treatment - Year 1		1	LS	$90,000	$90,000
	In situ Chemical Oxidation Treatment - Year 2 (75% year 1)		1	LS	$78,000	$78,000
	In situ Chemical Oxidation Treatment - Year 3 (50% year 1)		1	LS	$58,000	$58,000
	In situ Chem Ox Monitoring (5 times / year)		20	LS	$3,000	$60,000
	Area 1 Regrading					
	Clearing and Grubbing of Area 1		2	Acre	$1,500	$3,000
	Regrading of the Existing Surface		10,000	SY	$2	$20,000
	Design and Oversight					
	Predesign Investigation for Chem Ox Process		1	LS	$30,000	$30,000
	DNAPL Removal Design		1	LS	$20,000	$20,000
	Enhanced DNAPL Removal Design		1	LS	$20,000	$20,000
	In Situ Chemical Oxidation Design		1	LS	$20,000	$20,000
	Long Term Monitoring Program Development		1	LS	$15,000	$15,000
	Preparation of Construction Completion Report		1	LS	$30,000	$30,000
	Groundwater Treatment System (A-4) (Phase 1)					
	Bench Scale (Treatability Testing) for Groundwater		1	LS	$50,000	$50,000
	Subtotal Construction Costs (Phase I)					$990,500

Table 3.3: Feasibility Study Cost Estimate for Alternative 2c.

Feasibility Study Cost Estimate for Alternative 2c:

DNAPL Recovery followed by *In Situ* Chemical Oxidation Treatment, Whole House Water Treatment, Bench-Scale and Pilot Testing of *In Situ* Groundwater Treatment Technologies, Full Scale Implementation of *In Situ* Groundwater Treatment Technology (A-4), Institutional Controls, Groundwater Monitoring

Job No.: 445737 — **PARSONS**

Riverfront Superfund Site OU2 / OU6 — **ESTIMATE WORK SHEET**

Location: New Haven, Missouri

Item	Description	Ref.	Quant.	Unit	Unit Cost	Total
	Groundwater Treatment System (A-4) (Phase 2)					
	Pilot Study (includes well installation)		1	LS	$60,000	$60,000
	Well Installation - Area A-4		1	LS	$310,000	$310,000
	Area A-4 - GW Treatment Wall - Chem Ox (5 years - 100 %)		1	LS	$1,800,000	$1,800,000
	In Situ Chem Ox Monitoring (5 times / year)		25	EA	$3,000	$75,000
	In Situ Chemical Oxidation Design		1	LS	$25,000	$25,000
	Subtotal Construction Costs (Phase II)					$2,270,000
	Subtotal Construction Costs w/ Contingency (5%)					**$3,430,000**
	O&M Costs (30 years, unless noted otherwise)					
	Annual GW Monitoring (40 wells - VOCs)		1	YR	$120,000	$120,000
	Annual Site Inspections and Reporting		1	YR	$30,000	$30,000
	Whole House Water Treatment Unit O&M		1	YR	$50,000	$50,000
	Subtotal O&M Costs (annual)					$200,000
	Subtotal O&M Costs (30 years @ 7%)					**$2,490,000**
	TOTAL REMEDIATION CONSTRUCTION & O & M COSTS				**Total**	**$5,920,000**

NOTES

1 Whole-house water Treatment System (WHWT) is currently operating at JS-14, JS-36, JS-38, and JS-52.

2 O&M Costs for WHWT include periodic replacement of carbon units and quarterly monitoring of the systems

3 Estimated Time Frames

DNAPL Recovery Design - 3 months
DNAPL Recovery Well Installation - 3 months
DNAPL Recovery - 2 years
Pre-Design Investigation for Area A-1 *In Situ* Chemical Oxidation - 3 months (overlap with recovery operation)
Pilot Scale Operation of Area A-1 *In Situ* Chemical Oxidation - 12 months (after DNAPL recovery)
Full Scale Area A-1 *In Situ* Chemical Oxidation System Design - 3 months (after pilot scale test)
Installation of additional wells for Area A-1 *In Situ* Chemical Oxidation - 3 months
Operation of Area A-1 *In Situ* Chemical Oxidation System - 3 years
Pre-Design Investigation for *In Situ* Groundwater Technologies - 3 months (overlap with recovery operation)
Bench Scale Testing of *In Situ* Groundwater Technologies - 12 months (overlap with recovery operation)
Pilot Scale Operation of *In Situ* Groundwater Technology - 12 months
Full Scale *In Situ* Groundwater Technology System Design - 3 months
In Situ Groundwater Technology System Well Installation - 6 months
Operation of *In Situ* Groundwater Technology System - 5 years

4 Bench scale studies would be conducted to determine most effective groundwater remediation technology. Cost is based on *in situ* chemical oxidation

5 Remediation Technology Costs for materials provided by vendor

6 Activation chemicals may vary, resulting in cost variance. Cost is based on best estimate of volume required, to be determined through pre-design Investigation and bench scale testing.

7 *In Situ* Groundwater Technology System would be installed and put in service after treatment at other area is implemented.

8 Present worth of O&M Costs based on 7 % interest rate for a period of 30 years unless noted otherwise.

Table 3.3: Feasibility Study Cost Estimate for Alternative 2c.