WORKPLAN FOR THE REMEDIAL INVESTIGATION OF THE NEW HAVEN PUBLIC WATER SUPPLY SITE, NEW HAVEN, MISSOURI

PREPARED FOR THE

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION VII

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PREPARED BY:
U.S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
MISSOURI DISTRICT

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APPROVED:

_____**James Barks** ____________________________ Date:_______________
District Chief, U.S. Geological Survey, Missouri

_____**Jeff Imes** ____________________________ Date:_______________
EPA-USGS IAG Project Manager, U.S. Geological Survey, Missouri

_____**John Schumacher** ____________________________ Date:_______________
Project Chief, U.S. Geological Survey, Missouri

_____**Shelley Brodie**________________________________ Date:_______________
U.S. EPA Project Manager

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ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

--	incomplete or absent data
<	less than
alt	altitude
Alvm	Alluvium soils
ATD	at time of drilling
bls	below land surface
BW	bedrock well
cc	cubic centimeters
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cis-DCE	cis-1,2-dichloroethene
Cotter	Cotter Dolomite formation
e	estimated
EM	electromagnetic survey
Eminence	Eminence Dolomite formation
ft	foot
fig	figure
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
Gasc	Gasconade Dolomite formation
GC	gas chromatograph
GIS	Geographic Information System
gpm	gallons per minute
HPLC	High Performance Liquid Chromatography water
HRS	Hazardous Ranking System
IAG	Interagency Agreement
MDNR	Missouri Department of Natural Resources
MDOC	Missouri Department of Conservation
MDOH	Missouri Department of Health
mg/kg	milligrams per kilogram
mi	mile
mL	milliliters
MTBE	methyltertiarybutyl ether

ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

MW	Monitoring well
NE	not estimated
NWQL	National Water Quality Laboratory
OU	Operable Units
oz	ounce
PAH	polyaromatic hydrocarbons
PCE	tetrachloroethene
Potosi	Potosi Dolomite formation
ppb	parts per billion
QAPP	Quality Assurance
RA	Risk Assessment
RAC	Response Action Contractor
Rbdx	Roubidoux Sandstone formation
RI	Remedial Investigation
RPM	Remedial Project Manager
SP Cond	specific conductance
SVOC	semi-volatile organic compound
TCE	trichloroethene
TLCP	Toxicity Characteristic Leaching Procedure
trans-DCE	trans-1,2-dichloroethene
TW	temporary alluvial well (alluvial well)
u	unknown
ug/L	micrograms per liter
ug/mg	micrograms per kilogram
uS/cm	microseimens per centimeter at 25 degrees Celsius
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Survey
VC	vinyl chloride
VOC	volatile organic compound
W	public or industrial well
WL	water level

1.0 Introduction

This work plan describes the tasks to be completed for the Remedial Investigation/Feasibility Study (RI/FS) of the Riverfront Site (herein designated the Riverfront RI Site) in New Haven, Missouri. The U. S. Environmental Protection Agency (USEPA) Region VII is conducting this RI/FS under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund). The U. S. Geological Survey (USGS) is the principle investigator and is responsible for conducting all RI tasks excluding the Risk Assessment (RA) and treatability studies (if needed) under interagency agreement DW 1495217301-0. The Missouri Department of Health (MDOH) is responsible for conducting the RA for the USEPA, and a USEPA Response Action Contractor (RAC) will conduct the FS. The overall RI/FS coordinator is Ms. Shelley Brodie, USEPA Region VII Remedial Project Manager (RPM).

1.1 Objectives and Scope

Since 1986, it has been known that two public-water supply wells in the city of New Haven (wells W1 and W2) have been contaminated by the chlorinated solvent tetrachloroethene (PCE). This solvent has been found at several locations in New Haven. The overall objective of this work plan is to describe the planned work tasks to be performed for the completion of the RI and RI report, and to assign responsibilities and document the projected schedule and costs of these tasks. This work plan also describes the environmental setting of the Riverfront RI site, summarizes results of previous investigations, identifies the expected types of wastes present, states the data needs, and presents a general approach to the field investigations designed to fulfill these needs. Specific Field Sampling Plans (FSPs) will be developed later, describing detailed sampling strategies at the various Operable Units (OUs).

The USGS has been designated as the primary investigator for the RI, yet other work tasks may be handled by additional entities, with the USGS participation restricted to minor or no support. Because the work tasks of the Riverfront RI/FS effort are being conducted by various entities and, the iterative nature of the RI/FS process itself, a significant amount of coordination is required for the successful completion of the RI/FS. Each specific RI task and the responsible agency and contact person are listed in the following table (table 1).

Table 1. Remedial Investigation (RI) work tasks

TASK	DESCRIPTION	RESPONSIBLE ENTITY	CONTACT	USGS ROLE
1	Project planning and support	U.S.EPA, USGS, MDOH	Shelley Brodie	Major
2	Community relations	U.S. EPA, USGS, MDNR	U.S. EPA	Minor
3	Field investigations	USGS	John Schumacher	Lead
4	Sample analysis	USGS	John Schumacher	Lead
5	Analytical support and data validation	USGS	Jerri Davis	Lead
6	Data evaluation	USGS	John Schumacher	Lead
7	Risk assessment	MDOH	Pam Holley	None
8	Treatability study/pilot testing	USEPA	RAC	None
9	RI report	USGS (also MDOH, USEPA)	USGS-John Schumacher MDOH	Lead
10	Remedial alternatives screening	USEPA contractor	RAC	None
11	Remedial alternatives evaluation	USEPA contractor	RAC	Minor
12	FS report	USEPA contractor	RAC	None
13	Post RI support	USEPA	Shelley Brodie	Minor
14	Negotiation support	USEPA	Shelley Brodie	Minor
15	Administrative record	USEPA	Shelley Brodie	None
16	Close out	USEPA	Shelley Brodie	Minor

1.2 Report Organization

The PCE contamination exists at more than one facility in proximity to the contaminated city wells, none of which have been identified as the source of contamination to the city wells. As a result, several operable units (OUs) have been designated for this RI and this work plan is organized accordingly. The format of this work plan generally follows that suggested in the CERLCA guidance document (U.S. Environmental Protection Agency, 1988), and is organized into seven sections:

Section 1	Introduction: objectives and scope.
Section 2	Background: problem statement, environmental setting, and previous investigations.
Section 3	Initial Evaluation: operable unit designations, types of wastes, migration pathways, and preliminary identification of response objectives and remedial alternatives.
Section 4	Rationale: overview of data needs and description of approach and proposed field investigation activities.
Section 5	Project Management: discussion of key assumptions and project costs, project schedule, deliverables, and project personnel.
Section 6	References.

2.0 Background

2.1 Problem

There are five deep, high-production wells in New Haven (fig. 1)--four city wells (W1, W2, W3, W4) and one well owned by a local bottling company (hereinafter referred to as the Pepsi well[1]). The completion data for each of these wells are listed in table 2. During 1986 the Missouri Department of Natural Resources (MDNR) began testing public-supply wells for volatile organic compounds (VOCs), and detected the chlorinated solvent PCE in city wells W1 and W2 (Missouri Department of Natural Resources, 1988). Concentrations of PCE in water samples from well W2 increased steadily with time from the initial detection of 28 µg/L (micrograms per liter) to a maximum of 140 µg/L before the well was removed from service in 1993. The concentrations of PCE in water samples from well W1 generally were less than the maximum allowable contamination level than 5 µg/L; however, well W1 is in the Missouri River flood plain, and had a prior history of bacterial contamination attributed to a poor surface casing seal that resulted in its removal from service in 1989. During 1988 and early 1994 two additional city wells (wells W3 and W4) were installed in the southern part of the city (fig. 1) to compensate for the loss of wells W1 and W2. To date, various agencies have sampled city wells W3 or W4, and the Pepsi well (BW-0), and VOCs have not been detected in these wells.

[1] Use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Table 2. Completion data for public and industrial supply wells in New Haven

Description	City Well W1	City Well W2	City Well W3	City Well W4	Pepsi Well
Altitude of land surface (feet above sea level)	500	534	602.5	668	621
Year installed	1939	1963	1988	1994	1965
Total depth (feet bls)	992	1,075	885	982	1,155
Geologic log available	Yes	Yes	No	No	Yes
Casing size (inches)	10	10	12	12	8
Casing depth (feet bls)	153	210	525	560	406
Altitude of bottom of casing (feet above sea level)	347	324	77.5	108	215
Upper most producing formation	Cotter	Cotter	upper Gasc	upper Gasc	Rbdx
Bottom formation	Potosi	Potosi	Eminence	Eminence	Potosi
Yield (gpm)	250	335	506	450	120
Drawdown (feet)	5	17	210	30	--
Pump capacity (gpm)	133	213	400	450	--
Static water level ATD (feet bls)	20	72	105	168	128
Static water altitude ATD (feet above sea level)	480	462	498	500	493
Year removed from service	1989	1993	active	active	standby
Specific capacity (gallons per minute per foot of drawdown)	50	19.7	2.41	15	--

[bls, below land surface; Cotter, Cotter Dolomite; Gasc, Gasconade Dolomite; Rbdx, Roubidoux Formation; Eminence, Eminence Dolomite; Potosi, Potosi Dolomite; gpm, gallons per minute; ATD, at time of drilling; --, no data]

Results of various investigations of the Riverfront RI Site by the MDNR and the USEPA have identified at least four potential sources of chlorinated solvents in New Haven (fig. 2):

1. The Riverfront site[2] – the location of an old manufacturing facility in downtown New Haven, where solvents were used and disposed of on-site

2. The Kellwood site – a manufacturing facility were solvents were disposed of on-site

3. The old city dump – disposal area for large quantities of various industrial wastes and household waste

4. The old dry cleaners

[2] The entire USEPA RI project in New Haven, Missouri is titled 'The Riverfront Site' and is designated herein as the Riverfront RI site. Within this site are four operable units (OUs), one of which is the Riverfront site located in the downtown business district. Any reference to the Riverfront site in this work plan will mean the Riverfront OU site.

The Riverfront site and the old dry cleaners are within 700 ft (feet) of the two contaminated city wells (W1 and W2), with the Kellwood site approximately 1.25 mi (miles) south (but less than 700 ft from city well W3), and the old city dump approximately 1.5 mi southeast (fig. 2). Subsurface soil sampling conducted by the MDNR and USEPA detected large concentrations of PCE in soil samples from the Riverfront site (thousands milligrams per kilogram), the Kellwood site (hundreds of milligrams per kilogram), and the old city dump (less than 1 milligram per kilogram). No soil sampling has been done at the old dry cleaners; however, tree core samples from the site did not contain PCE, whereas tree core samples from the Riverfront site and the old city dump did contain PCE. In addition to the soil contamination at the Riverfront site, results from an Expanded Site Investigation-Remedial Investigation (ESI-RI) indicated large concentrations of PCE (less than 0.1 to 199 ug/L), TCE (trichloroethene; less than 0.1 to 48.8 ug/L), cis-DCE (cis-1,2-dichloroethene; less than 0.1 to 246 ug/L), and VC (vinyl chloride; less than 0.2 to 17.1 ug/L) are in the alluvial aquifer that is beneath the site. PCE has also been detected in a stream about 1,500 ft south of the Riverfront site, and a recent (July 2000) confidential interview with a resident indicated that PCE was disposed in the city sanitary sewer system, and possibly on the land surface, at a residence about 0.5 mi southwest of city well W2.

Because of the uncertainty in the direction of ground-water flow and the detection of PCE in soils at several places in the city of New Haven, the PCE contamination in city wells W1 and W2 has not been attributed to any one particular source. The potential for continued and additional human exposure to the contaminant PCE has warranted the Riverfront RI Site be placed on the National Priorities List (NPL) to receive USEPA Superfund assistance. This listing is attributed to the presence of multiple potential sources (some known and some unknown) of PCE at New Haven. The two main concerns that lead to the listing were the detection of large PCE concentrations in the soil and ground water at the Riverfront site, and the detection of PCE in shallow ground water at the Kellwood site, which is located near city well W3 and several domestic wells.

2.2 Environmental Setting

The city of New Haven (population about 1,600) is located along the southern bank of the Missouri River in Franklin County, about 50 mi west of St. Louis, Missouri (fig. 1). The city is similar in character to other small towns and cities along the Missouri River, with historic late-1800s era homes built along the steep river valley slopes overlooking a downtown business district adjacent to the river. The downtown business district is located within a narrow (less than 600 ft wide) strip of flood plain and consists of several small shops and restaurants, a few homes, and several small old manufacturing facilities. This area is surrounded by a flood protection levee, which is maintained by the United States Army Corp of Engineers. The principle road in New Haven is State Highway 100, which runs along part of an east-west trending ridge about 1 mi south of the Missouri River. The ridge forms a topographic divide between the Missouri River valley to the north and the Boeuf Creek valley to the south (fig. 2). An industrial park (developed in the mid-1970s) containing several large manufacturing facilities, one of which is the Kellwood Company, is located south of this ridge and State Highway 100 (fig. 2). Land use north of the highway, including the downtown area, is mostly residential, and land use outside the city is mostly pasture with some row crops.

2.2.1 Physiographic setting

The Riverfront site is located in the downtown area of New Haven, Missouri, on a narrow strip alluvium within the Missouri River valley (fig. 2). New Haven is located along the northern boundary of the Salem Plateau physiographic subprovince (fig. 1; Fenneman, 1938). The Salem Plateau is characterized by a moderate to rugged terrain of thin soils and narrow steep walled valleys (Imes and others, 1996). Topographic relief is the result of gradual uplift of the Ozark Dome in southern Missouri and erosion of the uplifted rocks by precipitation, runoff, and stream flow (Imes and others, 1996). The relief in the New Haven area is accentuated because of proximity to the Missouri River, which controls the base level for most streams in western and central Missouri. Land surface altitude ranges from a low of 470 ft above sea level at the Missouri River to about 920 ft on a ridge about 3 mi west of the city. In the upland areas of New Haven, loess deposits as much as 15 ft thick overlie the cherty, silty, clay residuum that is characteristic of surficial materials throughout most of the Salem Plateau (Mosby, 1988). Average annual precipitation is about 37 in. (U.S. Department of Commerce, 1990).

2.2.2 Geohydrology

There are two primary aquifers in the New Haven area, the Missouri River alluvial aquifer and the bedrock Ozark aquifer. The Riverfront site is located within the Missouri River floodplain on a narrow (less than 600 ft) strip of alluvium between the river channel and bluffs bordering the southern edge of the river valley. The Missouri River alluvium is composed of silty-clay or clay near the land surface grading downward into coarser-grained sand and gravel near the base. Typically the silt and clay zone is less than 20 ft thick. Using seismic sounding, Emmett and Jeffery (1968) calculated the maximum thickness of the alluvium at about 105 ft near the center of the valley (about 1 mi north of the Riverfront site). However, beneath the Riverfront site the alluvium is about 30 ft thick. The saturated, coarser-grained sediments of the alluvium are a highly productive alluvial aquifer that is used in Missouri for domestic, industrial, and public supply. Specific capacity values of about 65 gallon per ft have been calculated for the more productive areas of this alluvial aquifer (Emmett and Jeffery, 1968). In the immediate vicinity of New Haven, however, the alluvial aquifer is unused.

Bedrock units beneath New Haven are part of the Ozark aquifer. The Ozark aquifer is a thick sequence of water-bearing dolostone, limestone, and sandstone formations ranging in age from Late Cambrian to Middle Devonian (Imes and Emmett, 1994). Although these formations collectively are a regional aquifer, the water-yielding capacity of the individual formations is variable (table 3). Geologic logs from New Haven city wells W1 and W2 and the Pepsi well indicate that the uppermost bedrock units beneath New Haven are the Ordovician age Cotter Dolomite and Jefferson City Dolomite (fig. 3). The thickness of the Cotter Dolomite in the New Haven area varies substantially (87 to 230 ft, table 3) because the formation has been partially eroded. The Cotter and Jefferson City Dolomites contain numerous thin shale and mudstone partings and are less permeable than the underlying formations of the Ozark aquifer (Imes and Emmett, 1994). Most domestic wells in the New Haven area are completed in the Jefferson City Dolomite or the top of the underlying Roubidoux Formation.

Beneath the Cotter and Jefferson City Dolomites, geologic formations in the Ozark aquifer are, in order of increasing age, the Roubidoux Formation, Gasconade Dolomite, Gunter Sandstone Member of the Gasconade Dolomite, Eminence Dolomite, and Potosi Dolomite. The Roubidoux Formation probably is the most widely used formation in the Salem Plateau for domestic supply (Miller and Vandike, 1997). The lithology of the Roubidoux Formation is highly variable and includes sandstone, sandy dolomite, dolostone, mudstone, chert, and cherty dolostone (Thompson, 1991). Although yields from domestic wells open to the Roubidoux Formation average between 15 and 35 gpm (gallons per minute), in areas such as New Haven where the formation is buried several hundred feet, well yields typically are larger (Miller and Vandike, 1997). The Roubidoux Formation beneath New Haven is about 115 ft thick (table 3). The deeper units, especially the Gunter Sandstone Member of the Gasconade Dolomite and the Potosi Dolomite, are target units for high-capacity municipal and industrial wells. Wells open to the Gunter Sandstone Member typically yield 40 to 50 gpm; however, yields from production wells open to this unit just east of New Haven can be as large as several hundred gallons per minute (Miller and Vandike, 1997). New Haven city wells W1, W2 and W4, and the Pepsi well were drilled into the Potosi Dolomite. The Potosi Dolomite is the lowermost geologic unit in the Ozark aquifer, and yields of 200 to 1,000 gpm are not unusual from wells open to this unit. The high yields are thought to be the result of interconnected vugs (small dissolution voids) and solution channels within the formation (Imes and Emmett, 1994). City well W3 was originally drilled into the Potosi Dolomite but because of turbidity problems, the lower part of the well bore was plugged leaving the well open to the Gasconade and Eminence Dolomites. Although not as productive as the underlying Potosi Dolomite, yields from wells open to the Eminence Dolomite range from 75 to 250 gpm (Miller and Vandike, 1997).

Table 3. Geologic units of the Ozark aquifer at New Haven

[gpm, 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]

System	Formation	Thickness (in feet)	General lithology	General hydrologic properties
Ordovician	Cotter Dolomite	87 to 230	Crystalline cherty dolostone with abundant shale partings and ocassional thin sandstone beds.	Adequate for small domestic supply. Yields of 5 to 15 gpm locally.
	Jefferson City Dolomite	150 to 165		
	Roubidoux Formation	110 to 120	Cherty, sandy dolostone. Middle 35 feet is clean sandstone.	Normal yields of 15 to 35 gpm. 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 gpm.
	Gunter Sandstone Member of Gasconade Dolomite	35 to 50	Dolostone with less than 10 percent sand.	Normal yield of 40 to 50 gpm, but 200 to 500 gpm locally.
Cambrian	Eminence Dolomite	145 to 180	Crystalline dolostone with less than 5 percent chert and sand	Yields of 75 to 250 gpm
	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 gpm.

Modified from Miller and Vandike (1997).

2.2.3 Ground-water flow

Ground-water in the Missouri River alluvial aquifer comes from infiltration of precipitation, overbank flooding, or sustained high river stages. A relatively small amount comes from discharge of underlying bedrock aquifers (Emmett and Jeffery, 1968). Water in the alluvial aquifer generally is unconfined, except during wet seasons when the silty-clay cap that extends across much of the floodplain may marginally confine the aquifer. Ground-water discharge mainly occurs by seepage from the alluvium into the river during low river stages. During high river stages flow is reversed and water from the river recharges the alluvium. Under most conditions, flow in the alluvial aquifer is generally towards the river channel and downstream. Water levels from the USGS-installed alluvial monitoring wells (TW-A, TW-B, TW-C, TW-D) and a privately owned hand dug well (TW-E) measured during the ESI-RI indicate that during non-flood stage conditions, the direction of flow in the alluvium at the Riverfront site is to the northeast (fig. 4).

Ground water in the Ozark aquifer is unconfined throughout the Salem Plateau and ground-water flow directions are strongly influenced by regional topography (Imes and Emmett, 1994). Ground-water movement generally is from upland areas between major rivers and streams towards valleys where it discharges as base flow to the streams. The Missouri River and associated alluvial aquifer are regional ground-water discharge areas. Regional ground-water flow within the Ozark aquifer generally is from upland areas more than 60 mi south of New Haven northward towards the Missouri River. Superimposed upon the regional flow system are local, shallower, flow systems influenced by local topography.

As part of USEPA ESI-RI efforts, the USGS conducted an inventory of domestic wells and high-production wells in the New Haven area during the spring of 1999. During the inventory, water-level measurements were made in selected wells within 5 to 6 mi of New Haven on the south side of the Missouri River (fig. 5). Results of the inventory indicate that water levels are the highest along the topographic ridge between the Missouri River and Boeuf Creek and in the uplands south of Boeuf Creek, and are lowest along Boeuf Creek and the Missouri River. The highest water levels (more than 580 ft above sea level) are west of New Haven and several miles south of New Haven (fig. 5). Shallow ground water flows perpendicular to contour lines of equal hydraulic head, or water-level altitude, from topographic highs toward discharge areas along Boeuf Creek and the Missouri River. In the immediate vicinity of New Haven, a shallow ground-water divide is centered along State Highway 100 south of the topographic divide (fig. 5). Shallow ground-water south of this divide flows south, opposite of the regional gradient, toward Boeuf Creek.

It is unlikely that the shallow ground-water divide extends to the base of the Ozark aquifer (more than 1,000 ft below the surface); two separate ground-water flow systems (shallow and deep) probably exist within the Ozark aquifer in the New Haven area. Based on the available data, the boundary between shallow and deep flow systems cannot be determined, but it probably occurs below the Roubidoux Formation. Most domestic wells in the New Haven area are about 400 ft deep, are drilled into the lower part of the Jefferson City Dolomite or upper part of the Roubidoux Formation, and therefore, are open to the shallow flow system. The city and Pepsi wells are much deeper (more than 800 ft deep), have deeper casing, and probably are open predominantly to the deep flow system. City wells W1 and W2 have relatively shallow casing depths (less than 220 ft) and probably are open to both the shallow and deep flow systems.

Along the shallow ground-water divide in southern New Haven, a downward gradient exists between the shallow and deep flow systems. The static water-level altitude in city wells 3 and 4 and the nearby Pepsi well ranged from 493 to 500 ft above sea level when these wells were drilled. The altitude of shallow ground water in this same area during the spring of 1999 was about 525 ft above sea level (fig. 5). Assuming no substantial changes in the water levels during the past few decades, a downward gradient of about 0.05 ft/ft (foot per foot) exists between the Jefferson City/Roubidoux Formation (open interval of most domestic wells) and the lower Gasconade Dolomite through the upper Potosi Dolomite (open interval of city wells W3 and W4) in this area. This downward gradient indicates the potential for shallow ground water, and any contaminants dissolved within it, to move downward into the deep flow system. The magnitude of this downward gradient decreases with increasing distance away from the shallow ground-water divide, and the vertical gradient reverses and becomes upward, as shown by geophysical studies in city well W2, near the Missouri River where the regional flow system dominates. The direction of the gradient between the shallow and deep flow systems is unknown in the vicinity of Boeuf Creek.

2.2.4 Ground-water quality

During the ESI-RI, the USGS collected water-quality samples from domestic wells, municipal and industrial wells, and four alluvial and six bedrock monitoring wells installed during the ESI-RI. Results of the domestic well sampling did not indicate widespread PCE contamination in wells outside the New Haven City limits; however, PCE was detected in one domestic well south (downgradient) of the Kellwood site and a TCE plume was detected on the western edge of the city limits in the vicinity of an old truck stop (fig. 6). Large concentrations of PCE also were detected in alluvial monitoring wells downgradient of the Riverfront site (fig. 7). Results from bedrock monitoring wells indicate the largest PCE concentrations were detected in a well about 800 ft south of city well W2 (fig. 8; BW-02, 310 ug/L PCE). Because well BW-02 is upgradient of city well W2, the detection of large PCE concentration in BW-02 indicate a PCE source south of city well W2 and most likely south (upgradient) of well BW-02. A reconnaissance of seeps, springs, and streams in the vicinity of monitoring well BW-02 indicated the presence of PCE in the 20 to 30 ug/L range in samples from a tributary (hereinafter referred to as the 210 tributary). The main unnamed tributary flowing into the Missouri River along the east side of New Haven was assigned the number 200. Branches of this unnamed tributary were assigned unique 200 series numbers to facilitate their distinction. The PCE concentrations in the 210 tributary were largest near the upstream end of the tributary where flow first begins to appear (fig. 8). This point is about 700 ft south of monitoring well BW-02 and indicates a source of PCE other than the Riverfront site. Concentrations of PCE in the 210 tributary decreased with increasing distance downstream of this point. A monitoring well (BW-03) installed about 200 ft northwest of the old city dump (between the dump and city well W2) contained only small concentrations of PCE (less than 3 ug/L), but perched water at this location contained very large concentrations of ethanol (12,000 ug/L) and ethyl-acetate (3,600 ug/L).

2.3 Previous Investigations

The MDNR began testing of all public-supply wells in Missouri for VOCs during 1986. Results from the first round of sampling indicated the presence of the chlorinated solvent PCE in city wells W1 and W2 (Missouri Department of Natural Resources, 1988). Concentrations of PCE in water samples from well W2 increased steadily with time from the initial detection of 28 μg/L to a maximum of 140 μg/L before the well was removed from service in 1993. Concentrations of PCE in water samples from well W1 generally were less than 5 μg/L. Between 1988 and 1993 the MDNR and USEPA conducted several investigations in the New Haven area. Findings of these studies resulted in a MDNR supervised cleanup of PCE contaminated soils at the Kellwood site and an ESI of the Riverfront Site recommending the site be nominated to the NPL with an HRS (Hazard Ranking System) score of 50 and a score of 100 for ground-water pathway (Jacobs Engineering Group Inc., 1994). At the request of the USEPA, the USGS began conducting ground-water investigations in the New Haven area during 1999. Data from the previous MDNR, USEPA, and USGS investigations were used by the USEPA and MDNR to propose the Riverfront Site be nominated to the NPL in August 2000.

2.3.1 Riverfront Site

The Riverfront Site is located on the northeast corner of the intersection of Front Street and Cottonwood Street in downtown New Haven (fig. 7). Various industries have operated at the site since the 1950s. No buildings are evident at the site on a 1945 aerial photograph, except for one home located in the approximate vicinity of the current (2000) loading dock area. The west one-third of the building (cinder block construction) is visible on a 1958 air photo, and by 1965, the remaining two-thirds (metal construction) of the building had been built.

During September 1987, the MDNR conducted a PA (Preliminary Assessment) of what was then called the New Haven Public Water Supply site (Singleton, 1987). Interviews with employees from area industries indicated several potential sources of the PCE detected in city wells W1 and W2, including the Riverfront site, ARP (American Recreational Products) Metals unit (hereinafter referred to as the Kellwood site), ARP Fabrics Division, Midwest Metal Fabricators, and an old city dump. Both ARP facilities were formerly part of the Kellwood Company, Inc., which commenced operations in New Haven during the 1950s. Kellwood eventually ceased operations in New Haven and sold divisions of its tent and tarp manufacturing facilities to ARP in the 1970s and 1980s. For a short period in the early 1970s, the Kellwood Company owned the Riverfront site. Prior to 1958 a machine shop operated at the Riverfront site (Struckhoff, 1989). From 1958 to 1972 the Riverfront site was owned by NHMC (New Haven Manufacturing Company). Information collected by the USEPA indicates that over time activities at NHMC increasingly focused on the custom swaging and bending of tubing for the Kellwood Company until by the early 1970s, Kellwood was NHMC's sole client. Kellwood purchased all of NHMC around 1972 and within 6 months, because of increased production demands, moved tubing operations to a new facility in southern New Haven, which is now the Kellwood site. Between 1983 and 1987, Riverfront Industries occupied the site and manufactured furniture for nursing homes and hospitals and also may have used PCE in addition to paint solvents. Tenants occupying the facility after Riverfront Industries included TSI (Transportation Specialists Inc.) and Wiser Enterprises. According to MDNR and USEPA records, TSI and Wiser Enterprises Inc. did not use PCE in their operations. However, automotive brake cleaner that is occasionally used by Wiser Enterprises Inc. (16 ounce aerosol cans) does contain PCE. The industries that have operated at the Riverfront site with their potential for PCE usage are summarized in table 4.

Table 4. Summary of industries that have operated at the Riverfront site.

Dates	Industry	Operations	PCE Usage
1947 – 1958	Local Machine Shop	General machinery repair	None
1958-1975	New Haven Manufacturing Company	Tube swaging and cleaning	Yes
1983 –1989?	Riverfront Industries	Furniture manufacturing and painting	Possible solvent use (PCE or TCE) in painting operations
1989-1993	Transportation Specialists Inc. (TSI)	Truck spring fabrication	None
1997-2000	Wiser Enterprises	Boat and automobile repair	Occasional use as aerosol brake cleaner

During 1988 and 1989, the MDNR collected a total of four soil samples from the Riverfront site (Missouri Department of Natural Resources 1988 and1989). Results of the sampling detected PCE in all three soil samples at concentrations of 6.1, 41, 72 and greater than 6,500 ug/kg (micrograms per kilogram). A sample also was collected from several drums stored at the facility and analyzed for metals, VOCs, and flashpoint; however, the VOC analysis was not reported. The sample did not contain detectable metals and had a low flash point (21 degrees Celsius) indicating the presence of a volatile, flammable, organic solvent. According to the NIOSH (Montgomery, 1991) PCE is a non-combustible solvent; therefore, the low flash point of the sample suggests it was not PCE.

During 1999, the USGS conducted investigations in the New Haven area as part of an ESI/RI. These investigations included a well inventory in the New Haven area, the collection of core samples from trees growing near the Riverfront site and the old city dump, sampling seeps at the old city dump, and the installation of alluvial monitoring wells. A water sample collected during the well inventory from a hand dug well immediately north of the Riverfront site contained large concentrations of PCE (168 ug/L). Headspace analysis of the tree core samples indicated the presence of PCE in tree core samples at the Riverfront site, with the largest concentrations along the north property line near the middle of the site (fig. 9). Analytical data from the four alluvial monitoring wells (TW-A, TW-B, TW-C, TW-D) installed at or adjacent to the Riverfront site indicated large concentrations of PCE (199 ug/L) in well TW-C near the northeast corner of the Riverfront building. Water levels from the wells indicate that flow in the alluvial aquifer at the site is northeast toward the Missouri Department of Conservation (MDOC) boat ramp, on the

Missouri River. A sample from the upgradient alluvial well (TW-A) did not contain PCE or other VOCs.

During the ESI-RI, the USGS also installed five bedrock monitoring wells in New Haven (spring 2000). Two of the wells (BW-01, 385 ft deep and BW-01A, 130 ft deep) are located between the Riverfront site and city well W2, and two (BW-02, 465 ft deep, and BW-02A, 140 ft deep) are located about 800 ft south of city well W2. A fifth well (BW-03, 230 ft deep) is located about 200 ft northwest of the old city dump (fig. 10). Analytical data from these wells indicate PCE concentrations in the bedrock south of city well W2 (0 to 310 ug/L) are much larger than those in the bedrock between the Riverfront site and city well W2 (about 20 ug/L). Ground-water flow in the bedrock near city well W2 is generally north toward the Missouri River, and the detection of large PCE concentrations south of city well W2 indicate a source of PCE other than the Riverfront site. No PCE was detected in samples from well BW-03 near the old city dump.

During June 2000, while sampling the alluvial and bedrock monitoring wells, the USGS detected large concentrations of PCE (21 to 2,200 ug/L) in faucets supplied by a polyethylene water line running along the south side of the Riverfront building. The USEPA conducted a time-critical removal action to replace the water line with a steel line and remove near surface (less than 8 ft deep), PCE contaminated soils. Results of geoprobe borings, backhoe pits, and additional tree core analysis made during the removal action indicated that soils south of the Riverfront building contained large (tens to hundreds of thousands of parts per billion) PCE concentrations. Results of these analyses will be provided later in an addendum to this document.

2.3.2 Kellwood Site

The Kellwood site is located at 202 Industrial Drive in southern New Haven. This site consists of an industrial building currently owned by Metalcraft Inc. and a 1-acre vacant lot owned by the city of New Haven immediately north of the Metalcraft building (fig. 11). The Kellwood site was identified as a potential source of PCE contamination to city wells W1 and W2 during the PA conducted during 1987 (Singleton, 1987). Interviews with current and former employees indicated that during 1972, metal operations formerly housed at the Riverfront site were moved to a new facility on Industrial Drive (Kellwood site), and that the both facilities used PCE (Singleton, 1987; Mosby, 1988; Bobbit, 1992). In addition to transferring operations from the Riverfront Site, a tube mill was installed at the new facility that also used PCE. Apparently, 5 gal (gallon) buckets of waste PCE were routinely dumped on the north side of the site between 1972 and about 1984 (Struckhoff, 1989). Interviews indicate that the practice of disposing waste solvent on the ground north of the building ceased when PCE was detected in the city wells by the MDNR (Bobbit, 1992). Large concentrations of PCE (13,000 ug/kg) and TCE (6,500 ug/kg) were detected in a composite soil sample collected along the north side of the Metalcraft building (Missouri Department of Natural Resources, 1989). The contamination extended to bedrock (auger refusal) that was encountered at a depth of about 5 ft (Geotechnology, 1991). During 1994, the Kellwood Company and MDNR entered into an agreement for remediation of PCE and TCE contaminated soils at the site. As part of this agreement the Kellwood Company removed about 80 cubic yards of soils containing more than 380 mg/kg PCE and 280 mg/kg TCE. In September 1994, land farming was initiated to reduce the residual soil contamination to less than 1 mg/kg PCE and TCE via volatilization. As part of this cleanup, a french drain and three shallow (less than 60 ft deep) monitoring wells were installed. Cleanup goals for soils at the site were set at 1 mg/kg in an agreement between the Kellwood Company and the MDNR. In 1999, the cleanup goal for soils was met; however, small concentrations of PCE continue to be detected in water samples from the french drain system.

During 1999, five temporary monitoring wells (5.0 to 61 ft deep) were installed by a third party at the Kellwood site and nearby facilities owned by Metalcraft Inc. as part of a potential property transaction. Data obtained through a USEPA 104(e) information request letter indicates large concentrations of PCE (up to 4,000 ug/kg) were present in the temporary monitoring wells downgradient (southwest) of the Kellwood cleanup site. The contaminated wells were between the Kellwood site and the well JS-14, a domestic well identified during the ESI-RI well inventory as containing PCE (fig. 10).

2.3.3 Old City Dump

The old city dump was used as a community dump for domestic and industrial wastes from the mid-1950s to 1972, when the dump was closed. An inspection of the site during September 1989 indicated the presence of paint wastes and dozens of old drums. A composite soil sample (0 to 7 ft deep) collected down slope of the dump had an organic solvent odor and contained 150 ug/kg of PCE (Coen, 1989). Interviews with a number of citizens indicated that hundreds of drums of industrial wastes from the Kellwood Fabrics Division were disposed of in the dump. Interviews also indicate that liquid contents of the drums were burned in a pit and that the smoke from the fire could be seen for miles. Because the dump is located more than 1 mi southeast of city wells W1 and W2, the MDNR did not consider the dump a likely source of the PCE contamination in the city wells, and no further investigations were done at the site.

During the ESI-RI, the USGS collected core samples from trees on the north and east sides of the dump and sampled two seeps along the north face of the dump. One tree core from the east side of the dump contained a small concentration of PCE (less than 1 ug/L), and a seep on the north side of the dump contained a trace amount of PCE (0.11 ug/L).

2.3.4 East New Haven area

The 250-acre East New Haven Area encompasses the area bounded on the north by Orchard Street, on the west generally by Miller Street, on the south by State Highway 100, and on the east by the 200 tributary (fig. 8). The area is mostly overgrown pasture with thick woods on steep slopes. A reconnaissance and preliminary investigation of the area was initiated during ESI-RI efforts after the detection of large PCE concentrations (more than 300 ug/L) during the drilling of bedrock monitoring well BW-02. Monitoring well BW-02 was intended to be an upgradient monitoring well from the Riverfront site and city well W2, and PCE was not expected to be detected. The detection of PCE deep within the bedrock strongly indicates a PCE contamination source further upgradient to the south. Because of the detection of PCE in monitoring well BW-02, a reconnaissance of seeps, springs, and streams was conducted in the area south of BW-02. Results of this reconnaissance indicate the presence of PCE in a tributary (210 tributary) that flows northeastward from Miller Street (fig. 8). Samples collected at various intervals along this tributary indicated PCE concentrations were less than detection limits in the uppermost parts of the tributary. Concentrations of PCE (20.7 ug/L) were detected in the vicinity of an old barn along the middle reach of the tributary (fig. 8), and decreased to less than detection in the lower reaches of the tributary. PCE also was detected in a sample from a creek south of the old city dump (estimated concentration of 44 ug/L). An old truck body, rusted drums, and debris were present in the creek bank immediately upstream of this sample location. A sample from the creek about 200 yards upstream did not contain PCE, suggesting the source of the PCE may be drums and debris observed in the creek bank upstream of the sampling point.

3.0 Initial Evaluation

3.1 Operable Unit Designations

Results of previous studies have indicated PCE contaminated soils and shallow ground water at two facilities in New Haven --the Riverfront site and the Kellwood site. Trace concentrations of PCE were detected in soils at the old city dump (Coen, 1989) and in a seep at the city dump sampled by the USGS during the ESI-RI. In addition, PCE has recently (2000) been detected in a bedrock monitoring well south of city well W2 (BW-02) and a small tributary (210 tributary) south of this monitoring well, indicating a source of PCE south of city well W2.

Four OUs have been identified for the Riverfront RI Site: (1) the Riverfront site in downtown New Haven, OU-1; (2) the Kellwood site on Industrial Drive in southern New Haven, OU-2; (3) the old city dump in eastern New Haven, OU-3; and (4) the undeveloped area south and east of monitoring well BW-02, hereinafter referred to as East New Haven, OU-4. OU-1, OU-2, and OU-3 were designated because they are geographically disconnected, have different histories of industrial use and waste disposal activities, and potentially have different receptors and contaminant migration paths. OU-4 (East New Haven) was designated because of an apparent unidentified PCE source upgradient of city well W2 and monitoring well BW-02. A summary of the OUs is given in table 5.

Table 5. Summary of Operable Units designated for the Remedial Investigation.

Operable Unit Number	Name	Approximate area of investigation	Contamination summary
1	Riverfront site	2 acres	- Known PCE in soils above MDOH guidelines - PCE, TCE, vinyl chloride above MCL in ground water - Proximity to contaminated city wells W1 and W2 (600 ft)
2	Kellwood site	20 acres (primary site is about 7 acres)	- Previously contaminated soils remediated to less than 1 mg/kg PCE - PCE above MCL in shallow ground water - PCE in nearby domestic well - Proximity to city well W3 (700 ft)
3	Old city dump	3 acres	- Trace levels of PCE in soils and ground water - History of heavy use by various industries
4	East New Haven	300 acres	- Unknown PCE source or extent - PCE above MCL in bedrock and surface water - Upgradient of city well W2. - Possible PCE dumping in nearby sanitary sewer

3.2 Riverfront Site (OU-1)

3.2.1 Types and volumes of wastes present

Interviews conducted by the MDNR and USEPA indicate that industrial activities that occurred at the Riverfront site include metal fabrication, furniture assembly and painting, metal tempering, and automotive repair. Given the types of industrial uses at the facility, the types of waste expected include scrap metal and metal shavings (aluminum and steel), chlorinated solvents (used to degrease metals), paints and paint solvents, and hydrocarbons (fuels and oils).

Analysis of several samples collected during the USEPA water-line removal activities detected primarily chlorinated solvents (PCE and TCE) with smaller concentrations of SVOCs (semi-volatile organic compounds), PAHs (polyaromatic hydrocarbons), organochlorine pesticides, and small concentrations of metals (table 6). Analysis of water from alluvial monitoring wells indicate the presence of various VOCs (maximum concentrations in parentheses) including: PCE (376 ug/L). TCE (174 ug/L), 1,1-DCE (1,1-dichloroethene; 0.41 ug/L), cis-DCE (246 ug/L), trans-DCE (trans-1,2-dichloroethene; 21.4 ug/L), VC (17.1 ug/L), MTBE (methyltertiarybutyl ether; 4.39 ug/L), toluene, xylenes, and various tri- and tetra-methyl benzenes.

Table 6. Concentrations of selected inorganic and organic compounds in soil and ground-water samples collected during water-line removal activities at the Riverfront site (laboratory data).

[ug/kg, micrograms per kilogram; ug/L, micrograms per liter; <, less than; mg/kg, milligrams per kilogram; ND, no detection; --, no data]

Compound or class	Soil samples (range in micrograms per kilogram)	Ground-water Samples (range in micrograms per liter)
PCE	<6.2 – 190,000 [a]	<0.1 - 376
TCE	<6.2 – 170,000	< 0.1 –174
DCE (total)	<6.2 – 45,000	<0.1 - 246
VC	<6.2 - 410	<0.1 – 17.1
Total Semivolatile organic compounds	<10 – 1,137	--
4,4'-DDD	<2.1 - 690	--
4,4'-DDE	<2.1 - 200	--
4.4'-DDT	<2.1 - 120	--
PCBs	ND	--
Arsenic (mg/kg)	2.7 – 8.5	--
Antimony (mg/kg)	<1.2	--
Cadmium (mg/kg)	<.62 – 1.0	--
Chromium (mg/kg)	8.6 – 18.1	--
Mercury (mg/kg)	<0.01 – 0.12	
Lead (mg/kg)	8.1 - 615	
Molybdenum (mg/kg)	<2.5	--
Nickel (mg/kg)	9.3 – 18.0	--
Silver (mg/kg)	<1.2	
Zinc (mg/kg)	72.7 - 512	

[a] Maximum concentration detected by field gas chromatography was 1,000,000 ug/kg.

The volumes of hazardous materials used and disposed at the facility are unknown and the volume of contaminated media (soils and ground water) is only approximately known. Results of MDNR and USPA investigations, including ESI-RI activities and the water-line removal action indicate substantial PCE contamination of surface and subsurface soils along the south side of the Riverfront building. The contamination extends under the asphalt of Front Street (fig. 7). Analysis of core samples from trees growing along the northern boundary of the Riverfront site showed trees near the north-central part of the site (along the building) to contain PCE, indicating subsurface soil and/or ground-water contamination in this area. The aerial extent of PCE contamination in soils (excluding the building footprint) is limited to about 6,000 ft^2 (square feet). The extent of PCE contamination greater than 700 ug/kg is probably much smaller, perhaps in the range of 1,500 ft^2.

Data from the existing alluvial monitoring wells are sufficient to bound the extent of PCE contamination in the alluvial aquifer except on the west and downgradient to the northeast (fig. 7). Assuming a plume of PCE contaminated ground water extends to the Missouri River, the extent of PCE contamination in the alluvial aquifer is about 180,000 ft^2 (fig. 7). The vertical distribution of PCE in the alluvial aquifer is unknown, but given the sand and gravel nature of the saturated sediments, the entire thickness of the alluvial aquifer may be contaminated. Assuming an average saturated thickness of about 20 ft, the volume of PCE contamination in the alluvial aquifer is about 3,600,000 ft^3. Small concentrations of PCE have been detected in the bedrock aquifer immediately upgradient of the Riverfront site. An upward gradient exists between the bedrock and alluvium beneath the Riverfront site indicating ground-water discharge into the alluvium from the bedrock. Because PCE has also been detected further upgradient in the bedrock at city well W2, monitoring well BW-02, and a tributary nearly 1,500 ft upgradient and topographically higher than the Riverfront site, it is likely that a bedrock PCE plume is emanating from another source upgradient of the Riverfront site.

3.2.2 Potential contaminant migration pathways and impacts

A conceptual model for contaminant migration and exposures has been developed (Attachment A). The likely migration pathways for a dense non-aqueous phased liquid (DNAPL) are percolation (resulting from land surface disposal) and sorption onto fine-grained organic carbon-rich sediments in the upper 5 to 15 ft of the alluvium. Downward movement of a DNAPL would continue unimpeded to the alluvium-bedrock interface where lateral transport would then dominate. The bedrock surface beneath the alluvium generally slopes toward the Missouri River and would probably direct movement of a DNAPL towards the north/northeast. Given the huge volume of water in the Missouri River, it is unlikely that measurable impacts to the River ecosystem or riverbed sediments exist.

3.2.3 Identification of remedial investigation objectives and remedial alternatives

Primary remedial investigation objectives at the Riverfront site focus on determining the extent and magnitude of the PCE and other VOC contamination in the soils and ground water. Specific objectives will determine if: (1) contaminated soils at the site present an exposure risk by contact or volatile emissions, (2) a DNAPL is present beneath the site in the alluvial sediments, (3) if PCE migrating in ground water from the site presents unacceptable risks to the Missouri River or the underlying bedrock aquifer, and (4) if the site contributed to the PCE detected in closed city wells W1 and W2.

Remedial alternatives may include excavation and removal of highly contaminated near-surface soils outside the building footprint. Depths of excavations are restricted to 8 ft because of the proximity to a flood protection levee. Deeper soils and sediments may be remediated using SVE (soil-vapor extraction) technology, although application of the technology may be limited by the permeability of silts and high water contents of the sediments. Potentially contaminated soils beneath the building represent a significant challenge. Removal of these soils would require partial to complete demolition of the existing building, and thus would have to pose a significant risk to human health to warrant their removal. Alternative technologies, primarily soil-venting or SVE, may be applicable to these soils.

3.3 Kellwood Site

3.3.1 Types and volumes of wastes present

The Kellwood site consists of a manufacturing building (about 60,000 ft^2) currently owned by Metalcraft Inc., and a 1-acre vacant gravel-covered lot north of the building owned by the city (fig. 11). PCE was used as a cleaning solvent for metal cutting and metal tubing fabrication processes and disposed on the ground north of the building (Struckhoff, 1989).

Because of previous remedial activities at the site, PCE contamination in soils at the site has apparently been reduced to less than 1 mg/kg. Soils at the site are thin, averaging less than 5 ft thick. Assuming a 120 by 120 ft area 5 ft thick containing an average of 0.5 mg/kg PCE and density of about 100 lbs(pounds) per cubic foot, less than 2 kg (kilogram)of PCE remains in soils at the site. The amount of PCE removed from the site is estimated to have been at least 38 kg (assuming an average PCE concentration of at least 380 mg/kg in 225,560 lbs of soil removed). No information exists on the presence of PCE in the bedrock beneath the thin soils at the site; however, the detection of PCE in samples from the 1999 temporary monitoring wells (less than 0.01 to 2,200 ug/L) installed near the land farm area indicate PCE has migrated into the underlying bedrock. The depth to which PCE has penetrated into the bedrock is not known because monitoring wells at the site are less than 65 ft deep. The lack of PCE detection in 1999 temporary monitoring wells MW-1, MW-3, MW-5, monitoring wells MW-101, MW-102, MW-103, and domestic well JS-27, and detection of PCE in domestic well JS-14 (fig.11) suggests that PCE is migrating toward the southwest in the shallow ground water.

3.3.2 Potential contaminant migration pathways and impacts

Monitoring data indicate that PCE has migrated into the bedrock aquifer beneath the Kellwood site. Based on the mode of waste disposal on the thin soils at the site (dumping a waste solvent on the land surface), it is likely that PCE has migrated into the bedrock beneath the site as a DNAPL. Because of the relatively low vertical permeability of the Cotter and Jefferson City Dolomites (Miller and Vandyke, 1997), lateral movement of thin zones of DNAPL along bedding planes and fractures in the bedrock is likely. The regional dip of rocks in the area is to the north and northwest; however, local dips and fracture orientations may vary considerably. If a DNAPL phase exists at the site, it poses a risk to city well W3, especially if it migrates vertically into a more permeable zone that is influenced by the pumping of the city well.

Data from the temporary monitoring wells and the ESI-RI well inventory indicate that a plume of dissolved PCE is present in the shallow bedrock aquifer. Samples from monitoring wells MW-2, MW-2A, MW-4, and domestic well JS-14 contained PCE (fig. 11). The dissolved PCE appears to be migrating down the shallow ground-water flow gradient toward the southwest. Several additional domestic wells are located south and southwest of the site and may already or could be impacted by PCE migrating from the site.

3.3.3 Identification of remedial investigation objectives and remedial alternatives

The initial remedial investigation objective at the Kellwood site focuses on determining the vertical extent of PCE contamination in the bedrock. One or more monitoring wells need to be installed at the site. One or more of these wells needs to extend into the Roubidoux Formation downgradient of the site and between the site and city well W3.

Depending on the extent and type of contamination (DNAPL or dissolved plume), a wide range of remedial alternatives may be considered. The shallow bedrock aquifer in the area is aerobic and probably contains small quantities of organic matter; therefore, substantial reductive dechlorination of PCE is not expected. The application of pump and treat methods is marginal because of the limited permeability of the Cotter and Jefferson City Dolomites. Pump and treat may be applicable in the Roubidoux Formation, which has much higher permeabilities. Vapor extraction technologies may be considered for near surface contamination or treatment of DNAPL "hot spots."

3.4 Old City Dump

3.4.1 Types and volumes of wastes present

The old city dump was used as a community dump for domestic and industrial wastes from the mid-1950s to 1972, when the dump was closed. An inspection of the site during September 1989 indicated the presence of paint wastes and dozens of old drums. A composite soil sample (0 to 7 ft deep) from immediately down slope of the dump had an organic solvent odor and contained a PCE concentration of 150 ug/kg (Coen, 1989). Interviews with several citizens indicate that hundreds of drums of industrial wastes from the Kellwood Fabrics Division were disposed of in the dump. Interviews also indicate that liquid contents of the drums were burned in a pit and that the smoke from the fire could be seen for miles. During June 2000, several hundred drums of industrial wastes were discovered on a farm about 0.75-mi south of the old city dump. Several former employees identified samples of debris, stained soil, and residues from this dump as mineral spirits and dye wastes from the Hawthorne/Kellwood Fabrics Division plant. Analytical data collected from the drums indicated large concentrations of xylenes, naphthalene, Pb (lead), Cr (chromium), and Ba (barium). No PCE or other chlorinated solvents were detected in the drum wastes, which is consistent with MDNR and USEPA interview results that indicated the Kellwood Fabrics Division did not use chlorinated solvents.

The 1.5-acre old city dump is about 320 wide and 200 ft deep (north-south). The dump is located in a steep-sided ravine, and the north face of the dump is more than 30 ft high. Assuming the dump has a triangular cross section with a base of 160 ft and width of 300 ft, the total volume of the dump is about 27,000 yd^3 (cubic yards). Former employees have indicated that from the 1950s to about 1972, the Hawthorne/Kellwood Fabrics Division placed a dozen or so 55-gallon drums of waste in the dump each week. These drums were mixtures of solids and liquid wastes. Large concentrations of ethanol (120,000 ug/L) and ethyl acetate (3,600 ug/L) were detected in water samples during the installation of a monitoring well (BW-03) northwest of the dump (fig. 10). Among the various industrial uses listed for ethyl acetate is textile cleaning (Merck, 1989).

3.4.2 Potential contaminant migration pathways and impacts

Refuse at the old city dump has been covered by as much as 10 ft of demolition debris, yard wastes, and fill. Because it is currently covered, airborne erosion of contaminated materials or sediments from the site is probably negligible. The primary migration pathways are percolation and infiltration into the underlying bedrock beneath the dump and seepage from the dump face and subsequent transport to surface-water bodies. Ground-water flow at the site is northeast towards the Missouri River (fig. 6). Land use downgradient of the old city dump is predominately rural with a small industrial tract immediately east of the dump. There are four homes with domestic wells downgradient of the dump, the closest of which is about 3,500 ft from the dump. There are also two perennial springs in the vicinity of the dump, one about 3,000 ft to the northeast and one about 2,000 ft to the northwest. Screening samples (analyzed by a field GC) collected from these springs during 1999 did not contain detectable PCE or other VOCs. It is unlikely that contaminants migrating from the dump are, or would, affect the New Haven public-water supply. Contaminants migrating from the dump would likely impact either of the vicinity springs before affecting domestic wells further downgradient.

3.4.3 Identification of remedial investigation objectives and remedial alternatives

The initial remedial investigation objective at the old city dump focuses on determining if PCE or other chlorinated solvents are migrating into the underlying bedrock aquifer northeast of the site. Samples from monitoring well BW-03 (northwest of the dump) did not contain detectable concentrations of PCE or other VOCs; however, contaminants migrating from the dump may be moving to the northeast. A secondary objective is to determine if PCE is migrating in the vadose zone along the soil/bedrock contact along the steep drainage north of the site.

Remedial alternatives at the dump are dependent upon results of additional site characterization. Capping of the dump is a readily achievable non-invasive alternative. Although construction of a low permeability cap would reduce infiltration and leachate production, if sufficient quantities of PCE were placed in the dump to present a risk to domestic water supplies more than 3,000 ft downgradient, the PCE probably would be present as a DNAPL phase and its movement would not be greatly affected by capping the site. Because of the large volume and thickness of wastes in the dump, and the mixed nature of the wastes, removal of contaminated material is likely to be more hazardous than leaving them in place.

3.5 East New Haven

3.5.1 Types and volumes of wastes present

The detection of PCE in bedrock monitoring well BW-02 and the 210 tributary indicate the disposal of PCE containing wastes in this area. The location and quantity of the waste is unknown. The presence of PCE in the 210 tributary suggests that the PCE source is nearby.

3.5.2 Potential contaminant migration pathways and impacts

The detection of PCE in the 280 to 465 ft deep interval in bedrock monitoring well BW-02 indicates that PCE has migrated vertically through more than 200 ft of relatively low permeability bedrock of the Cotter and Jefferson City Dolomites. The MDNR has suggested that PCE may be migrating deep into the bedrock through an improperly abandoned well. However, the detection of PCE in the 210 tributary at an altitude above the water table suggests that the PCE is migrating in perched water from a nearby source. It is not known if the source of PCE in the 210 tributary is related to the source of PCE detected in monitoring well BW-02.

Impacts of the unknown PCE source(s) on ground-water resources are potentially large. Except for shallow monitoring wells adjacent to the Kellwood site, monitoring well BW-02 contains the largest PCE concentrations (290 ug/L) detected in ground-water in New Haven. Because monitoring well BW-02 is upgradient of the contaminated city well W2, it is likely that whatever source resulted in the contamination at BW-02 is contributing to the contamination detected in city well W2. This connection would imply a groundwater plume at least 1,500 ft in length (from downtown New Haven to BW-02).

Concentrations of PCE in the 210 tributary are above the MCL of 5 ug/L; however, they decrease to less than 1 ug/L several hundred feet downstream due to volatilization. The East New Haven area is predominately undeveloped land; however, given that the land is within the city limits and close to the downtown area and established subdivisions, development in the area is likely to occur. It is possible that activities associated with future land use in the area could expose buried PCE wastes allowing workers or residents to come into contact with PCE contaminated soils.

3.5.3 Identification of remedial investigation objectives and remedial alternatives

The primary response objective for the East New Haven area is to determine the source of the PCE contamination detected in monitoring well BW-02 and the 210 tributary. A thorough characterization of the extent and magnitude of the PCE is needed but cannot be done until the source is identified. Interviews with several citizens indicate that dumping of waste PCE may have occurred in a ravine south of monitoring well BW-02. Another potential source is the apparent disposable of PCE in the sanitary sewer system in the vicinity of Miller Street and Maiden Lane (fig. 8). Until a source area can be identified, remedial alternatives cannot be evaluated; however, the most likely remedial alternative is source removal, providing the source can be located.

4.0 Project Rationale and Approach

Several areas of known PCE contamination in soils or ground-water exist within New Haven; however, none of these sources have been unequivocally linked to the PCE contamination detected in city well W1 and W2. Because the successful remediation of ground-water contamination depends upon determining the contaminant source, a significant part of the RI effort is directed towards determining the source(s) of PCE contamination. The work plan was segregated into four separate OUs to more clearly identify the specific DQOs (Data Quality Objectives) in each proposed area of investigation and facilitate the management of field tasks. This approach is essential given the widely scattered nature of the sites, unknown mechanism of transport into the closed city wells, and unknown source and extent of ground-water contamination in New Haven. The entire project will be managed in phases of essentially 4 months in length. A phased approach will allow collected data to be evaluated and drive decisions made in subsequent phases saving time and costs. A summary of decision statements, decision rules, and data gaps is given in table (attachment B).

4.1 DQO Needs

In general, two types of data are to be collected during the project: (1) field screening data using portable gas chromatography, and (2) analytical-specific rigorous laboratory analyses. Generic field screening methods, such as total VOC analyzers are not anticipated to be used in this investigation. In general, field-screening data will be used to identify the possible presence and extent of contamination in soils, surface-water, or ground-water. Screening data also will be used to indicate health and safety measures required for specific work tasks. Field screening data will be verified by the submission of a subset of samples for rigorous laboratory analyses. Laboratory data will primarily be used as defensible data for risk assessment calculations and legal issues. Laboratory analysis of VOCs in water samples will be done by the USGS National Water-Quality Laboratory in Lakewood, Colorado using USGS published method 4054. Method 4054 is a modification of the USEPA GC-MS method 524.2. Laboratory analyses of VOCs in soil and other solid matrices will be done by a USGS contract laboratory using EPA methods (such as 8260).

Data needs for the four OUs vary and are dependent on the amount and quality of existing data, physical nature of the site, contaminant source, potential receptors, and probable migration pathways, among others. (Attachment B).

4.2 Approach

4.2.1 Riverfront Site

Sufficient data has been collected at the Riverfront site to establish that PCE contamination in soils is above the health limits of 700 mg/kg for surface soils. Concentrations of PCE, TCE, and VC in ground-water samples from the site have been detected above the USEPA drinking water MCL and above the MDNR limits for ground water. The investigative approach at the Riverfront site focuses on determining the extent and magnitude of soil and ground-water contamination and providing sufficient data required to complete a human-health and ecological risk assessment. The primary media to be sampled are soils (surface and subsurface), ground water (alluvial and bedrock aquifer), surface water (Missouri River), and stream-bed sediments (Missouri River bed sediment).

4.2.1.1 Soils

A substantial amount of field screening and laboratory data was collected during the water-line removal action for soils less than 8 ft deep at the site. This data was collected on a fixed 20 ft grid and indicated that most PCE contamination is limited to the south side and southeast corner of the building (fig. 7). Additional data is needed along the north and east sides of the Riverfront building and beneath the building slab.

The current footprint of the Riverfront building is the result of at least five expansion efforts. Cinder block walls identify the original, pre-1960s building. Samples from beneath the building slab will be biased towards sampling outside of the pre-1960 building footprint, assuming waste solvent was dumped outside the original building. Random sampling also will be conducted throughout the metal part of the building, focused in the areas of expansion joints, drains, and interior walls. About 10 to 15 surface and 10 to 15 subsurface soil samples will be collected and submitted for laboratory analysis of VOCs, metals, pesticides, and SVOCs to provide sufficient data for risk assessment calculations. The specific numbers of samples collected for laboratory analysis will depend on the results of field screening by the field GC, needs of the risk-assessment team, and best professional judgment and will be identified in a FSP (Field Sampling Plan) specific to the Riverfront site.

4.2.1.2 Ground water

A moderate amount of ground-water data exists for the site; however, additional characterization of the spatial and temporal distribution of PCE and its degradation products in the alluvial and bedrock aquifers is needed. Two additional alluvial monitoring wells (one west of the site and one northeast of the site near the Missouri River) will be installed during phase I activities. The new and existing alluvial wells will be sampled five to six times during the project beginning in November 2000. Sampling will be conducted at various stages of the Missouri River to provide information on the relation between river stage, ground-water levels and flow directions, and PCE concentrations. In addition, to determine if a DNAPL phase is present within the alluvium, several drive-point wells may be installed along the south and north sides of the building. A bedrock monitoring well nested with alluvial well TW-C (fig. 7) may be installed during phase II or phase III dependent upon data from the alluvial well and drive-point sampling.

4.2.1.3 Missouri River

Release of PCE from the site to the Missouri River can occur through runoff from the site or ground-water discharge to the river. Contaminated sediments and runoff can enter the river through a storm water drop box located at the northeast corner of the Riverfront building. This drop box discharges into a 60-in concrete storm main that runs north to the Missouri River. Bed sediments in the river upstream and downstream of this storm main outfall will be sampled during low-base flow conditions of the river.

Under non-flood conditions, ground water in the alluvium beneath the Riverfront site flows to the northeast and discharges into the Missouri River in the vicinity of the MDOC boat ramp. Water samples will be collected from near the bank of the river using a submersible pump suspended just above the sediment-water interface upstream and downstream of the boat ramp, and at locations where riverbed sediment samples are be collected.

4.2.1.4 City Water Distribution System

During the late 1980s, the MDNR sampled a number of taps at private residences and businesses within the city of New Haven to determine the extent of PCE contamination in the distribution system. Results of this sampling indicated that PCE contamination existed throughout the distribution system--mostly the result of contaminated water being pumped by well W2. Well W2 was removed from service in 1993 and samples from the new wells (W3 and W4) have not contained PCE. However, because of the recent contamination detected and remediated in a plastic water line near the Riverfront site, the concern exists that other unknown sources of PCE contamination in proximity to water lines might result in localized contamination in the distribution system. Therefore, to confirm that the distribution system is free of PCE contamination, a number of taps from residences and businesses on the city water supply system will be sampled and screened for the presence of PCE. In addition, several samples from taps previously sampled by the MDNR (such as a preschool, car wash, and residences on Mary Hammock, and Locust Street) will be submitted for laboratory analysis of VOCs.

4.2.2 Kellwood Site

The investigative approach at the Kellwood site is to determine the general extent of PCE contamination in the bedrock and its direction of migration. The data objective is not a detailed characterization of the extent and magnitude of contamination but to provide data of adequate quality to assess the potential risk to city well W3 and nearby domestic wells. Because city well W3 is cased 535 ft deep through the low permeability Cotter and Jefferson City Dolomites, the primary risk to city well W3 is through vertical migration of a DNAPL phase.

4.2.2.1 Soils

Because a large number of soil samples have previously been analyzed from the site and soils have apparently been remediated to less than 1 mg/kg of PCE or TCE, only a limited soil sampling effort is planned. Soil sampling will focus on the collection and analysis of soil samples during the installation of a monitoring well beneath the area formally containing the largest PCE concentrations in the soil. Samples will be collected every 1 ft of depth and screened for PCE and other VOCs. A single split-spoon sample (from the interval containing among the largest field screening concentrations) will be collected and submitted for laboratory confirmation. In addition, 3 to 5 soil borings will be made at other locations and screened for PCE and other VOCs. Several of these samples also will be submitted for laboratory confirmation.

4.2.2.2 Ground water

Data from abandoned shallow monitoring wells (less than 65 ft deep) installed at the site indicate a plume of PCE contamination extending at least 500 ft downgradient to the southwest to monitoring well MW-4 (fig. 11). Because the depth and lateral extent of contamination is unknown, three bedrock monitoring wells will be installed at or near the site. One well (BW-20) will be installed beneath the area that formerly contained the largest PCE concentrations in soils. The remaining two wells (BW-21 and BW-22) will be installed 700 to 1,000 ft downgradient (southwest) of the site. All wells will be drilled into the Roubidoux Formation which is anticipated to be about 370 ft deep. During drilling, drill cuttings will be sampled every 5 to 10 ft and scanned for VOCs . After completion, ground-water samples will be collected quarterly from the wells and submitted for laboratory analysis.

4.2.3 City Dump

The investigative approach at the old city dump is to determine if a significant (greater than MCL) release of PCE has occurred to the shallow bedrock aquifer. This will be accomplished by the collection of field screening samples from seeps, and shallow hand drilled wells in unconsolidated sediments along the edges of the sump, reconnaissance sampling of nearby springs and streams, and the installation and sampling of a bedrock monitoring well downgradient (northeast) of the dump.

4.2.3.1 Soils

Soil boring will be done along the edges of the dump, and drill cuttings will be scanned for PCE and other VOCs. Because large quantities of demolition and yard debris have been placed on the surface of the dump by the city since the dump was closed in 1972, no borings are planned for that area. Several soil boreholes will be completed as unsaturated zone monitoring wells. These wells and tree core samples will be scanned for VOCs and detections verified by laboratory methods. Soil and tree core sampling is scheduled to take place during phases I and II. Several soil-gas samplers will be installed in the southwest part of the site where local citizens have indicated drums were disposed. If soil gas sampling cannot be conducted because of debris in the shallow subsurface, then a backhoe trench may be dug in this area.

4.2.3.2 Ground water

One bedrock monitoring well (BW-03) was installed during the ESI-RI about 200 ft northwest of the dump. Large concentrations of ethanol and ethyl acetate were encountered at depths less than 20 ft in this borehole; however, PCE concentrations in this borehole during drilling were less than 1 ug/L. Concentrations of PCE and other VOCs were less than the detection of 0.2 ug/L in laboratory samples from the completed well (cased 100 ft and open from 100 to 230 ft). This well was purposely installed between the dump and city well W2 and, based on water-level measurement made during the ESI-RI well inventory, is probably not directly downgradient of the dump. A second monitoring well will be installed northeast of the dump during phase II to confirm that a substantial release of PCE has not occurred from the dump.

4.2.3.3 Surface water

The old city dump is located in the upper end of an ephemeral tributary that flows about 900 ft to the northeast where it empties into a larger unnamed tributary. This tributary generally contains small pools but no flow during dry periods. During phase I, a reconnaissance of the tributaries north and within 0.5 mi downstream of the dump will be made. Samples will be collected from the tributaries, seeps, or pools and tree cores and scanned for PCE and other VOCs. Detections will be confirmed by laboratory analysis. The tributary reconnaissance will be repeated during phase III.

4.2.4 East New Haven

The investigative approach to the East New Haven area focuses on activities designed to identify the source of PCE detected in the 210 tributary and monitoring well BW-02 (fig. 8). Provided the source can be identified, additional characterization of the extent and magnitude of the contamination of the source will be done. Phase I activities will be oriented toward determining the boundary of the area of contamination through reconnaissance of soils and surface water, surface EM (electromagnetic) survey, and by the installation of several bedrock monitoring wells. Historic aerial photography will be used to identify potential dumpsites. Much of the phase I effort will be screening level data with laboratory data used for verification. Provided a source area is identified, characterization of the source will be done to provide data of adequate quality to be used for assessing the risk to human health and the environment. Specifics on the type of characterization will depend on the type of source identified and its location.

4.2.4.1 Surface water

To verify the results of the ESI-RI reconnaissance sampling along the 210 tributary, an extensive reconnaissance of the 200 tributary and its various branches in the east New Haven OU will be conducted (fig. 8). The reconnaissance will be conducted during late phase I or early in phase II and after the leaves have fallen to facilitate identification of disturbed areas along the drainages. The reconnaissance includes about 5,300 linear ft of stream courses upstream of the industrial facility located at the east end of Orchard Street. Each stream course will be walked and tree core and water samples collected at intervals of every several hundred feet. Samples will be screened for VOCs and about 10 percent of the detections (and several non-detections) will be verified by laboratory analysis. Results of the reconnaissance will be used to focus additional sampling efforts (one to two rounds under varied hydrologic conditions) on specific stream reaches containing PCE. Data from the stream reconnaissance will be used to design additional soil, soil-gas, and subsurface characterization efforts.

4.2.4.2 Soils

Soil characterization efforts will be divided into two efforts, one during phase I, and the second during phase II or III. Initial phase I efforts will focus on the immediate area around the old barn along the 210 tributary, and include an EM survey, tree core sampling, soil borings, and soil-gas measurements. The purpose of the EM survey is to potentially identify areas containing buried drums. Tree cores samples, shallow soil borings (less than 5 ft deep), and soil gas measurements will be made in a series of concentric arcs within several hundred feet of the old barn (fig. 8). After the stream reconnaissance is conducted, a second round of EM surveys and soils borings will be conducted. This second round of activity will focus on disturbed areas identified from historic aerial photography and disturbed or PCE containing areas identified during the stream reconnaissance.

4.2.4.3 Ground Water

Ground-water investigations in the East New Haven area will be conducted throughout the RI. Initial efforts to bound the area of PCE contamination in the bedrock aquifer will involve the installation of two to five bedrock monitoring wells open to the Roubidoux Formation. During phase I, two monitoring wells will be installed in the east New Haven area. One well (BW-05) will be installed along Orchard Street about 700 ft east of BW-02 (fig. 8). This well is intended to aid in defining the width of the PCE plume in the bedrock emanating south of BW-02. A second well (BW-06) will be installed on private property about 0.25 mi south of BW-02 to determine the southern extent of contamination. During drilling, drill cuttings will be sampled and analyzed in the field to aid in determining the vertical extent of bedrock. Representative samples of the well being drilled will be collected and sent to the MDNR, Department of Geology and Land Survey (DGLS) to have the formation boundaries determined. The installation and exact location of additional bedrock monitoring wells is dependent upon data collected from the initial monitoring wells, stream reconnaissance, soil borings, EM and soil gas surveys, and reviews of historic aerial photography. Bedrock monitoring wells will be sampled quarterly (laboratory analyses) to provide data to be used in risk and human health assessments.

5.0 Project Management

5.1 Personnel

Shelley Brodie, the USEPA RPM, will coordinate the RI/FS. The USGS is responsible for conducting field activities, ensuring data quality, and preparation of the RI document. Specific RI/FS project tasks and primary responsibilities have previously been summarized in section 1.1 and in table 1. The primary USGS personnel working on the RI include John Schumacher, project chief (GS-12, full time); Jack Friesner, project hydrologist (GS-9, full time); Jerri Davis, project QA officer (GS-12, part time); Jeffrey Imes, supervisory hydrologist (GS-13, 0.2th time), and various hydrologic technicians. All field personnel will have received a minimum of 40 hours of health and safety training for hazardous waste sites before conducting fieldwork. A yearly medical exam is also required for field personnel, along with an 8-hour safety refresher coarse. Responsibilities of key USGS personnel involved with the project are summarized in table 7.

Table 7. Responsibilities of USGS project staff

Jim Barks	USGS District Chief	Responsible for all USGS-WRD activities in Missouri and responsible for ensuring USGS policy is followed and USGS obligations are met.
Jeffrey Imes	USGS Ground-water Section Chief	Responsible for overall project budgets and personnel resources; primary reviewer of technical interpretations.
John Schumacher	USGS RI Project Manager	Responsible for project planning, coordination, and ensuring project deadline and deliverables are met. Also responsible for overseeing field investigation activities and ensuring FSP activities are followed and project is completed within budget. Duties also include preparation of contract specifications and oversight of subcontracts. Also responsible for preparing quarterly narrative progress reports and project GIS database.
John Schumacher	USGS Health and Safety Officer	Responsible for ensuring those provisions in the health and safety plan are implemented in the field. Changing field conditions require decisions to be made concerning work practices and protective equipment.
Pam Keeney	USGS Administrative Officer	USGS administrative officer responsible for financial management of MOU between USGS and USEPA, addressing USEPA audits, and oversight of all subcontracts.
Jerri Davis	USGS RI Quality; Assurance Officer	Responsible for ensuring appropriate data collection protocols are followed and properly documented and QA/QC procedures are followed and suitable to meet project DQOs. Also responsible for project database.
Jack Friesner	Field-Work Team Leader	Field team leader and responsible for conducting field activities and following FSP or documenting and reporting deviations to the project manager.
Paul Brenden	Hydrologic Technician	Assists in the collection of field data, sample shipment, and sample management.
Stephanie Klein	Field Sampler	Assists in the collection of field data, sample shipment, and sample management.

The USEPA has identified 13 tasks to be accomplished by the USGS to fulfill project management obligations outlined in the statement of work prepared by the USEPA. The work elements, responsible USGS team member, and deliverable dates are summarized in table 8. Project deliverables are dependent upon receipt of funding and initiation of work by the USEPA. A signed SOW (statement of work) and transfer of funds was not initiated until July 2000; therefore, the project schedule initially set forth in the statement of work has been delayed by 3 months and the entire project schedule has been shifted accordingly.

Table 8. Specific work tasks to be performed under the RI Task I project planning and support and project deliverables.

Work task	Responsible USGS personnel and task summary	Deliverable date
1.1 Scoping meeting	Project chief, USEPA RPM, risk assessor,	August 28, 2000
1.2 Site visit	N/A as USGS has conducted ESI-RI activities	
1.3 RI Work Plan	Project chief and USGS team members	Sept 12, 2000 draft
1.4 Work plan revisions and Final RI Work Plan	2-week review by EPA and 2 week turn-around by USGS. Project chief and supervisory hydrologist	Oct 13, 2000
1.5 Conflict of interest statement	WRD administrative officer and District Chief	Sept 30, 2000
1.6 Health and Safety Plan (HSP)	USGS subcontractor	Sept 30, 2000
1.7 Field Sampling Plan (FSP)	General FSP to cover overall field procedures, individual FSP prepared for specific OUs as needed. Project chief, QA officer, project hydrologist	Sept 19, 2000
1.8 QAPP	General DQOs summarized in work plan. Draft QAPP prepared by project QA officer and project chief	Sept 19, 2000
1.9 Project management tasks	Project chief and supervisory hydrologist	As needed
1.10 Review existing site files and data	Project chief, project hydrologist, QA officer	As needed
1.11 Development of site conceptual model	Project chief, conceptual model presented in draft work plan	Sept. 8, 2000
1.12 EPA external audits	Project administrative officer	As needed
1.13 Monitoring well abandonment	Project chief and project hydrologist	At conclusion of RI/FS and remedial action alternatives
5.4 Data validation report	Project QA officer and project chief	December 2001, or within 45 days of the last field event
2.0 Public meeting support	Project chief	As needed
6.7 Data evaluation administrative letter	Project chief. Format reserved for quarterly narrative reports that have data interpretation and will to be submitted through the USGS peer review process	Quarterly or as needed
8.0 Draft RI report	Project chief	February 2002
8.0 Final RI report	Project chief	April 30, 2002, or within 45 days of receipt of EPA comments on draft

5.2 Reports

5.2.1 Quarterly Progress Reports

The USGS will provide the USEPA with quarterly narrative progress reports that will include a description of field activities, summary of findings, and narrative explaining how the activities did, or did not, meet the DQOs. In addition, the USGS will provide the USEPA with data transmittal packets for all laboratory samples collected during the investigation within 30 days of their receipt from the laboratory. Data packets will include a summary table of the analysis and their concentrations for each property owner, and a copy of the field sheet, ASR (analytical services request form), chain-of custody for each sample, laboratory QC data, and a short QA summary of sample collection, shipment, and analytical results. Raw data from the USGS contract laboratory will be furnished in Adobe Acrobat format on CD-ROM.

5.2.2 Internet Data Access

To facilitate the rapid distribution of data to the USEPA and other project team members, such as the MDOH RA team, the USGS will provide access to project data through a web site. The web site will include maps of sample locations, sample descriptions, analytical and field screening data, and photographs of selected field activities. Access to the web site will be restricted to specific IP addresses designated by the USEPA project manager Shelley Brodie.

5.2.3 Data Validation Report

The project QA officer will be responsible for preparing a report outlining data validation procedures used and usability of project data. The report will include a review of field screening and laboratory data collection, sample preservation, sample shipment, and quality assurance (QA) data.

5.2.4 Remedial Investigation

The USGS will prepare a RI report in accordance with the latest revision of "Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA", OSWER Directive 9355.3-01. The USGS will be the primary author of the report and will be responsible for incorporating sections (such as the risk assessment) authored by other entities. The RI report will be prepared as a USGS administrative report and subject to the USGS peer review process. As policy, USGS administrative reports are not citable by the USGS; therefore, with USEPA consent, the USGS will pursue the publication of the RI as a USGS Open-File Report or Water Resources Investigative Report.

5.3 Project Schedule

The full performance period of the RI is from June 2000 through December 30, 2002. The milestone and deliverable dates listed in table 8 are approximate and dependent upon the actual start date of fieldwork and results obtained during phases of the investigation. The detection of PCE south of city well W2 in monitoring well BW-02 and the 210 tributary has expanded the original scope of work from the downtown New Haven area to most of the community. This expansion will most certainly result in additional time and resources required for the completion of the RI beyond the original scope of work. The target date for the RI report is April, 2002. A thorough review of project activities, results, and planning and budgeting for subsequent phases of work will be conducted at approximately the conclusion of each phase of activity, which are approximately in 4-month intervals.

5.4 Project Budget

Submitted separately.

6.0 References

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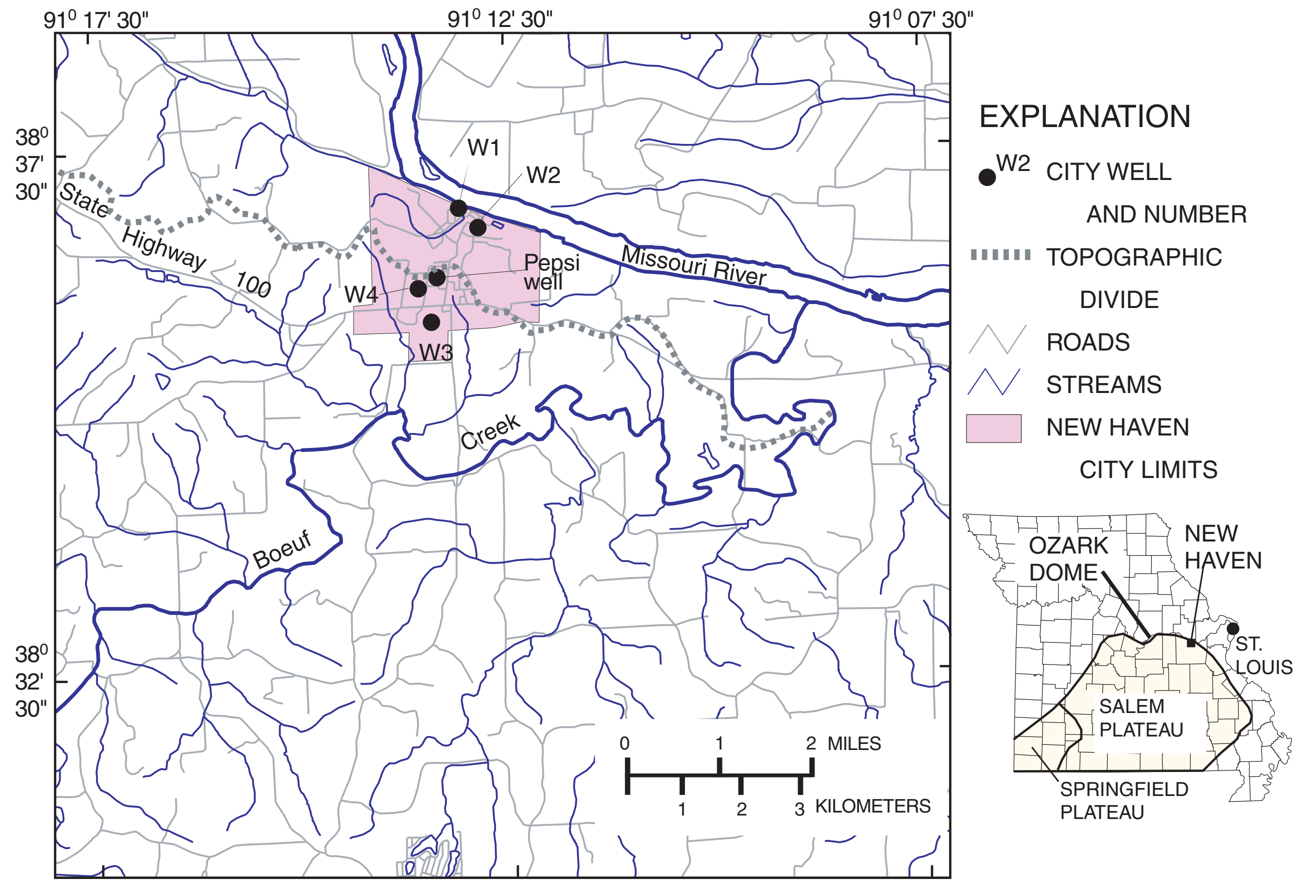


Figure 1. Location of New Haven, Missouri.

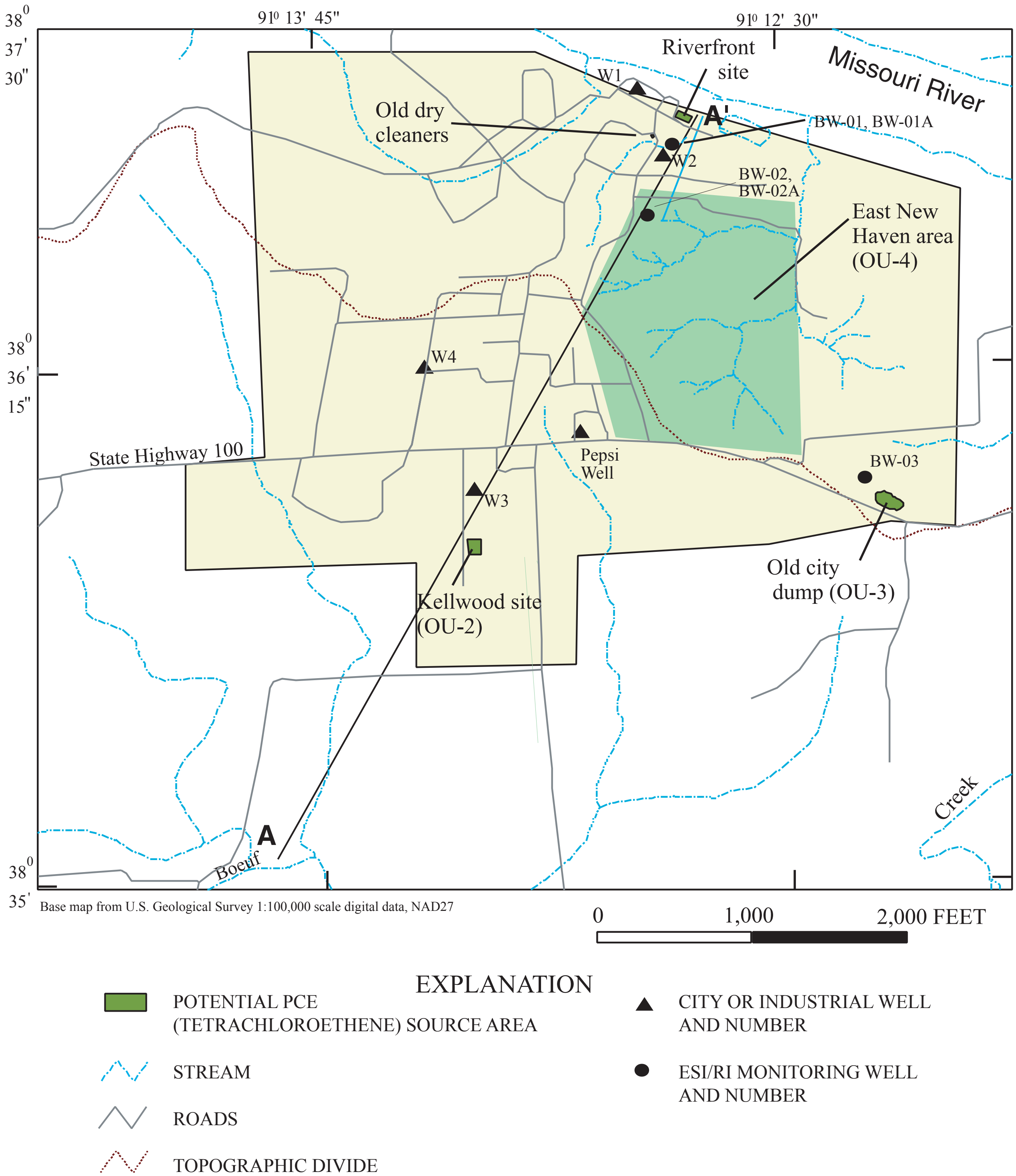


Figure 2. Location of the potential tetrachloroethene (PCE) source areas in New Haven and the proposed operable units (OUs) for the remedial investigation as identified by the Missouri Department of Natural Resources and the U.S. Environmental Protection Agency.

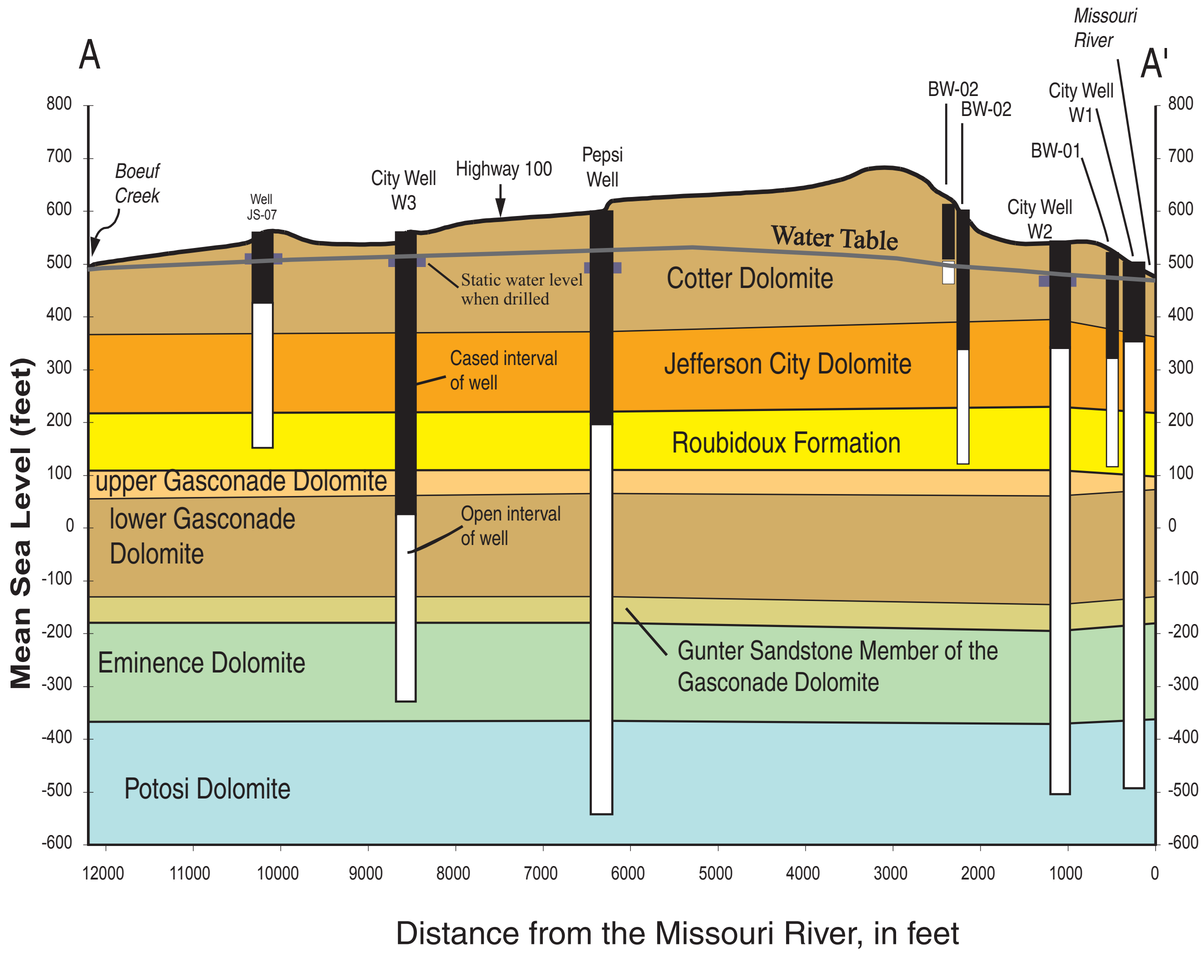


Figure 3. Generalized geohydrolgic section A-A' in the New Haven area. Location of the section is on figure 2

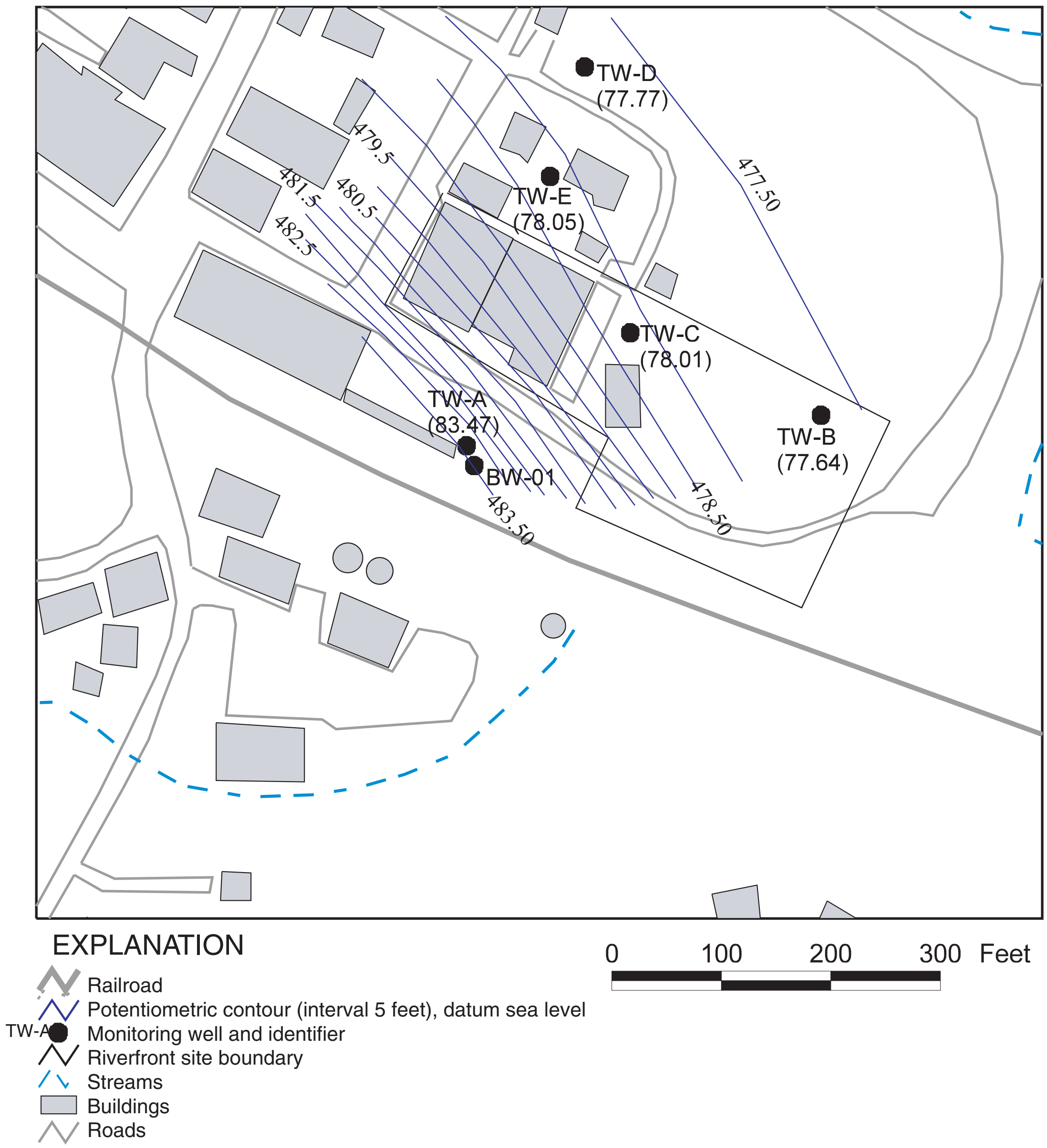


Figure 4. Potentiometric surface in the Missouri River alluvial aquifer at the Riverfront site, July 26, 2000.

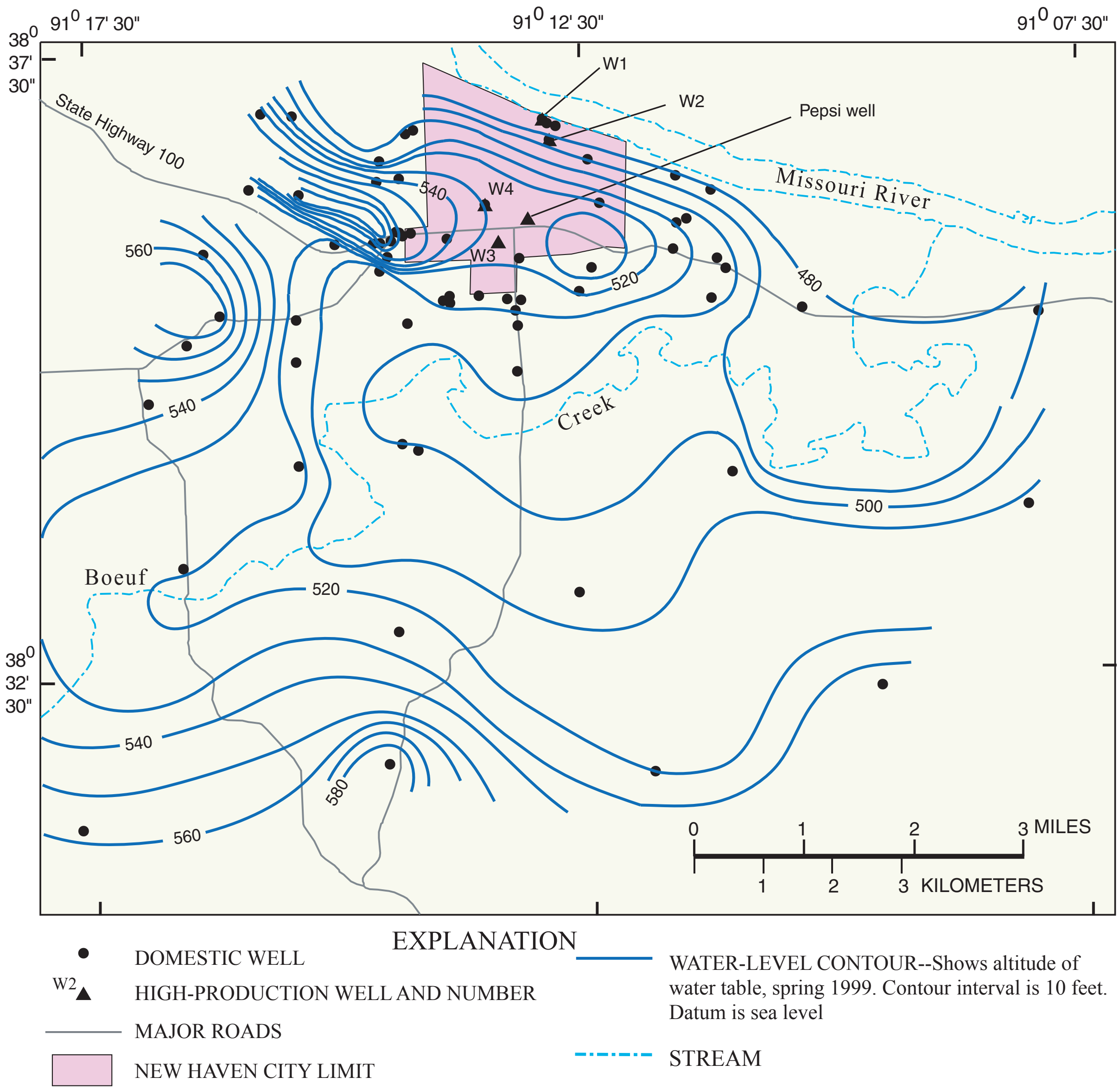
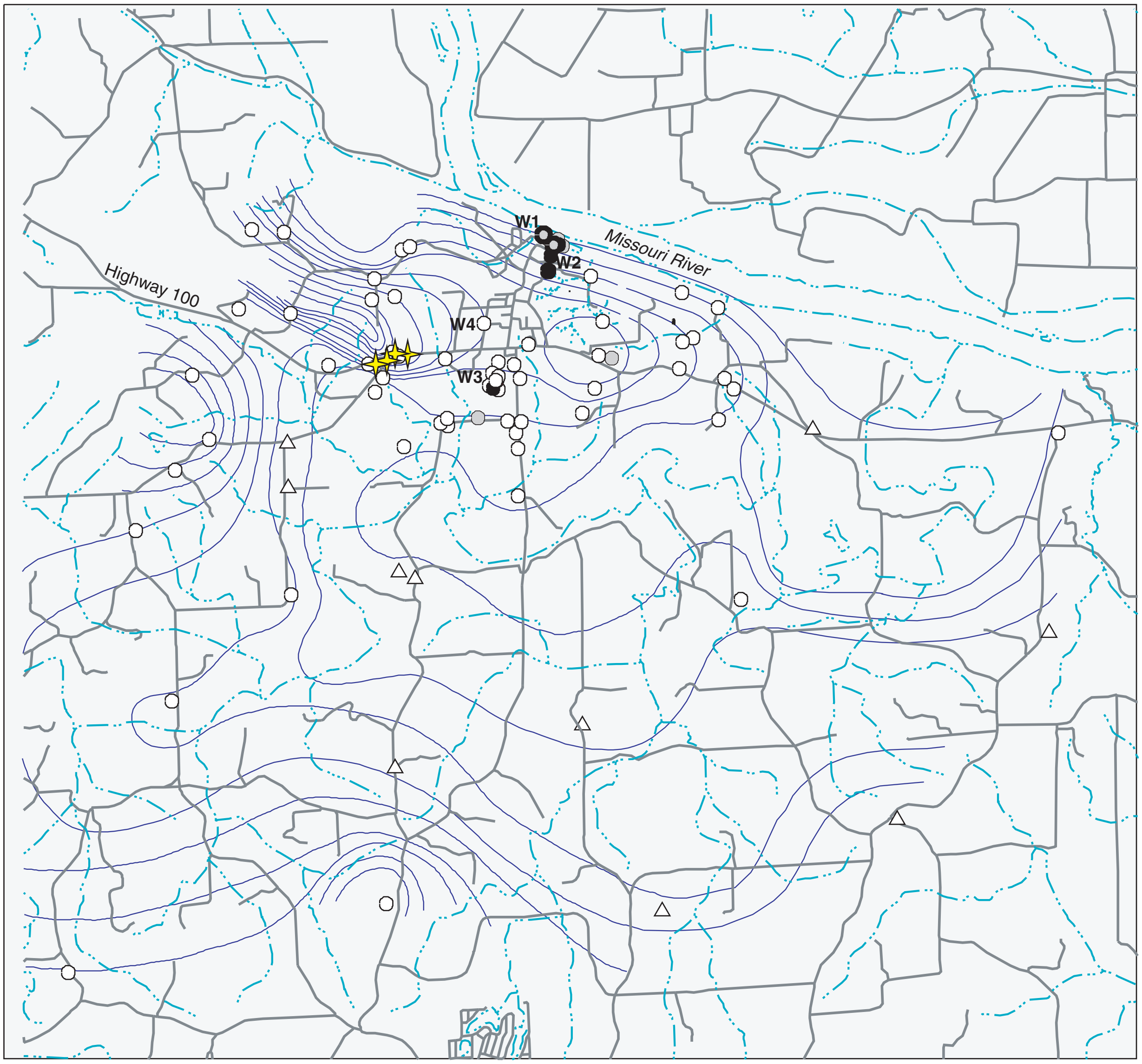


Figure 5. Altitude of shallow ground water in the vicinity of New Haven, spring 1999.



Base: UTM NAD 1927, U.S. Geological Survey 1:100,000 digital data.

0 1 2 MILES

EXPLANATION

Well inventoried and PCE (tetrachloroethene) concentrations in micrograms per liter (✦ indicates only TCE [trichloroethene] detected at less than 5.0 micrograms per liter)

△ Not sampled
○ less than 0.1
◉ 0.1 to 4.99
◎ 4.0 to 99.9
● greater than 100

Streams
Roads
Potentiometric contour--Shows attitude of water table during spring 1999(see figure 5)

Figure 6. Location of wells sampled for volatile organic compounds during the 1999 well inventory and detections of tetrachloroethene (PCE) and trichloroethene (TCE).

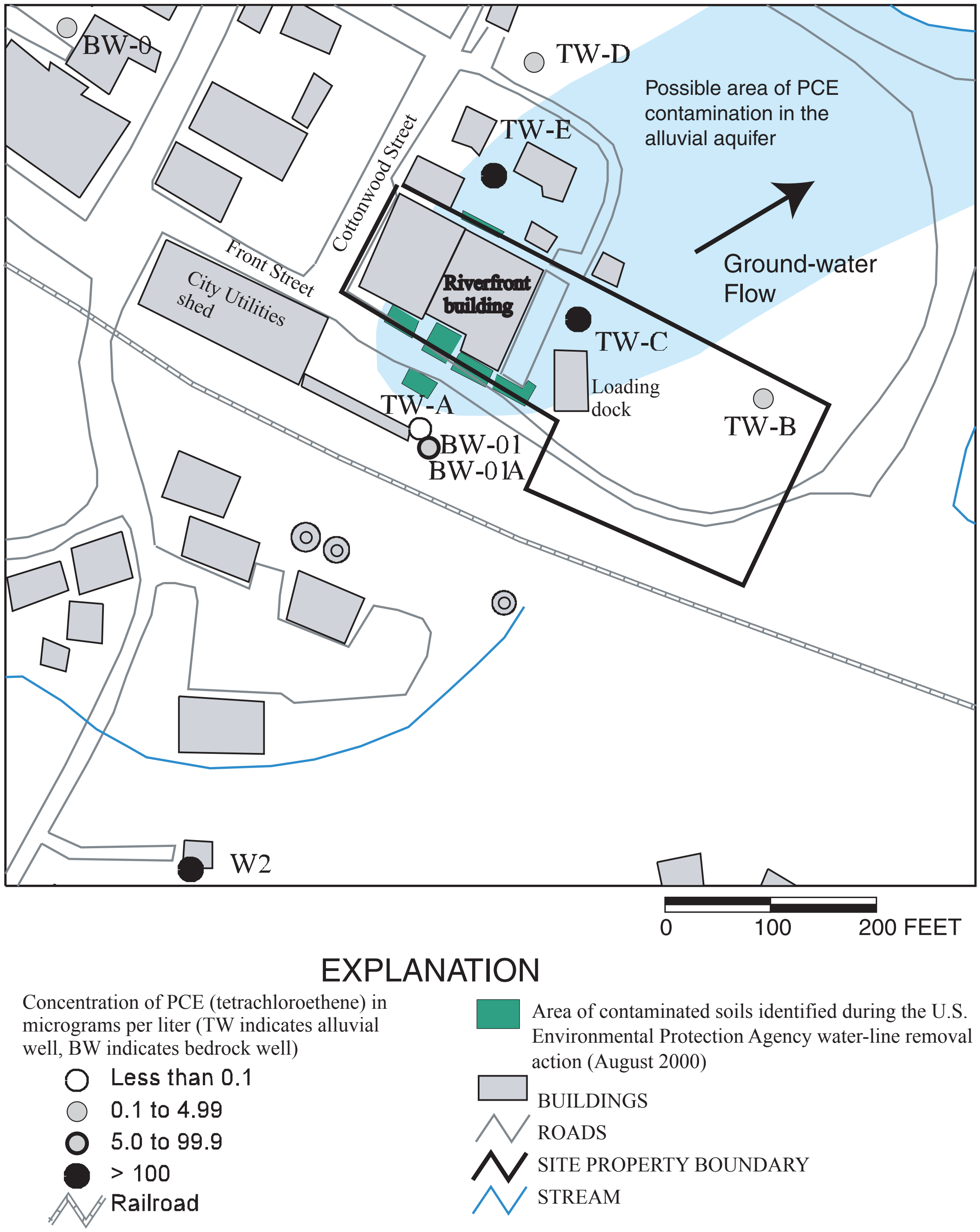


Figure 7. Concentrations of tetrachloroethene (PCE) detected in alluvial and bedrock wells in the vicinity of the Riverfront site

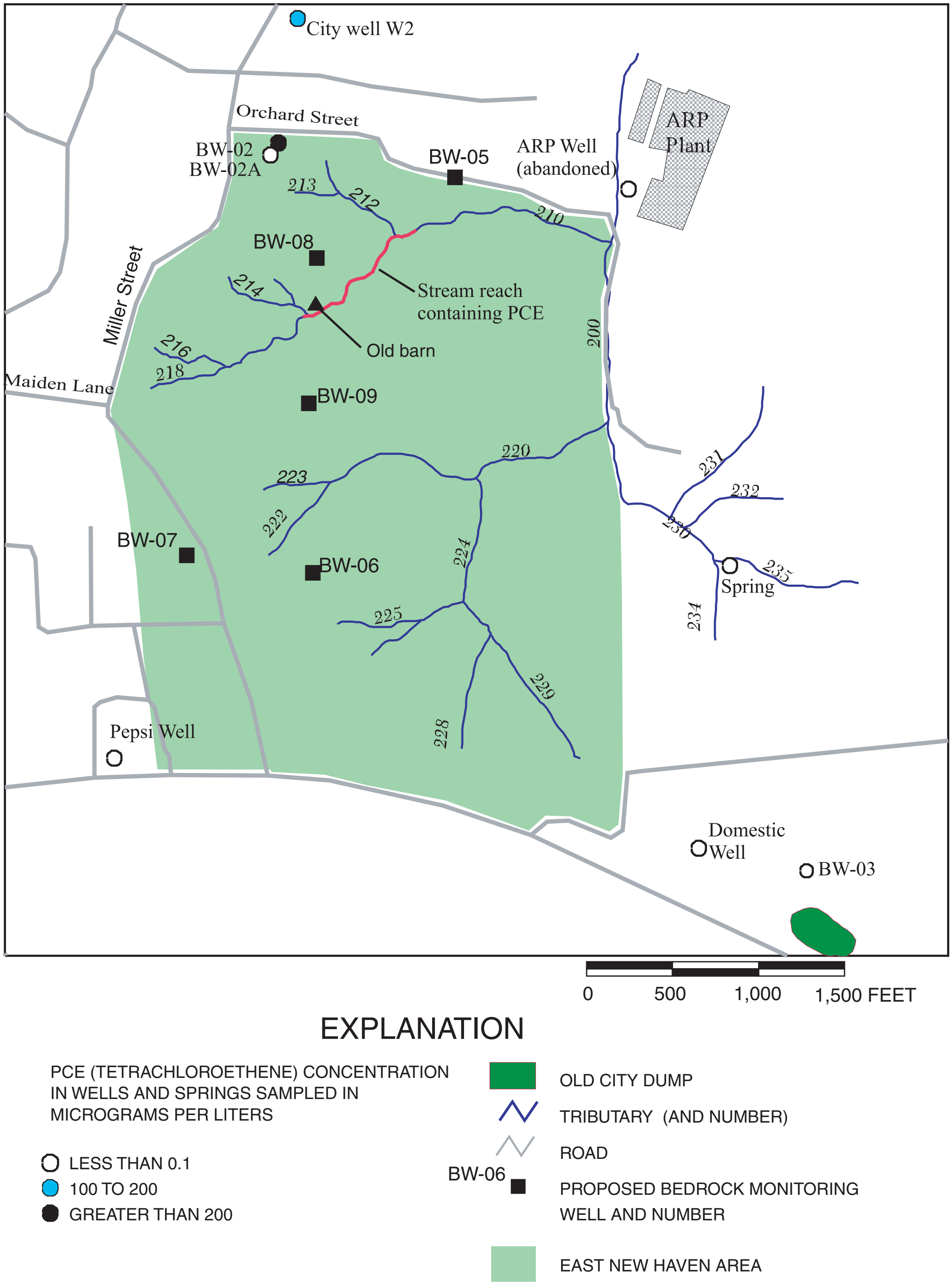


Figure 8. Concentrations of tetrachloroethene (PCE) in samples from wells, springs and streams in the east New Haven area (OU4).

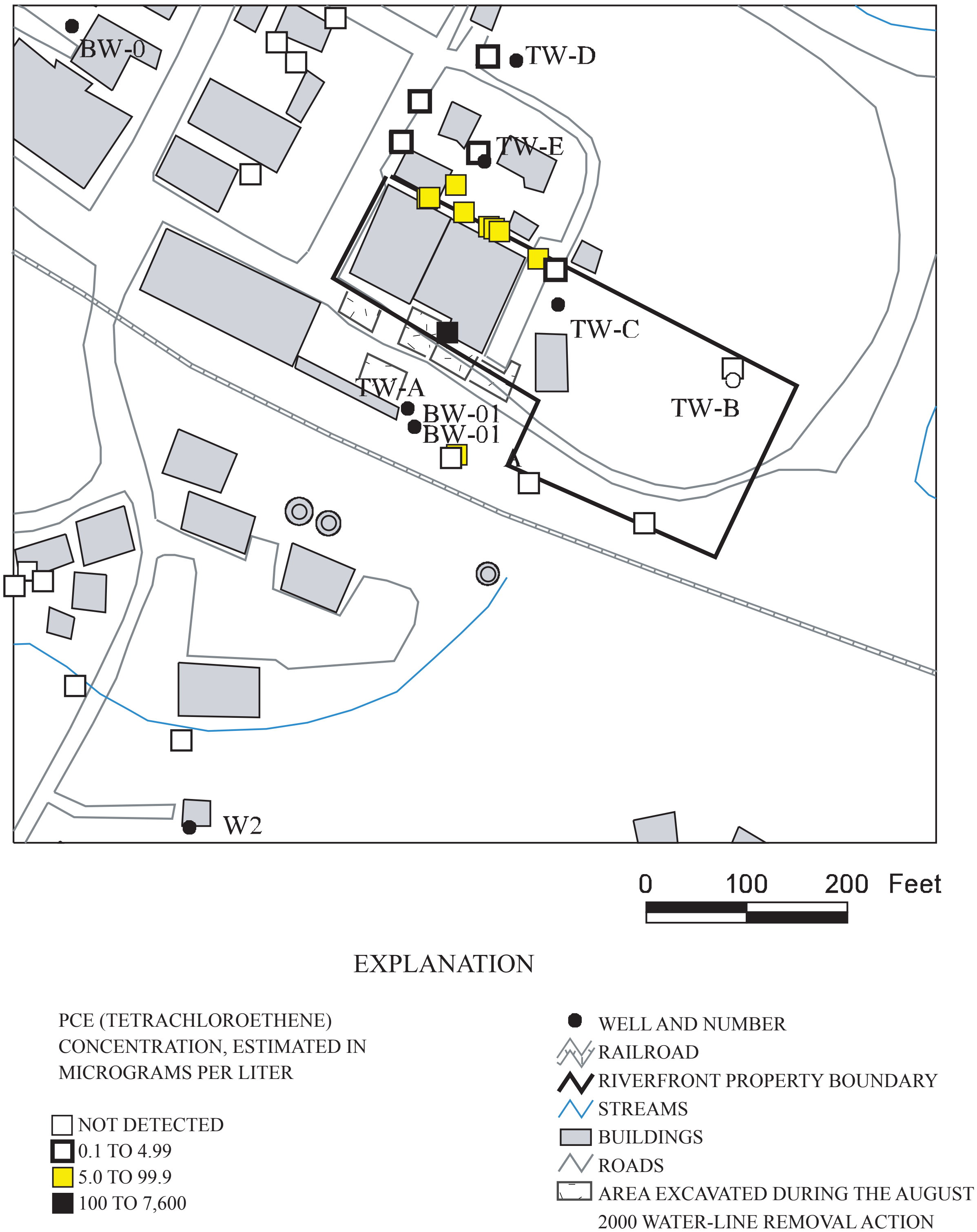


Figure 9. Relative concentration of tetrachloroethene (PCE) in the tree cores samples from the Riverfront site and vicintiy.

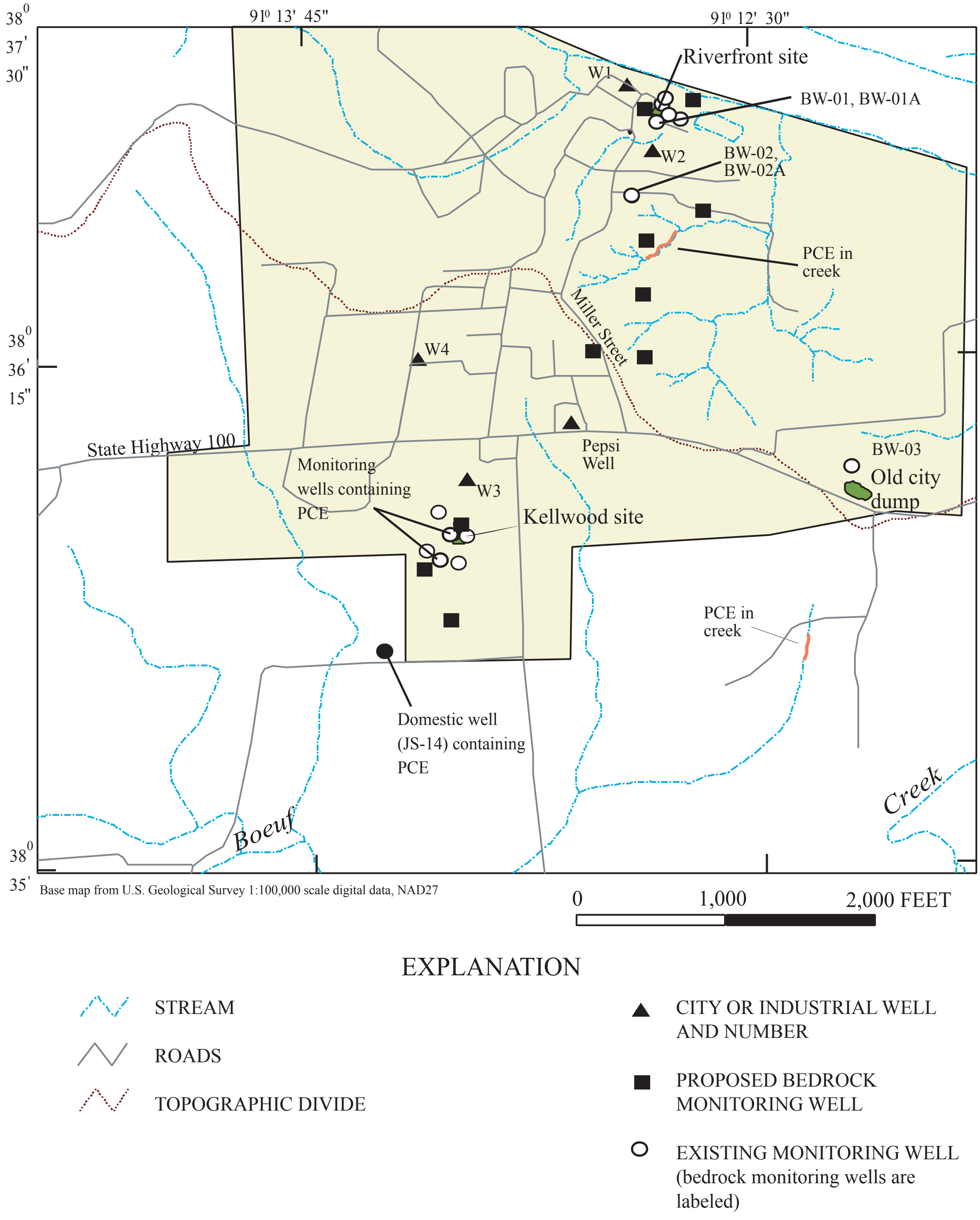


Figure 10. Location of the monitoring wells and domestic wells containing tetrachloroethene (PCE) in New Haven and the proposed additional bedrock monitoring wells to be installed during the Remedial Investigation.

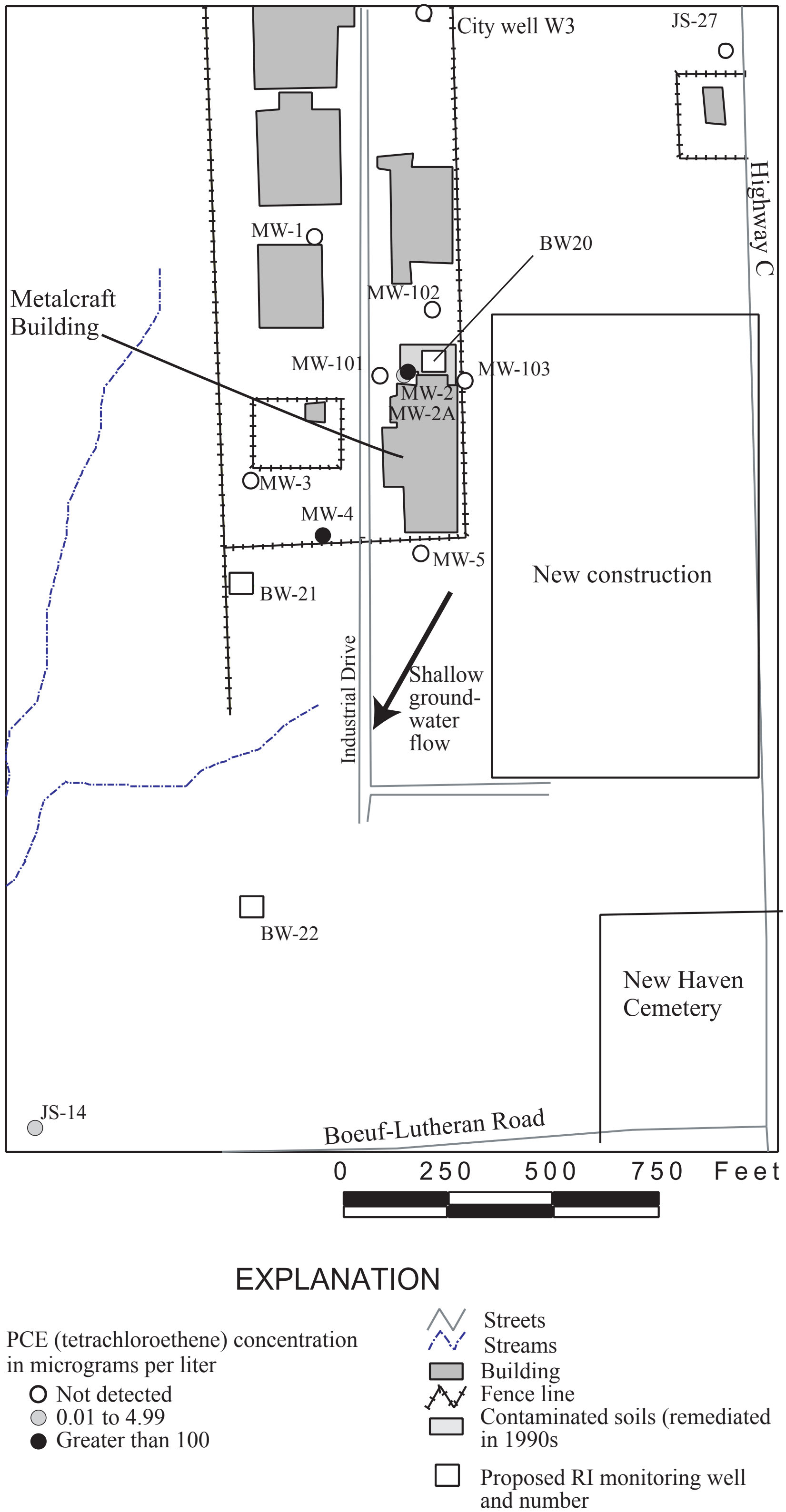
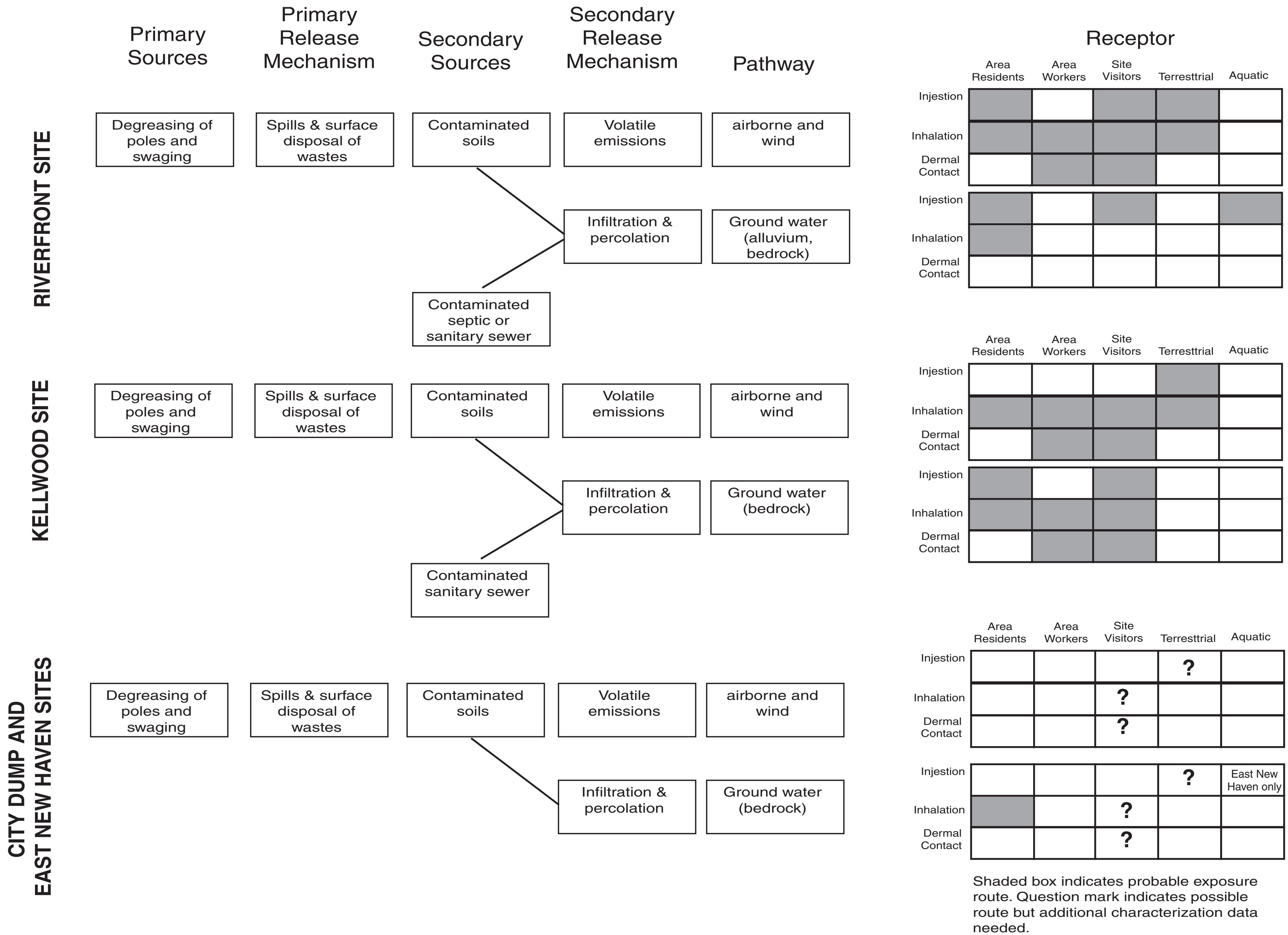


Figure 11. Features of the Kellwood/Metalcraft site (OU-2) and location of proposed monitoring wells.



Attachment A. Summary of study unit conceptual site exposure models.

Attachment B. Summary of RI Operable Units, data needs, possible remedial actions, DQO decision statements, and general work tasks.

Description / concern	Matrix	OU1. Riverfront Site	OU2. Kellwood/Metalcraft Site	OU3. Old City Dump	OU4. East New Haven Area
Amount of existing data	Soils	Moderate	Large	Minimal	None
	Ground water	Moderate	Minimal	Minimal	Minimal
	Surface Water	None	None	None	Minimal
Possible connection to closed city wells	Possible connection to closed city wells	Moderate	Low	Low	High
Possible risk to new city wells	new city wells W3, W4	Low	Moderate	Low	Low
Possible risk to nearby domestic wells	domestic wells	Low	High	Moderate	Low
Known COCs	Soils	- PCE, TCE, DCE, VC - BTEX, SVOCs	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC - Hydrocarbons & other SVOCs - Paint residues and strippers - Mineral spirits - Dyes (associated metals)	- PCE, TCE, DCE, VC
	Ground water	- PCE, TCE, DCE, VC - BTEX	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC
	Surface Water	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC	- PCE, TCE, DCE, VC
Possible COCs (PCOCs)		- Paint residues and strippers	- Inorganics (anions, metals)	Ethanol, ethyl acetate	- Ethanol, ethyl acetate
DQO Decision statements		Determine if the site contributed to PCE detected in the city wells and poses an unacceptable "risk" to human health (soils, vapors) or environment (Missouri River) that requires further response actions.	Determine if ground-water contamination at the site poses an unacceptable risk to the nearby city well W3 and downgradient domestic wells and requires additional response actions.	Determine if a release of PCE or its degradation products has occurred and requires further action.	Determine the source of the PCE detected in nearby media (ground and surface-water) and determine if that source contributed to the city well W2 contamination and poses an unacceptable risk to human health or the environment.

Description / concern	Matrix	OU1. Riverfront Site	OU2. Kellwood/Metalcraft Site	OU3. Old City Dump	OU4. East New Haven Area
Decision rule		If the site is hydraulically connected to city well W2 or PCE concentrations in soils or ground water pose unacceptable risks, response actions are required.	If PCE is detected in the Roubidoux Formation near the site or a DNAPL is encountered, additional response actions are needed.	If concentrations of PCE and degradation products in ground-water are less than the MCL, no further response action is needed, otherwise addition response actions are needed.	If the PCE source can be identified then additional response actions are required, otherwise if the risks to existing city wells or domestic source are minimal no further response actions are required.
Data Gaps or needs		- Extent of soil contamination - Determine if DNAPL is present in alluvial aquifer. - Temporal PCE in alluvium with various Mo River stages. - Connection to city well W2 - PCE in Mo River water/sediment	- Extent of PCE contamination in Roubidoux and younger Formations. - Direction and rates of flow in bedrock aquifer - Connection to city well W3	- PCE concentrations in shallow bedrock aquifer	- Locate source area(s) - Extent of PCE contamination in bedrock -Possible connection to sanitary sewer system - location of old water wells
Possible Remedial Actions		- removal of "hot soils" - pump/treat of "hot" GW - Chemox of DNAPL - SVE - Reactive/barrier walls - Natural attenuation w/ source removal - Deed restrictions	- Pump/treat of GW - In situ Chemox of DNAPL - Filtration on domestic wells	- Impermeable cap over site - leachate trench w/ treatment - Source removal	- Source removal - Insitu Chemox of DNAPL - SVE - Natural attenuation w/ source removal - Deed restrictions
Data levels needed	Soils	- Level II for extent & magnitude - Level III for Risk assessment & FS design.	- A few level III to confirm previous soil remediation efforts.	- Level II for extent & magnitude (soils, tree core, soil-gas) - Few level III to confirm level II field data.	- Level II for extent & magnitude (soils, tree core soil-gas) - Level III for Risk assessment & FS design
	Ground water	- Time series @ various Mo River stages (level II and III) - Level III for Risk assessment & FS design.	- Level III at additional monitoring points, city well and domestic wells	- Level II (seeps and perched water) - Few level III to confirm level II field data	- Extensive level II for perched water - Level III to confirm level II data and for Risk assessment and FS design.
	Surface water	- Level I and III for surface and near bottom and sediments.	- Level II for stream reconnaissance and level III to confirm level II "hits"	- Level II for stream reconnaissance and level III to confirm level II "hits	- Level II for stream reconnaissance and level III to confirm level II "hits
PHASE I (Sept-Dec. 00)		- Install 2 alluvial wells - monthly VOCs (level III) in wells - Hand auger/drive point wells around bldg. (Level II & III) VOCs and FS data (physical properties, perm. tests) - Mo. River sampling (water, sediments	-Install well beneath remediated soils - Install downgradient wells (2) - quarterly sampling (level III) of bedrock wells	- Hand auger borings on north side & install temp shallow wells (<10ft deep)—level II sampling. - VOC screen of tree core and nearby creeks (level II)	- Install two bedrock wells (school and Orchard St.) - quarterly sampling of bedrock wells (Level III) - tree core and soil boring recon along 210 tributary

Description / concern	Matrix	OU1. Riverfront Site	OU2. Kellwood/Metalcraft Site	OU3. Old City Dump	OU4. East New Haven Area
		for level III) if stage permits.	- VOC screen of nearby creeks and domestic wells (level II)	- Begin quarterly sampling (level III) of BW-03	(Level II)
Phase II (Jan-Apr 01)		- Slug testing of monitoring wells - Sub-slab samples inside bldg (level II & III)	- Additional bedrock well(s) (1-2) between site & city well 3 (level III sampling) - Slug testing of monitoring wells	- Additional bedrock well northeast of dump - Slug testing of bedrock wells - Continue bedrock monitoring (level III)	- Slug testing of bedrock wells - Additional soil probing/gas (geoprobe?)—level II
Risk Assessment	All	Summarize data and present to Risk assessment team for data gaps			
Phase III (May-Aug01)		- Possible bedrock well beneath site near TW-C. - Continue quarterly level III sampling - FS scoping & data collection	- To be determined - Continue quarterly level III sampling - FS scoping & data collection	- To be determined - Continue quarterly level III sampling - FS scoping & data collection	- To be determined - Continue quarterly level III sampling - FS scoping & data collection
Phase IV (Oct-Dec)		Prepare Draft RI			