FINAL

1999 NAPL FIELD INVESTIGATION REPORT

McCormick and Baxter Superfund Site
Stockton, California

Volume 1 of 2

June 2, 2000

Prepared for

EPA
REGION 9

U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, California 94105-3901

Prepared by

U.S. Army Corps of Engineers
Seattle District
4735 East Marginal Way South
Seattle, Washington 98134

URS Greiner Woodward Clyde
2401 4th Avenue, Suite 808
Seattle, Washington 98121-1459
53F0072263

EXECUTIVE SUMMARY

Soil, groundwater, and nonaqueous-phase liquid (NAPL) samples were collected and analyzed during a 4-month field investigation conducted in 1999 at the McCormick and Baxter Superfund site, located in Stockton, California. The purpose of this investigation was to support selection of a final groundwater remedy, including an evaluation of in situ thermal remediation technologies. The 1999 NAPL field investigation was conducted by the U.S. Army Corps of Engineers (USACE) for the U.S. Environmental Protection Agency (EPA) Region 9. The investigation activities, as well as the findings and recommendations based on the data interpretation, are presented below.

1999 NAPL Investigation Activities

Specific tasks conducted during the 1999 field investigation included the following activities:

- Site survey
- Surface geophysical survey
- Soil sample collection and subsurface characterization using the site characterization and analysis penetrometer system (SCAPS), cone penetrometer (CPT), and laser-induced fluorescence (LIF) sensor
- Rotosonic soil borings and soil sample collection and analysis
- Groundwater monitoring well installation
- Groundwater and NAPL sample collection and analysis
- Laboratory treatability study soil sample collection and analysis

1999 NAPL Investigation Findings

Based on the data collected, the primary findings of the 1999 NAPL investigation are listed below.

- NAPL occurs in the A-zone through the D-zone and is strongly suspected to have contaminated the E-zone, based on data collected from two wells southeast of the property boundary. NAPL has migrated laterally and downward from the Main Processing Area towards the south and southeast as far as the Union Pacific Rail

Road (UPRR) property and the southern McCormick and Baxter property boundary near the stormwater retention ponds and the main gate. NAPL is present at shallow depths along Old Mormon Slough and as deep as 160 feet below ground surface (bgs) near the Main Processing Area.

- The volume of NAPL in the subsurface is estimated at between 160,000 and 1,600,000 gallons.

- The volume of NAPL-contaminated soil is estimated at 220,000 cubic yards.

- Naphthalene was detected in the A- through E-zone groundwater, and generally not detected or detected at low concentrations outside the main NAPL plume. PCP and dioxin are dissolved in high concentrations in the A-zone groundwater outside, and downgradient of, the boundaries estimated for the main creosote NAPL plume. Crystalline PCP was observed on the ground surface near soil sample SE-08. Di-isopropyl ether was detected in the surface soil collected at EP-01 in the Cellon Process Area.

- An unknown subsurface obstruction was encountered at approximately 16 feet below ground surface (bgs), which prevented SCAPS sample collection in the area near SE-03, SE-52, and SE-95.

1999 NAPL Investigation Recommendations

Based on the findings presented above and the postinvestigation data gaps and uncertainties discussed in Section 6.0, the recommendations for additional data collection are presented below.

- Conduct subsurface investigation north of (i.e., on the Dutra and Stockton Cold Storage properties) and/or beneath Old Mormon Slough

- Conduct subsurface investigation on the Union Pacific Railroad property

- Conduct further subsurface investigation south of the stormwater retention ponds and the main gate area

- Investigate the PCP source area

- Develop a groundwater strategy and implement a groundwater monitoring program

- Investigate the subsurface obstruction at SE-03, SE-52, and SE-95.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

APPENDIXES

TABLES

FIGURES

PLATES

ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
bgs	below ground surface
CADD	computer-aided drafting and design
CEC	cation exchange capacity
CLP	Contract Laboratory Program
COC	chain of custody
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CPT	cone penetrometry
CSM	conceptual site model
DCQAR	Daily Chemical Quality Control Report
DNAPL	dense nonaqueous-phase liquid
DO	dissolved oxygen
DQO	data quality objective
DWR	State of California Department of Water Resources
Eh	oxidation reduction potential
EM	electromagnetic
EMLL	electromagnetic line locating
EPA	U.S. Environmental Protection Agency
FASP	Field Analytical Support Program
FID	flame ionization detector
FSP	field sampling plan
GC	gas chromatograph
GMS	Groundwater Monitoring System
HCl	hydrochloric acid
IDW	investigation-derived waste
IPC	in-phase component
IS	internal standard
LCS	laboratory control samples
LIF	laser-induced fluorescence
LNAPL	light nonaqueous-phase liquid
LOD	level of detection
MCL	maximum contaminant level
MS	mass spectrometry
MS/MSD	matrix spike/matrix spike duplicates
msl	mean sea level
NAD83	horizontal measurement referent, California State Coordinate System Zone 3

ABBREVIATIONS AND ACRONYMS (Continued)

NAPL	nonaqueous-phase liquid
NSPC	Newark-Sierra Paper Company
NVD88	vertical measurement referent, California State Coordinate System Zone 3
PAH	polycyclic aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PDS	postdigestion spike
PE	performance evaluation
PID	photoionization detector
POL	petroleum, oil, and lubricants
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QC	quality control
redox	oxidation reduction
RI	Remedial Investigation
ROD	Record of Decision
RPD	relative percent difference
rpm	revolutions per minute
SAP	sampling and analysis plan
SCAPS	site characterization and penetrometer system
SDG	sample delivery group
SOP	standard operating procedure
SVOC	semivolatile organic compound
TAL	target analyte list
TC	terrain conductivity
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorinated dibenzofuran
TEC	toxicity equivalent concentration
TFM	total field magnetometry
TIC	tentatively identified compound
TOC	total organic carbon
TPAH	total polycyclic aromatic hydrocarbons
TPH	total petroleum hydrocarbon
TPH-Dx	total petroleum hydrocarbons–diesel range (extended)
TRPH	total recoverable petroleum hydrocarbons
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers

UNITS OF MEASURE

°C	degrees Celsius
°F	degrees Fahrenheit
cm	centimeter
cm/s	centimeters per second
cP	centipoise
cst	centistoke
ft/day	feet per day
ft/ft	feet per foot
ft^3	cubic foot
g	gram
g/mL	grams per milliliter
g/cc	grams per cubic centimeter
gpm	gallons per minute
L	liter
µg/L	micrograms per liter
meq/g	milliequivalents per gram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mm	millimeters
m/min	meters per minute
mS/cm	milliSiemens per centimeter
mV	millivolt
ng/kg	nanograms per kilogram
pg/L	picograms per liter
ppm	part per million
rpm	revolutions per minute
yd^3	cubic yard

1.0 INTRODUCTION

This report presents the results of the soil and groundwater investigation that was conducted by the U.S. Army Corps of Engineers (USACE) Seattle District for the U.S. Environmental Protection Agency (EPA) at the McCormick and Baxter Superfund Site in Stockton, California, from July to September 1999. This investigation report primarily addresses the nature and extent of the subsurface nonaqueous-phase liquid (NAPL) contamination at the site and presents technical conclusions and recommendations based on those results.

Specific tasks conducted during the 1999 field investigation included the following activities:

- Site survey
- Surface geophysical survey
- Soil sample collection and subsurface characterization using the site characterization and analysis penetrometer system (SCAPS) cone penetrometer (CPT) and laser-induced fluorescence (LIF) sensor
- Rotosonic soil borings and soil sample collection and analysis
- Groundwater monitoring well installation
- Groundwater and nonaqueous-phase liquid (NAPL) sample collection and analysis
- Treatability study soil sample collection and analysis

1.1 SITE DESCRIPTION AND HISTORY

The McCormick and Baxter Superfund site occupies approximately 32 acres in a predominantly industrial area near the Port of Stockton and the junction of Interstate 5 and State Highway 4 (Figure 1-1). Old Mormon Slough forms the boundary to the north and connects to the Stockton Deepwater Channel on the San Joaquin River. Site boundaries include Washington Street to the south, the Interstate 5 freeway to the east, and an industrial facility, which is located at the Port of Stockton Turning Basin, to the west. An 8-acre parcel in the southeastern portion of the site is owned by the Union Pacific Railroad (UPRR). The UPRR property boundaries shown in Figure 1-1 have been approximated from parcel maps.

The former processing areas and tank farm at the site are paved. The rest of the site surface is unpaved, with limited vegetative cover. A layer of gravel between 1 and 3 feet thick is found across most of the site. Railroad tracks are located on many areas of the site. Most of the former structures have been removed. The office building, two storage sheds, a stormwater collection system lift station, remnants of an old gas station, wooden tower, building near the tower, and an asphalt pad are the only remaining aboveground structures. Underground sump-like basement foundations and associated piping for the former pressure treatment units remain in the central portion of the site. Entry to the site is controlled by a perimeter fence and 24-hour security service.

The site is located on the margin of the Sacramento River–San Joaquin River Delta in the Great Valley geomorphic province of California. The site terrain is relatively flat and near sea level, ranging from 8 to 15 feet above mean sea level (msl). Surface water bodies in the vicinity of the site include Old Mormon Slough, New Mormon Slough, the Stockton Deepwater Channel, and the San Joaquin River. Old Mormon Slough is approximately 2,500 feet long and 180 feet wide. Most of the slough is approximately 10 feet deep, although the western portion near its mouth has historically been dredged for barge access. Old and New Mormon Sloughs are tidally influenced, with a maximum tidal range of approximately 3 feet. Stockton Channel, the Port of Stockton Turning Basin, and Old Mormon Slough are areas of net sediment deposition, and all but the inner portion of Old Mormon Slough are periodically dredged to maintain depths appropriate for ship traffic.

The McCormick and Baxter Creosoting Company operated at 1214 West Washington Street in Stockton, California, from 1942 until 1991. Various wood preservation processes were used at the site during its operational history. The treated wood products were used primarily by power utilities, railroads, and in construction. The preservatives included creosote, pentachlorophenol (PCP), arsenic, copper, chromium, and zinc. Solvents or carriers for these preservatives included petroleum-based fuels, such as kerosene and diesel, butane, and ether. A list of wood-preserving chemicals used at the site is shown in Table 1-1.

Most treatment processes consisted of pressure impregnation of the preservative solutions in retorts. Pressure-treated wood was removed from the retorts and allowed to dry in various wood storage areas throughout the site. The primary facility areas identified as the probable sources of contamination at the site include the Main Processing Area, Oily Waste Ponds Area, Cellon Process Area, and Treated Wood Storage Area. Figure 1-2 presents the potential source areas defined at the site.

1.2 PURPOSE OF FIELD INVESTIGATION

Soil and groundwater at the McCormick and Baxter Superfund Site are contaminated primarily with creosote, dioxins, PCP, and metals that were used as wood preservatives. Free-phase product is known to exist in the subsurface, as are dissolved contaminants in groundwater and adsorbed contaminants on the solid phase. The primary objective of the field investigation was to collect the data required to better define the type and extent of NAPL contamination and refine the conceptual site model (CSM). These data were collected to support selection of a final groundwater remedy, including an evaluation of in situ thermal treatment technologies that potentially could enhance the removal of contaminants from the subsurface. Site-specific factors that may impact the effectiveness/deployment of in situ thermal technologies include vertical and horizontal distribution of NAPL of varying compositions; physical and chemical characteristics of the NAPL; depth of NAPL penetration; type, thickness, and heterogeneity of subsurface geologic material; and the presence of manmade subsurface structures or materials. Thermal treatment methods under consideration include steam injection/stripping and electrical heating.

Secondary objectives of this project were to document the extent of groundwater contamination, investigate the possibility of polychlorinated biphenyl (PCB) contamination in the Cellon Process Area, and evaluate the potential for sidewall soils along the slough to contaminate the proposed sediment cap. Results of the slough sidewall sample collection effort are presented in a separate technical memorandum and will not be discussed further in this report.

1.3 FIELD INVESTIGATION REPORT CONTENTS AND ORGANIZATION

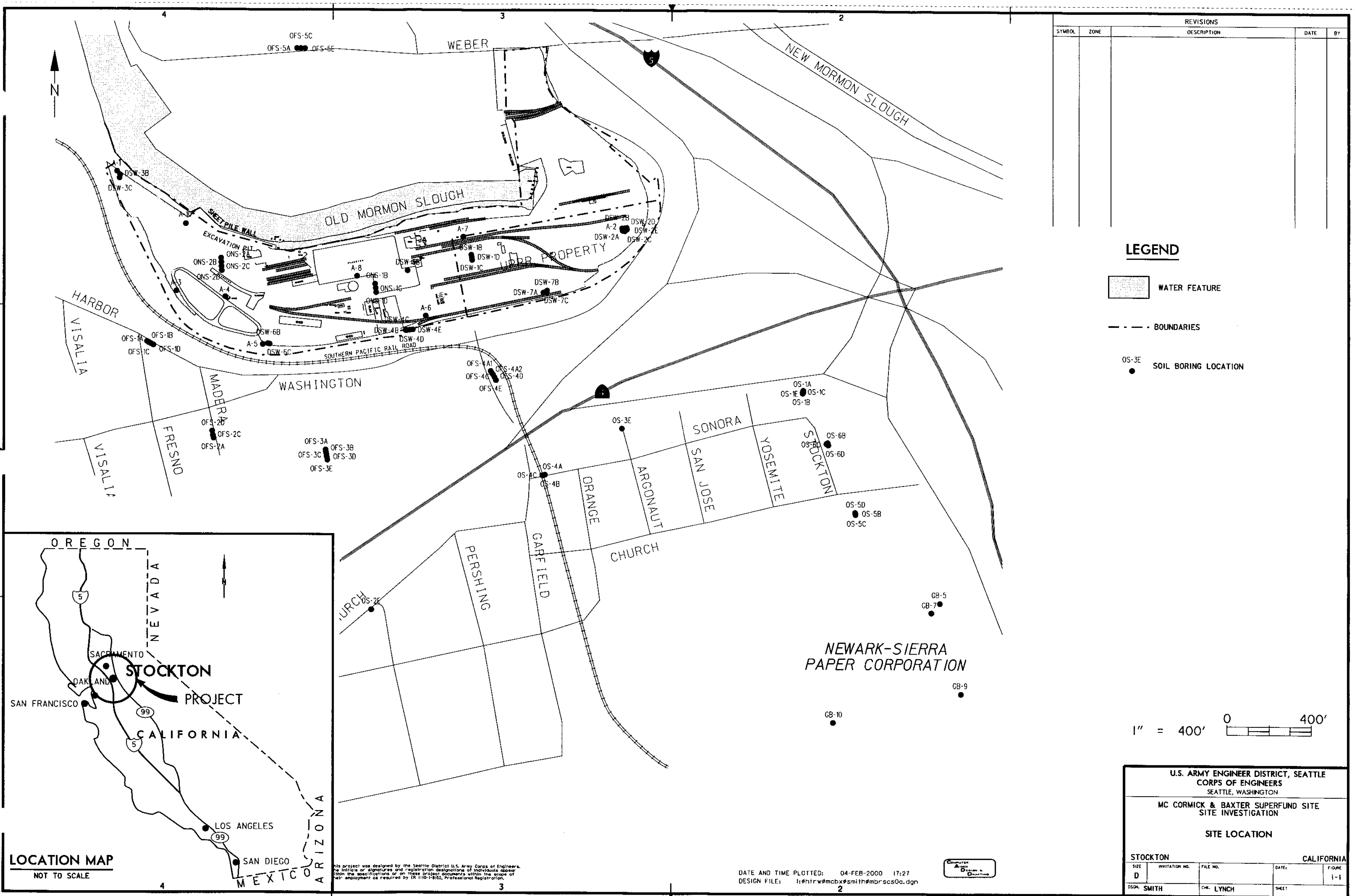
The purpose of this report is to present the 1999 groundwater and subsurface soil investigation results and the technical recommendations based on those results. To support the report objectives, this field investigation report contains:

- A detailed description of the subsurface soil and groundwater investigation
- Presentation and interpretation of analytical results
- Analysis of contamination source areas
- Estimates of the extent of lateral and vertical contamination
- Calculations of NAPL volume
- Calculations of contaminant plume migration
- Data gap identification
- Conclusions and recommendations

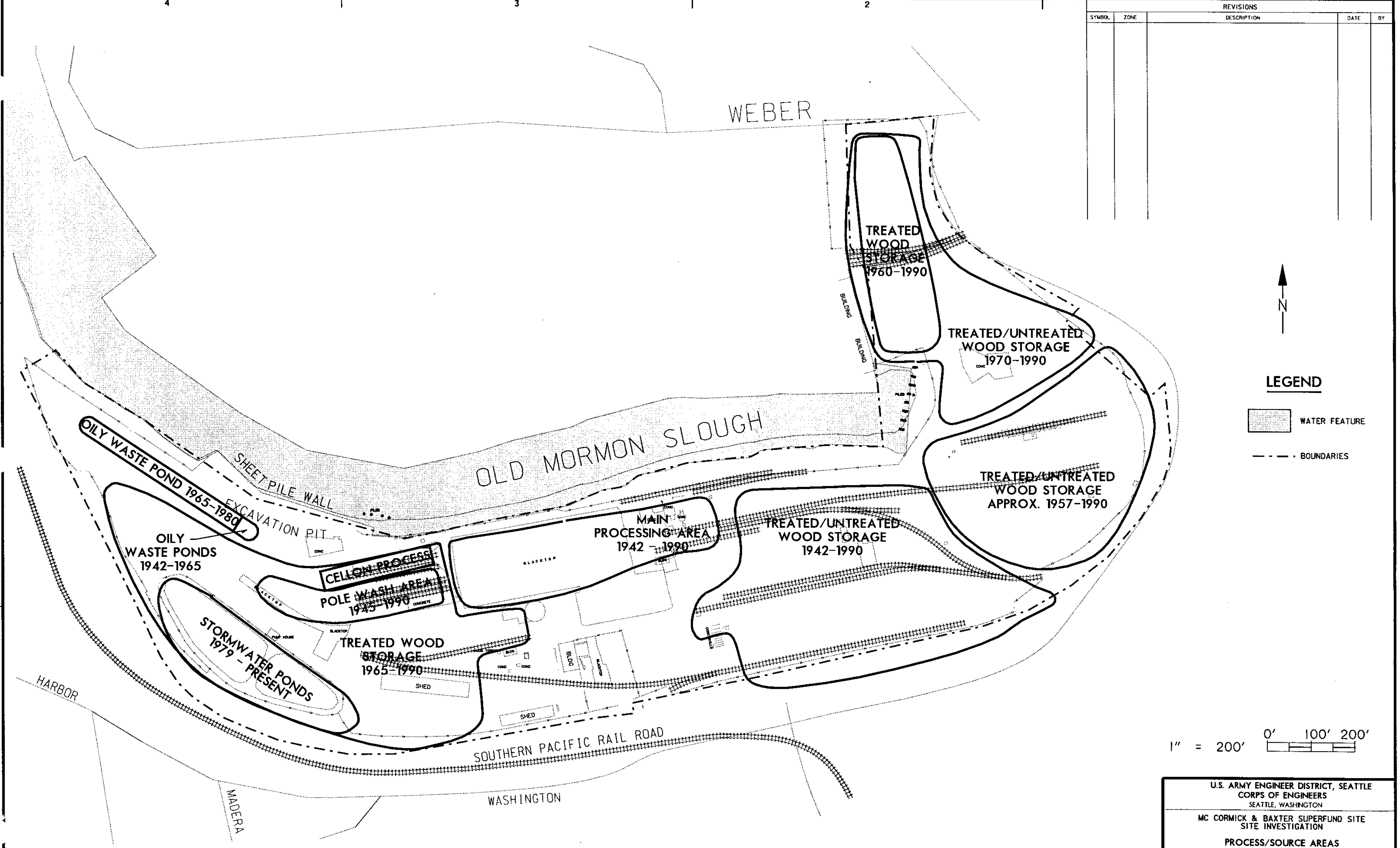
Tables and figures are presented at the end of the section in which they are first cited. Oversized plates are inserted in plastic sleeves at the end of the document.

Table 1-1
Wood-Preserving Chemicals Used at McCormick and Baxter

Common Name	Chemical Components	Period of Use
Creosote	Creosote and fuel oil	1942 to 1990
Pentachlorophenol	Pentachlorophenol and oil	1946 to 1990
Bouliden salts	Chromium, copper, and arsenic	1949 to 1952
CCA	Chromated copper and arsenic	1952 to 1970
Cellon	Pentachlorophenol, butane, and ether	1965 to 1988
ACA	Ammoniacal copper arsenate	1970 to 1986
Flamescape	Diammonium phosphate, ammonium sulfate, and boric acid	1976 to 1988
ACZA	Ammoniacal copper-zinc aresenate	1986 to 1990



WEBER
NEW MORMON SLOUGH
OLD MORMON SLOUGH
SHEETPILE WALL
EXCAVATION PIT
UPRR PROPERTY
SOUTHERN PACIFIC RAIL ROAD
HARBOR
VISALIA
WASHINGTON
MADERA
FRESNO
SONORA
SAN JOSE
YOSEMITE
STOCKTON
ARGONAUT
ORANGE
GARFIELD
PERSHING
CHURCH
NEWARK-SIERRA PAPER CORPORATION
OFS-5C
OFS-5A
OFS-5E
DSW-3B
DSW-3C
A-1
A-3
A-4
A-5
A-6
A-7
A-8
A-2
ONS-2A
ONS-2B
ONS-2C
ONS-2D
ONS-1B
ONS-1C
ONS-1D
DSW-6B
DSW-6C
DSW-1B
DSW-1D
DSW-1C
DSW-2B
DSW-2D
DSW-2A
DSW-2E
DSW-2C
DSW-7B
DSW-7A
DSW-7C
DSW-4C
DSW-4B
DSW-4E
DSW-4D
OFS-1A
OFS-1B
OFS-1C
OFS-1D
OFS-4A1
OFS-4A2
OFS-4C
OFS-4D
OFS-4E
OFS-2D
OFS-2C
OFS-2A
OFS-3A
OFS-3B
OFS-3C
OFS-3D
OFS-3E
OS-1A
OS-1E
OS-1C
OS-1B
OS-3E
OS-6B
OS-6D
OS-4A
OS-4C
OS-4B
OS-5D
OS-5B
OS-5C
OS-2E
GB-5
GB-7
GB-9
GB-10
N
REVISIONS
SYMBOL
ZONE
DESCRIPTION
DATE
BY
LEGEND
WATER FEATURE
BOUNDARIES
OS-3E
SOIL BORING LOCATION
1" = 400'
0
400'
OREGON
NEVADA
SACRAMENTO
STOCKTON
OAKLAND
PROJECT
SAN FRANCISCO
CALIFORNIA
LOS ANGELES
SAN DIEGO
ARIZONA
MEXICO
5
99
LOCATION MAP
NOT TO SCALE
DATE AND TIME PLOTTED: 04-FEB-2000 17:27
DESIGN FILE: l:#hirw#mcbx#smith#mbrscs0a.dgn
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
MC CORMICK & BAXTER SUPERFUND SITE
SITE INVESTIGATION
SITE LOCATION
STOCKTON
CALIFORNIA
SIZE
D
INVITATION NO.
FILE NO.
DATE:
FIGURE
1-1
DSGN. SMITH
CHK. LYNCH
SHEET



U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

MC CORMICK & BAXTER SUPERFUND SITE
SITE INVESTIGATION

PROCESS/SOURCE AREAS
IDENTIFIED IN THE RI

STOCKTON CALIFORNIA

SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
D				I-2
DSGN. SMITH		CHK. LYNCH	SHEET	

This project was designed by the Seattle District U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear within the specifications or on these project documents within the scope of their employment as required by ER 1110-1-8152, Professional Registration.

DATE AND TIME PLOTTED: 04-FEB-2000 17:17
DESIGN FILE: I:#htrw#McBx#smith#mbrscs012.dgn

2.0 INVESTIGATION ACTIVITIES SUMMARY

2.1 OVERVIEW OF INVESTIGATION OBJECTIVES

Soil and groundwater at the McCormick and Baxter Superfund Site are contaminated primarily with creosote, PCP, dioxin/furans, and metals that were used as wood preservatives. Free-phase product is known to exist in the subsurface. Dissolved contaminants are in groundwater and adsorbed contaminants are on the solid phase. The primary objectives of this field exploration were to:

- Collect data to better define the type and extent of NAPL contamination
- Evaluate the geologic conditions to support selection of a final groundwater remedy, including an evaluation of in situ thermal remediation technologies

These objectives are detailed in the field investigation's data quality objectives (DQO) process, summarized in Table 2-1. The activities associated with this investigation are detailed in the management plan (USACE 1999a).

2.2 SUMMARY OF FIELD AND LABORATORY ACTIVITIES

2.2.1 Site Survey

The survey crew surveyed the site in May 1999 and a topographic map was produced using Intergraph Microstation v.5. The components of the general survey included the following:

- Horizontal and vertical controls were established for the survey. The horizontal controls were in NAD83 and NVD88 state plane coordinates.
- Ten monuments were placed and surveyed on site.
- The survey was performed on a scale of 1 inch = 20 feet. Readings were taken on a 50-foot grid.
- The survey crew surveyed all pertinent site features, including all existing aboveground structures, the lined repository pit, the sheetpile wall along the slough, the perimeter security fence, the two stormwater holding ponds, the corners of the asphalt cap, buildings, paved areas, and the well pumphouse.

- Existing wells, new wells, and rotosonic boring locations were surveyed, with wells surveyed to a vertical control of 0.01 foot.

In addition, the banks along Old Mormon Slough were surveyed.

The topographic map that was generated from this survey included contours to an accuracy of 0.5 foot. These maps were used as the basis for documenting field activities.

2.2.2 Geophysical Investigation

A geophysical survey was performed to delineate the location and shape of subsurface features and metal debris. The project team used the data obtained by the geophysical survey when they selected sampling locations for the SCAPS investigation. The survey covered approximately 16 acres in the western portion of the site, where the presence of subsurface features and metal debris may affect the selection and design of the final groundwater remedy. Geophysical equipment was used to detect both ferrous and nonferrous material to a depth of 15 feet, the depth at which subsurface structures and metal debris were expected. Equipment used included the following:

- Electromagnetic line locating (EMLL) to determine the location of near-surface metal objects like utilities, railroad spurs, and near-surface buried metallic debris during the reconnaissance survey

- Electromagnetic (EM) with terrain conductivity (TC) and in-phase component (IPC) to determine shallow (10 to 15 feet below ground surface [bgs] maximum depth) conductivity variations possibly due to buried foreign objects or changes in subsurface materials

- Total field magnetrometry (TFM) to determine the presence of buried ferrous objects

A geophysical investigation report (Norcal 1999), including maps showing subsurface anomalies and interpretations of what those anomalies might be, was prepared and is available as a stand-alone report.

2.2.3 Groundwater Sampling

Groundwater samples were collected from 15 of the existing monitoring wells. The objectives of the groundwater sampling were threefold:

- To monitor the boundary of the naphthalene plume

- To collect data to aid with future evaluation of the natural attenuation potential and capacity of the system

- To evaluate the groundwater quality in six monitoring wells that have shown historical upward trends in PCP and/or tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalent concentration (TEC)

This was a limited groundwater sampling event to collect data specific to the NAPL field investigation. A summary of the rationale for why each well was sampled can be found in Table 2-2.

All but one of the 15 groundwater samples were collected using a low-flow purging technique. The one exception (from well DSW-4B) was collected using a higher-flow sampling technique, which involves purging three well volumes of water. This higher-flow sampling technique was used during previous groundwater monitoring events. A low-flow sampling technique was used for this sampling event because it provides data that is more reproducible and more representative than a higher-flow method and also generates less investigation-derived waste (IDW) than the higher-flow method. All existing pumps in these wells were removed, wrapped in plastic, and put into storage. Nondedicated Grundfos Rediflo 2 pumps were used for the low-flow sampling, and the Grundfos pump that used to be in well A-5 was used for the sampling of well DSW-4B to avoid contaminating a rented Rediflo 2 pump with NAPL. Purge water generated during groundwater sampling was contained in 55-gallon drums approved by the U.S. Department of Transportation or was allowed to evaporate on site. Groundwater sampling procedures are described in detail in the Field Sampling Plan (FSP), which is included in the Management Plan (USACE 1999a).

Samples were also collected from all 15 wells for groundwater density analyses at the EPA Kerr Research Laboratory in Ada, Oklahoma.

Additional details from the groundwater sampling event can be found in Appendix B.

2.2.4 NAPL Sampling

The previous data on NAPL composition from recovered product were not sufficient for groundwater remedy design purposes. Additional information was needed to determine whether NAPL composition and NAPL phase (dense NAPL [DNAPL] or light NAPL [LNAPL]) varied across the site. NAPL sampling was attempted at 18 existing monitoring wells, which included all wells with a previous record of LNAPL or DNAPL or wells where concentrations of dissolved phase contaminants were near their respective solubility limits. NAPL sampling was attempted at representative locations across the site (e.g., wells where NAPL was observed in the past, locations that may have NAPL that represents different sources and contaminant characteristics).

Following the removal of dedicated pumps, wells were checked for the presence of NAPL using an interface probe and other techniques to determine whether there was sufficient NAPL within the wells for sampling. Bailers were used to collect NAPL from the wells. Analyses, with the exception of boiling point distribution, were conducted by the EPA Kerr Laboratory. In addition, semivolatile organic compound (SVOC) and hydrocarbon analyses were conducted by Columbia Analytical Services and the EPA Kerr Laboratory.

A summary of the wells sampled and the analyses performed on those samples is shown in Table 2-3. Additional details from the NAPL sampling event can be found in the Daily Chemical Quality Assurance Reports for July 26, 27, and 28 in Appendix B.

2.2.5 SCAPS LIF and CPT

The SCAPS fluorescence intensity is generally proportional to in situ concentration of contaminants. The proportional feature of the SCAPS LIF can be used to pinpoint the zones of highest contaminant concentration and screen the variation in concentration across the site. The vertical and horizontal extent of the petroleum hydrocarbon plume was characterized using the SCAPS, equipped with an LIF sensor. Continuous fluorescence measurements and cone penetrometry (CPT) measurements were collected for the entire length of each of the SCAPS borings to provide an indication of relative concentrations of suspected contaminants. SCAPS LIF and cone penetrometry measurements started on July 12, 1999, and ended on September 5, 1999.

A total of 106 SCAPS pushes were placed at the site. SCAPS LIF and CPT locations were denoted with “SE” and a number (e.g., SE-01). The maximum depth of each push varied from 11.5 to 155.8 feet bgs, with an average push depth of 92.2 feet bgs. SCAPS penetrations were limited to on-site locations, except for two (SE-82 and SE-83) that were located on the California Cedar Products property south of the site. A summary of the SCAPS LIF and CPT activities is presented below. Further details can be found in the SCAPS field investigation report (USACE 1999b).

Details regarding the SCAPS LIF/CPT push locations can be found in Plate 1, as well as in Appendix B. The SCAPS penetration locations were measured daily with a cloth tape to the nearest 1 foot from a minimum of two directional orientations from already-surveyed site features. Salient information regarding the SCAPS penetrations, including location, dates, wavelength signature depth, and comments, was recorded on a push-probe penetration log form.

The initial 10 penetration locations were preselected based on known or suspected high levels of contamination or known data gaps. The remaining locations for SCAPS borings were selected in the field and were based on the following:

- SCAPS LIF borings were spaced to provide area-wide information on NAPL occurrence and stratigraphy. Data on extent of NAPL contamination were used to identify the area of interest for potential thermal treatment.

- Areas of highest contamination and different petroleum, oil, and lubricant (POL) contaminant types were further defined to evaluate whether more than one contaminant type might require treatment.

- The depth of POL contamination above the LIF threshold concentration was defined.

- The volume and location of free-phase product were evaluated. In addition, an evaluation of the vertical and horizontal extent of dissolved and free-phase contamination was conducted.

- Data were collected to fill in gaps for the conceptual site model.

During installation of the SCAPS probes, continuous geotechnical and stratigraphic data were collected to help interpret contaminant distribution and to delineate the continuity of subsurface materials that may influence contaminant movement, such as clay, silt, and cobble zones. The SCAPS data were also used to optimize the placement of rotosonic soil borings and monitoring wells. All SCAPS penetrations were grouted to ground surface with a silica flour and cement mixture.

2.2.6 SCAPS Soil Sampling

SCAPS soil sampling was conducted in three events: July 15, August 8 to 10, and September 6 to 10, 1999. The SCAPS LIF data were used to determine the SCAPS soil sampling locations for the field investigation. Soil samples were collected from the SCAPS push locations indicated in Table 2-4.

The primary objectives of the SCAPS soil sampling event were as follows:

- Obtain SCAPS LIF calibration and verification samples representative of different soil types, different emission spectra, and different emission intensities throughout the site within SCAPS depth limitations.

- Obtain soil samples to verify anomalous LIF sensor responses.
- Confirm the true bottom of POL, polycyclic aromatic hydrocarbon (PAH), and PCP contamination.
- Collect samples for physical analyses (i.e., permeability, density, porosity, grain size, cation exchange capacity [CEC], and total organic carbon [TOC]).

SCAPS soil sampling locations were selected in the field using the process described below.

1. Selected intervals to confirm threshold limit of SCAPS LIF. Push location intervals where contamination was suspected but not found were targeted to confirm low LIF response (i.e., 50- to 60-foot-thick sand zone).
2. Selected soil samples to evaluate intervals with different wavelength signatures.
3. Collected soil samples to determine the LIF response threshold above which NAPL may be present.
4. Collected samples in locations where nontarget fluorescence is suspected.

Details regarding how each sampling location was selected can be found in Appendix B. SCAPS soil sampling locations were denoted with “SS” and a number (e.g., SS-01).

One SCAPS penetration was placed in the Cellon Process Area (SS-08) to collect soil samples for PCB analysis. In addition, several penetrations were located in areas determined to be free of contamination to collect samples for TOC and permeability analyses. Details regarding the sample collection locations and what the samples were analyzed for can be found in Appendixes A and B.

SCAPS soil sampling locations were generally offset 1 to 2 feet from the initial LIF/CPT push location. The SCAPS truck pushed a hollow core to the desired sample collection depths and pulled out an approximately 2-foot-long by 1.5-inch-diameter soil sample. The soil core was then placed on a table in the field, where the sampling crew examined the core, performed a visual soil classification, and collected the subsequent soil samples in sample jars with Teflon-coated lids (samples for chemical and TOC analyses) or in plastic sleeves (samples for permeability and other physical properties) with caps over the ends of the sleeves.

Occasionally a 2-foot soil sample interval was split into more than one sample if there were two unique geologic zones or if NAPL contamination appeared to be isolated to a particular area of the 2-foot interval. Soil sample depths are included in the soil sample identification number for easy tracking (e.g., SS008-10-12 was collected from 10 to 12 feet bgs at SE-008).

After sampling was complete, the SCAPS borings were grouted to the ground surface with a silica flour and cement mixture.

2.2.7 Rotosonic Drilling, Soil Sampling, and Monitoring Well Installation

The rotosonic drilling commenced on August 3, 1999, and continued until November 9, 1999. During the field season, 18 borings were logged, as well as sampled and analyzed for total recoverable petroleum hydrocabons (TRPH), TPH-Dx, PCP, PAHs, heavy metals, and physical properties. Soil samples were also collected for use in treatability testing at the EPA Kerr Laboratory. Two monitoring wells were also installed. A total of 4,030 feet were drilled, with 3,045 feet logged and sampled.

The objectives of the contingency borings were twofold:

1. Determine the extent and composition of contamination and evaluate geology at depths where SCAPS penetrations are not possible

2. Determine downward migration potential for groundwater and NAPL

Contingency rotosonic boring locations were selected in the field using the process described below. Details regarding how each contingency boring location was selected can be found in Appendix B. Summary boring logs and well construction details can be found in Appendix D. Rotosonic boring locations were denoted with “SB” and a number (e.g., SB-01).

Most of the drilling locations were placed near SCAPS boreholes. The rotosonic explorations were used to confirm SCAPS LIF data as well as to collect soil samples and provide stratigraphic data at intervals deeper than SCAPS was able to penetrate. Of the 18 borings completed, 16 were collocated with SCAPS borings. Boring SB-99 was not collocated. It was placed to determine the extent of contamination originally found at depth at SB-06. This boring was completed as a continuous boring beginning at the ground surface. Two monitoring wells were installed on site (MW2E, a deep well located near SE-04, and MW1A, a shallow well located near SE-57). Rotosonic boring locations are shown in Plate 1.

The shallow well (MW1A) was placed in an area of known NAPL contamination (near the southern extent of the Cellon Process Area near SE-57) and was screened from 39.8 to 49.8 feet bgs. While drilling the boring for this well, it was noted that product seeped out of the ground in several places approximately 20 feet from the well. The deep E-zone well (MW2E) was placed in the E-zone gravel unit near the southern boundary of the site (SE-04) and screened from 245.5

to 255.5 feet bgs. The purpose of this well is to allow for sampling the E-zone near the southern boundary of the site to help determine whether contaminants are migrating from the site. Wells were completed using stainless steel prepacked well screens and were installed using a dielectric couple between the stainless steel and the mild steel casing.

Samples were collected from all borings and were analyzed for TPH-Dx, PCP, and PAHs. Samples were collected from a select set of borings and were analyzed for TRPH and using the bench (ex situ) LIF. Samples were also collected from another set of borings and used by the EPA Kerr Laboratory during treatability testing. In addition, other samples were collected and analyzed for heavy metals and physical properties. Details regarding the sample depth intervals and which analyses were performed for each sample can be found in Appendix D. Chemical analyses performed on each sample can be found in Appendix A.

2.3 DEVIATIONS FROM THE MANAGEMENT PLAN

It is common for field conditions to cause investigators to make changes from their plans to ensure that they can meet their investigation objectives. A number of changes from the management plan were made by investigation personnel. These changes are summarized below.

- Survey. No changes were made.

- Geophysical. No changes were made.

- Groundwater Sampling. Wells A-5, DSW-4B, DSW-4C, DSW-4D, DSW-6B, and DSW-6C were also analyzed for SVOCs using EPA Method 8270C. The groundwater sampling summary table in the management plan indicated that samples from these wells would not be analyzed for SVOCs. Three purge volumes were used during the sampling of well DSW-4B. The Management Plan called for low-flow sampling for all wells. However, the LNAPL present in DSW-4B did not allow for proper purging with the low-flow equipment. The Grundfos pump from well A-5 was used for sampling DSW-4B. In all other wells, nondedicated low-flow Grundfos Rediflo 2 pumps were used instead of the dedicated bladder pump system specified in the management plan. Microwells were not installed since the locations determined to be the most desirable for microwell placement were outside the property line and the Corps could not secure access agreements. Alkalinity was not measured during well sampling, although the Management Plan called for it, since it could be calculated using other measured parameters.

- NAPL Sampling. No changes were made.

- SCAPS LIF/CPT. Several different SCAPS probes and umbilical cords were used because of equipment failures and availability of a longer probe from the U.S. Navy. The SCAPS production rate was faster than projected, so 104 locations were investigated compared with the 40 estimated in the management plan. The maximum depth pushed using SCAPS was 155.8 feet bgs, although the objective was to push to 200 feet bgs if possible. The actual maximum depth was not longer than 155.8 feet bgs due to several factors (e.g., length of the SCAPS umbilical, encountering refusal, cone and sleeve CPT readings indicating possible probe breakage).

- SCAPS Soil. Permeability testing was performed by PTS Laboratories, Inc., not the EPA Kerr Laboratory. No microwells were installed. The physical testing methods cited in the Management Plan were clarified by PTS. The physical testing methods used were as follows:

  - American Society for Testing and Materials (ASTM) D2216 – Moisture Content
  - ASTM D2937 – Bulk Density
  - American Petroleum Institute (API) RP40 – Effective Porosity and NAPL Saturation
  - Walkley-Black – Total Organic Carbon
  - EPA 9081 – Cation Exchange Capacity
  - EPA 9100/ASTM 5084 – Permeability to Water
  - ASTM D4464 – Grain Size
  - ASTM D422 – Mechanical Sieve
  - ASTM 2887 – Boiling Point Distribution

- Rotosonic Drilling. Two additional borings were installed due to faster production rates than were estimated during project planning. Cores were collected continuously as needed. The Management Plan called for the two 250-foot continuous borings to be archived. Field personnel decided to archive individual samples from those borings instead of the entire borings. One shallow boring (SB-86) was drilled to collect treatability samples. The physical testing methods cited in the Management Plan were clarified by the laboratory, PTS. The physical testing methods used were the same as those described above for the SCAPS soil sampling.

- Additional Sampling. Surface samples of what turned out to be PCP crystals were collected near SE-08 and analyzed for PAHs and dioxins/furans. Sampling of these crystals was not included in the Management Plan because the crystals were not discovered until the field investigation.

- Performance Evaluation (PE) Sampling. Several PE samples were submitted to the SCAPS laboratory, the EPA Region 9 laboratory, and the FASP laboratory for analysis of TRPH, PAHs, and TPH-Dx. Some samples were mislabeled, incorrectly identified as site samples. This discrepancy was discovered during the quality assurance assessment of the data, and the sample IDs were corrected. In addition, there was a labeling mistake made in the field on samples SS079-80-81 and SS079-62-64. The sample labeled SS079-80-81 was actually a PE sample, which should have been identified as SS979-62-64. The sample labeled SS079-62-64 was the investigative sample collected from 80 to 81 feet bgs, and should have been labeled SS079-80-81. These sample numbers have been corrected in the database. Sample IDs that were corrected are summarized in Table 2-5.

2.4 DISPOSITION OF INVESTIGATION-DERIVED WASTE

Waste generated during the field investigation was collected and disposed of consistent with applicable regulations. Approximately 77 55-gallon drums of waste were generated during the field investigation (60 drums of soil cuttings and excess samples, 4 drums of water, 12 drums of personal protective equipment [PPE] and solid waste, and 1 drum of waste oil). All drums were labeled in accordance with the procedures described in the Management Plan. A summary of the investigation-derived waste (IDW) generated (and its current disposition) for each field activity is presented below.

- Survey. No waste was generated.

- Geophysical Investigation. No waste was generated.

- Groundwater Sampling. All purge water was placed in 55-gallon drums. Water that was contaminated with NAPL was stored on site for future disposal. All other water was allowed to evaporate in the drums on site. PPE that came into physical contact with NAPL was packaged in 55-gallon drums and stored on site for future disposal. All other PPE was packaged in plastic garbage bags and disposed of in the site's solid waste bin.

- NAPL Sampling. Spent plastic bailers and PPE that came into physical contact with NAPL were packaged in 55-gallon drums and stored on site for future disposal. All other PPE was packaged in plastic garbage bags and disposed of in the site's solid waste bin.

- EPA FASP Laboratory. Spent aqueous samples with hexane—about 0.5 liter (L)—were containerized in amber glass jars and given to USACE for disposal in the hazardous waste laboratory pack (55-gallon drum). Waste organic solvents (primarily hexane, about 1.2 L) were containerized in amber glass jars and given to USACE for disposal in the hazardous waste laboratory pack. An additional 6 L of aqueous waste was containerized in amber glass jars and given to USACE for on-site storage in the hazardous waste laboratory pack and was stored for future disposal. Solid laboratory waste (PPE, soil samples, and glassware) was containerized in a 55-gallon drum for disposal.

- SCAPS Laboratory. Water and acetone (contaminated rinse waste from the SCAPS laboratory) were collected in two 5-gallon buckets (approximately 8 gallons total). Freon waste (analytical calibration standards, extracted Freon from the SCAPS laboratory) was collected in three 4-liter glass bottles (approximately 10 L total) and was disposed of in a hazardous waste laboratory pack (55-gallon drum) stored for future disposal. Glassware (such as contaminated pipettes, soil jars, and vials from the SCAPS laboratory) was collected in plastic garbage bags. PPE (such as contaminated gloves, paper towels, and facial wipes from the SCAPS laboratory) was collected in one plastic garbage bag. These wastes were placed in the hazardous waste laboratory pack (55-gallon drum) and were stored for future disposal.

- SCAPS LIF/CPT and Soil Sampling. Soil cores that were not collected as samples were placed in 55-gallon drums and were stored on site for future disposal. One 55-gallon drum (approximately one-third full) contained hydraulic oil (i.e., less than 1 gallon of oil, plus soil) from an oil leak. Equipment decontamination rinsewater (water and laboratory-grade detergent) was collected in 55-gallon drums and was allowed to evaporate on site. PPE that came into physical contact with NAPL was packaged in 55-gallon drums and stored on site for future disposal. All other PPE was packaged in plastic garbage bags and disposed of in the site's solid waste bin.

- Rotosonic Drilling. Drill cuttings were collected in 55-gallon drums and were stored on site for future disposal. Soil cores that were not collected as samples were placed in 55-gallon drums and stored on site for future disposal. Equipment decontamination rinsewater (water and laboratory-grade detergent) was collected in 55-gallon drums and was allowed to evaporate on site. PPE that came into physical contact with NAPL was packaged in 55-gallon drums and stored on site for future disposal. All other PPE was packaged in plastic garbage bags and disposed of in the site's solid waste bin.

Table 2-1
McCormick and Baxter Data Quality Objectives Process

Problem Statement

Subsurface NAPL cannot be efficiently removed without thermally enhanced extraction methods. Sufficient data are not available to characterize contaminant extent and select a treatment technology.

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
SURFACE GEOPHYSICS			
Identify subsurface structures or debris present that might hinder exploratory work or impact the treatment system.	Delineate location and shape of subsurface structures and metal debris that will assist in: locating areas for SCAPS work; developing conceptual design for thermal treatment system	Perform over 16 acre area west of UPRR. Survey to depth of 15 feet on a series of profiles.	Detect ferrous and nonferrous material to a depth of 15 feet.
SCAPS CPT and LIF			
Determine where NAPL exists and the approximate extent (vertical and horizontal).	Horizontal and vertical extent of NAPL. Measure concentration of primarily 3 or more ring aromatic compounds (and some 2-ring compounds) using LIF.	LIF detection threshold: 100 to 500 mg/kg TPH. 40 LIF penetrations estimated; 10 preselected and 30 decided in field. Initial locations will be selected based on current hypothesis regarding NAPL locations. Spacing of penetrations will be determined in the field and will be evaluated against estimated 100-foot treatment unit size. Continuous readings to depth of 200 feet, if possible, final decisions regarding depth of penetration will be made in the field.	Threshold TPH value (reporting limit) determined in field. Approximately 100 to 500 mg/kg. Spatial resolution of 4 cm (0.13 foot) when driven at 1 m/min. LIF penetration locations will be determined on a daily basis by Kira Lynch (team leader/chemist), Richard Smith (hydrogeologist), Fred Hart (geologist), Randy Olsen (environmental engineer), and Steve Brewer (SCAPS team leader). SCAPS penetration locations will be selected to maximize understanding of the site conceptual site model and extent of NAPL contamination.
Identify if there are more than one unit (as defined by contaminant type) requiring treatment.	Spatial distribution of TPH contamination based on soil fluorescence emission spectra. These intervals will be targeted for collection of soil samples with SCAPS and analysis of soil samples for TPH, PAH, and PCP. Chemical data will assist with interpretation of LIF wavelength signature.	Non-target fluorescence will be evaluated by SCAPS soil sampling and analysis for TRPH. Soil samples TRPH and TPH-Dx results will be used in the field to verify apparent anomalous LIF sensor responses and assist with interpretation of wavelength signature.	Linear range of LIF is estimated to be 100 to 50,000 mg/kg for POL.
Determine how the hydrogeologic conceptual site model can be improved. Determine what natural subsurface features impact movement of NAPL.	Geotechnical and stratigraphic data from cone pressure and sleeve friction sensors. Aquitard topography and continuity.	Soil classification using SCAPS sensors according to ASTM Method D3441.	Soil classification compared to existing soil boring logs. Spatial resolution of 4 cm for soil classification at a rate of 1 m/min.

Table 2-1 (Continued)
McCormick and Baxter Data Quality Objectives Process

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
Determine where soil and groundwater samples will be collected.	Estimated contaminant concentrations in soil across site from LIF.	Select sampling locations where contamination is high and reflects a range of contaminant compositions as defined by wavelength signature.	Locations for SCAPS soil and groundwater samples will be determined in the field by Kira Lynch (team leader/chemist), Richard Smith (hydrogeologist), Fred Hart (geologist), Randy Olsen (environmental engineer), and Steve Brewer (SCAPS team leader). SCAPS soil and groundwater sample locations will be selected by evaluating existing data and SCAPS LIF data.
SCAPS SOIL and GROUNDWATER SAMPLING			
Determine accuracy of the SCAPS LIF data. Verify apparent anomalous LIF readings.	Collocated soil samples with SCAPS LIF penetrations.	Visual evaluation of soil cores for NAPL compared with LIF data. Collect soil samples at approximately 20 penetration locations for on-site analysis of TRPH by 418.1. Approximately 3 locations per penetration. Depths decided in field.	Sensitivity for TRPH must be at least as good as LIF threshold. LIF and confirmation TRPH should be in agreement on detect versus nondetect for 80% of the samples; false negative less than 5%.
Determine variability of contamination composition. Determine if contaminant extent can be better estimated. Confirm the bottom of POL, PAH, and PCP contamination. Develop the conceptual design of an in situ thermal treatment system.	Soil and groundwater data for TPH-Dx, PAH, and PCP. Compare soil chemical analysis with LIF results representative of different soil types, emission spectra and emission intensity. Chemical makeup, magnitude, and variability of contamination.	Soil samples analyzed by the following methods: SCAPS TRPH by 418.1, FASP TPH fingerprinting by GC/FID, limited SVOC TAL by GC/MS to be run by Region 9 Lab. Groundwater samples analyzed by the following methods: FASP TPH fingerprinting by GC/FID, limited SVOC TAL by GC/MS to be run by Region 9 Lab.	Sensitivity for TRPH, TPH, and SVOC analyses must be at least as good as LIF threshold. Sensitivity for SVOCs and TPH determined based on limitations of analytical instrumentation.
Determine how much NAPL is present. Evaluation of NAPL percent saturation is required to assist with evaluation of areas of mobile NAPL.	Percent saturation of NAPL contamination in soil.	Soil samples analyzed for TRPH. Data will be used to calculate percent saturation.	Sensitivity for TRPH analyses must be at least as good as LIF threshold.
Determine if PCB contamination of soil is encountered in Cellon Process area. This area of the site was targeted because evaluation of TPH GC chromatograms from soil samples previously collected indicate that hydraulic fluid was potentially used as the creosote carrier fluid in this process area.	Biased soil PCB data for locations in cellon process area.	Off-site analysis of soil samples for PCBs by EPA CLP SOW. Sample locations to be selected in the field to be representative of areas suspected to have the highest potential contamination. Samples will be collected from soil zones with higher relative clay content.	
Determine if the movement of dissolved organic contaminants is affected by adsorption onto naturally occurring organic matter.	Soil TOC concentrations in unimpacted areas and representative of soil conditions across the site.	9 to 12 soil samples analyzed for TOC using the Walkley-Black method. Samples will be selected to obtain TOC information representative of different aquifer and aquitard zones.	Detection limit of 1,000 mg C/kg to allow for K_d calculation.

Table 2-1 (Continued)
McCormick and Baxter Data Quality Objectives Process

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
Determine downward migration potential for groundwater and NAPL. Provide input for model.	Permeability (hydraulic conductivity) data on aquitard and aquifer materials. Need site-wide data to evaluate variability.	Collect soil samples from aquitard and aquifer materials for hydraulic conductivity measurements. Locations to be determined in the field.	Permeability measurements will be made on soil cores that may have to be repacked. The purpose of the permeability data is to estimate average permeability so this method should provide adequate permeability data quality.
Identify optimum locations for collecting continuous soil cores.	Soil contaminant concentrations.	Select boring locations in areas of highest contamination based on SCAPS results. In addition borings will be located in areas with different contaminant signatures if possible.	Selection of locations for continuous borings will be made in the field by Kira Lynch, Richard Smith, and Fred Hart. Decisions regarding well construction and design will be made in the field by Richard Smith and Fred Hart.
SCAPS MICROWELL INSTALLATION			
Determine the direction of groundwater flow across the site.	Water level data to establish flow conditions at corners of property.	Install two microwells at extreme NW and NE corners of project. Measure water levels to 0.01 feet.	Decisions regarding installation of microwells for water level measurements will be made in the field by Kira Lynch, Richard Smith, Fred Hart, and Randy Olsen.
Determine the extent and composition of NAPL.	Obtain NAPL samples from areas where no monitoring wells are located.	Install and sample up to ten microwells with hydrophobic screens. If NAPL samples are collected they will be analyzed as described for under NAPL samples.	Decisions regarding installation of microwells for NAPL sample collection will be made in the field by Kira Lynch, Richard Smith, Fred Hart, and Randy Olsen.
CONTINGENCY SOIL BORINGS			
Determine the extent/composition of contamination at depths where SCAPS penetrations are not possible.	Soil characterization where SCAPS met refusal before contamination was fully characterized.	Continuous sampling with a 10 ft core barrel with 5 ft split spoon to below SCAPS refusal to a depth of 200 to 250 feet at 15 locations. Selection of soil samples in field for analysis by: 1) SVOC limited TAL by GC/MS by Region 9 Lab. 2) TPH-Dx by GC/FID by FASP. All soil samples archived for additional chemical or physical testing.	Sensitivity for TRPH, TPH, and SVOC analyses must be at least as good as LIF threshold. Sensitivity for SVOCs and TPH based on limitations of analytical instrumentation.
Determine downward migration potential for groundwater and NAPL. Provide input for model.	Permeability (hydraulic conductivity) data on aquitard and aquifer materials. Need site-wide data to evaluate variability.	10 soil samples collected from locations selected in the field and analyzed for permeability by Kerr Lab. These samples will be collected if intervals of unique stratigraphy are encountered that were not sampled for permeability during SCAPS soil sampling.	Permeability measurements will be made on soil cores that may have to be repacked. The purpose of the permeability data is to estimate average permeability so this method should provide adequate permeability data quality.

Table 2-1 (Continued)
McCormick and Baxter Data Quality Objectives Process

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
SOIL BORINGS/MONITORING WELLS			
Determine how amenable the site and contamination are to treatment by thermal methods.	Soil samples collected for physical and chemical characterization of areas of heavy NAPL contamination and differing contaminant signatures.	2 soil borings to 250 feet bgs. Continuous soil cores will be obtained and archived. The cores will be visually evaluated to estimate NAPL saturation. Soil coring by split spoon or core barrel. Completed as monitoring wells. Soil samples for analysis collected from each of 5 aquifer zones and 5 aquitard zones (10 samples per boring for a total of 20 samples).	Samples will be selected from borings in the field. Selection criteria will be based on identifying unique geologic intervals and visible contamination.
	Chemical characteristics of NAPL contamination.	10 soil samples analyzed for dioxin/furans (1613B) and metals (arsenic, copper, chromium, and zinc by CLP RAS) at the Region 9 Lab.	Samples selected only from most contaminated areas of site to evaluate worst-case scenarios.
	Chemical characteristics of NAPL contamination.	20 soil samples for SVOCs full TAL with TICs (GC/MS) by Kerr Lab.	Sensitivity based on soil cleanup levels established in the site ROD (EPA Region 9, March 31, 1999). These samples will be split and also run by the FASP (TPH) and Region 9 (PAH and PCP, Modified 8270) labs to provide data for comparability analysis.
	Geochemistry comparison between zones to provide information to design extraction and treatment system.	20 soil samples for cation exchange capacity by PTS Laboratories.	Sensitivity based on limitations of analytical instrumentation. Samples selected from most sand-rich and clay-rich soils in clean zones.
	Physical characteristics of soil to determine downward migration potential for groundwater and NAPL. Provide input for model.	Soil classification during drilling. 20 soil samples analyzed for grain size (ASTM D422), density (ASTM D2937) and porosity (API RP40) by PTS Laboratories. 20 samples analyzed for permeability (Kerr Lab SOP) by Kerr Lab.	Soil classification compared to existing soil boring logs. Sensitivity based on limitations of analytical instrumentation. The purpose of the permeability data is to estimate average permeability so this method should provide adequate permeability data quality. Samples collected for physical testing will be from soil zones that appear to have relatively low levels of contamination, using visual inspection, and be representative of different stratigraphic horizons.
	Chemical and physical characteristics of NAPL contamination to provide information to design extraction and treatment system.	Up to 10 samples analyzed for oil and grease (9071A) by PTS Laboratories used with moisture content to calculate NAPL saturation.	Sensitivity based on limitations of analytical instrumentation. Samples selected from visibly contaminated zones.

Table 2-1 (Continued)
McCormick and Baxter Data Quality Objectives Process

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
Determine effect of heat on metals fate and transport.	Natural soil metals speciation data for comparison to treatability study results.	Up to 20 soil samples analyzed for metals speciation by Kerr Lab.	Sensitivity based on limitations of analytical instrumentation.
Determine the rate of creosote (PAH) recovery as a function of pore volumes of (condensed) steam injected, and determine the amount of residual creosote remaining after approximately eight pore volumes of steam have been injected. Determine effect of heat on metals fate and transport.	For feasibility and determination of design parameters of thermal treatment.	Up to 20 steam treatability tests, including steam column tests and leaching tests prior to and following steam treatment, by Kerr Lab. Study will focus on PAHs, but will include metals speciation information as well.	Focus on creosote and PAHs only. Samples for treatability testing will be selected in the field with input from Eva Davis. They will bracket the concentration range and be representative of varying contaminant signatures.
LNAPL and DNAPL TESTING			
Determine if NAPL composition varies across the site and if this will impact thermal treatment.	Chemical characteristics of NAPL across site and in different product phases to provide information for design of thermal treatment system.	10 to 20 NAPL samples will be collected from: 1) SCAPS penetrations, 2) existing monitoring wells, and/or 3) microwells. Chemical analysis for SVOCs (full TAL with TICs) and TPH-Dx (GC/FID) by Kerr Lab and Columbia.	Sensitivity based on limitations of analytical instrumentation. Samples will represent both DNAPL and LNAPL, and different contaminated areas.
Determine: 1) the tendency of NAPL to move downward when mobilized, 2) the ability of NAPL to flow to a recovery point, 3) the tendency of NAPL to dissolve in site groundwater, 4) if interfacial tension will effect the amount of residual creosote that will remain in soil, and 5) the potential for fractionation during thermal treatment.	Physical characteristics of NAPL to provide information for design of thermal treatment system.	Physical analyses performed by Kerr Lab for: 1) density from 10 to 90C each 10C, 2) viscosity from 10 to 90C each 10C, 3) solubility of NAPL in site groundwater at 10C and 90C, 4) oil-water interfacial tension from 10 to 90C each 10C using site groundwater, 5) wettability using a bottle test procedure, physical analyses by PTS Laboratories for: 6) boiling point distribution/distillation by ASTM D86.	Sensitivity based on limitations of analytical instrumentation. Density precision is approximately 0.001 gm/cm3.
MONITORING WELL GROUNDWATER SAMPLING AND ANALYSIS			
Determine dissolved naphthalene concentration and extent.	Measure PAHs and PCP in groundwater at perimeter well locations.	Collect samples from eight wells (A-8, DSW-7A, DSW-7B, DSW-7C, OS-3E, OS-4A, OS-4B, and OS-4C) and analyze for SVOCs full TAL with TICs by Region 9 Lab. Use low-flow sampling technique.	Sensitivity based on MCLs and PRG for naphthalene. Groundwater cleanup numbers have not been established for the site (EPA Region 9 ROD, March 31, 1999)
Determine if the historic upward trends in PCP and TCDD concentrations are continuing	Measure PCP or TCDD in groundwater from wells that have shown upward trend in dioxin or SVOC data.	Collect samples from seven wells (A-5, DSW-4B, DSW-4C, DSW-4D, DSW-6B, DSW-6C, and OFS-3B) and analyze for dioxin/furans by CLP lab and SVOCs full TAL with TICs by Region 9 Lab. Use low-flow sampling technique.	Sensitivity based on MCLs and PRG for naphthalene. Groundwater cleanup numbers have not been established for the site (EPA Region 9 ROD, March 31, 1999)

Table 2-1 (Continued)
McCormick and Baxter Data Quality Objectives Process

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
Determine if natural attenuation has the potential to impact contaminant migration.	Measure natural attenuation (NA) potential and capacity in groundwater samples.	Measure following parameters in 15 wells listed above: total and dissolved Mn (200), sulfate (300 Series), chloride (300 Series), nitrate/nitrite (300 Series), TOC (9060), Eh, pH, temperature, specific conductance, DO, turbidity and Hach field analysis of DO, dissolved CO2, total alkalinity, total hardness, total iron. Off-site analyses conducted by Region 9 Lab.	Sensitivity based on limitations of analytical instrumentation.
Determine the tendency of NAPL to move downward when mobilized.	Groundwater density measurements.	Measure density at 10 to 90C (Kerr Lab SOP) in 15 wells listed above.	Sensitivity based on limitations of analytical instrumentation. Precision is approximately 0.001 gm/cm3. Will provide data representative of density across site and in different zones.

Table 2-2
Monitoring Well Groundwater Sampling and Analysis

Monitoring Well ID	Rationale	Analyses to Be Performed
A-5	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
A-8	PCP upward trend	8270/NA parameters/RF parameters
DSW-4B	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
DSW-4C	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
DSW-4D	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
DSW-6B	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
DSW-6C	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
DSW-7A	Naphthalene migration well	8270/NA parameters/RF parameters
DSW-7B	Naphthalene migration well	8270/NA parameters/RF parameters
DSW-7C	Naphthalene migration well	8270/NA parameters
OFS-3B	Dioxin upward trend	1613B/8270/NA parameters/RF parameters
OS-3E	Naphthalene migration well	8270/NA parameters/RF parameters
OS-4A	Naphthalene migration well	8270/NA parameters/RF parameters
OS-4B	Naphthalene migration well	8270/NA parameters/RF parameters
OS-4C	Naphthalene migration well	8270/NA parameters/RF parameters

Notes:
NA - natural attenuation parameters (e.g., total and dissolved manganese, sulfate, chloride, nitrate, nitrite, TOC, dissolved oxygen, dissolved carbon dioxide, total hardness, total iron)
RF - routine field parameters (e.g., redox potential, pH, temperature, specific conductivity, turbidity, and dissolved oxygen)

Table 2-3
NAPL Monitoring Wells

Well ID	Well Total Depth (feet)	NAPL Sampled	Analyses Performed/Comments
A-4	37.05		No NAPL encountered
A-5	35.44		No NAPL encountered
A-6	(27.45)		No NAPL encountered
A-8	37.88		LNAPL encountered; however, insufficient volume to sample
A-10	34.58	X	8270/Hydrocarbon Fingerprinting/Physical Properties[1]
DSW-1D	(58.5)		No NAPL encountered
DSW-4B	74.38		LNAPL encountered; however, insufficient volume to sample
DSW-4C	129.61		No NAPL encountered
DSW-4D	179.58		No NAPL encountered
DSW-4E	266.39		No NAPL encountered
DSW-5B	78.25		No NAPL encountered
DSW-6B	90.37	X	8270/Hydrocarbon Fingerprinting/Physical Properties
DSW-6C	141.26		No NAPL encountered
OFS-4D	197.66		No NAPL encountered
OFS-4E	255.65		No NAPL encountered
ONS-1B	86.15	X	8270/Hydrocarbon Fingerprinting/Physical Properties
ONS-1C	144.58		LNAPL encountered; however, insufficient volume to sample
ONS-2A	59.71		No NAPL encountered

[1] Physical properties for NAPL samples only = density, viscosity, oil-water interfacial tension (all three using 10°C increments from 10 to 90°C), solubility at two different temperatures between 10 and 90°C, wettability, and boiling point distribution (by ASTM D86).

Table 2-4
SCAPS Soil Sampling Locations

Sample Location	Intervals Sampled (feet bgs)
SE-002	14.3-15.1, 15.1-16.0, 24.5-25.6, 25.6-26.5, 84-86
SE-005	29.5-30.5, 30.5-31.6, 43-45, 67-69, 86-87.5
SE-008	10.5-11.7, 19-21, 40-41.5, 42-44, 45-45.9, 48-50
SE-009	21-23, 55-57, 69-70
SE-010	12-14, 30-31.2, 59-59.8, 61.5-63
SE-020	29-31, 47-49, 51-51.8, 56-58, 60-62
SE-028	9.0-10.1, 10.1-11
SE-035	50-52, 54-54.4, 58-59.2
SE-037	31-32.6, 56-57, 93-95
SE-039	10-12, 19-20.6, 22-22.4, 40-42
SE-043	7-8.6, 13-15, 23-25, 27-29
SE-047	10-12, 12-14, 14-15, 21.6-22
SE-064	31-33, 34-36, 41-43, 50-51, 62-63.3, 67-69
SE-079	48.7-48.9, 51-52, 54.2-55, 54-54.2, 58-60, 63-63.9, 80-81
SE-081	50-50.6, 50-52
SE-088	5.4-5.8, 9-10.3, 10.3-11, 14-15.4, 20-21, 24-25.8, 36-38
SE-093	26.7-27, 45-46, 63-65, 66-67, 67-68
SE-096	63-65, 66-67.6, 73-74.2, 78-78.7, 81-82.4, 84.5-84.8, 94-96
SE-097	76.2-76.6, 87-89, 90-92, 92.6-94, 100-102
SE-097A	90-90.1, 90-92

Table 2-5
Performance Evaluation Sample IDs

Revised Sample ID	Sample Date	Sample ID Given in Field	TPH-Dx	PAH/PCP
SB901001	8/4/99		X	
SB906-144.0-144.4	8/5/99			X
SB925-140.0-140.2	8/27/99	SB025-140.0-140.2		X
SB930-204.0-204.3	8/25/99		X	
SB961-110.2-110.6	8/31/99	SB061-110.2-110.6	X	
SB961-138.2-138.6	9/1/99	SB061-138.2-138.6		X
SS908-10-12	8/8/99		X	
SS928-10.1-11	8/8/99			X
SS979-62-64	9/8/99	SS079-80-81		X
SS997-105-106	9/7/99		X	

3.0 DATA SUMMARY

3.1 SITE SURVEY

The Sacramento District U.S. Army Corps of Engineers Survey Branch conducted a detailed site survey of the approximately 32 acres of the McCormick and Baxter site during May through November of 1999. The survey work consisted of the following tasks:

- Placing 10 survey control monuments on site
- Surveying the uplands ground surface elevation on approximately 50-foot centers
- Surveying the locations of all pertinent aboveground site features
- Surveying the coordinates of all existing and new project monitoring wells
- Surveying a select set of borings and SCAPS push locations
- Surveying the bank of Old Mormon Slough from the east end of the sheet pile wall to the edge of the Union Ice property line on the north side of the slough
- Producing a CADD base map of the site

The slough bank survey consisted of 32 cross sections from the low tide line up to a minimum of 100 feet onto the upland. The survey cross sections were spaced at 50-foot intervals. Detailed surveying of the slough bank was conducted to support bank stabilization work to curtail the slumping of contaminated soils into the slough and onto a proposed sediment cap.

The horizontal coordinates and vertical elevations of all existing and new monitoring wells associated with the McCormick and Baxter site were surveyed. A select set of soil boring and SCAPS push locations were also surveyed by the Sacramento District USACE when the surveyors were on site to survey the new monitoring wells, MW1A and MW2E. Horizontal coordinates for soil borings and SCAPS push locations that were not surveyed were estimated by measuring each location's distance and bearing from surveyed features on the site map. The elevation of each nonsurveyed location was estimated from nearby surveyed ground surface elevations shown on the detailed site map.

All horizontal survey coordinates were measured using the California State Coordinate System Zone 3 (NAD83). All vertical elevations were measured using NVD88. Coordinate and elevation data measured for monitoring wells, SCAPS push locations, and soil boring locations are listed in Table 3-1.

3.2 GEOPHYSICAL SURVEY

A geophysical survey was conducted by Norcal Geophysical Consultants, Inc. The survey area included about 16 acres of the site, predominantly in the Main Processing Area, Cellon Process Area, Oily Waste Ponds Area, and the areas south and west of these areas. The results of the survey are shown in Figure 3-1. The results indicate subsurface anomalies in the anticipated locations (e.g., beneath the asphalt cap in the Main Processing Area, the Cellon Process Area, and former railroad track locations).

Since the results of any geophysical investigation indicate only the different types of subsurface anomalies (electromagnetic and magnetic for the McCormick and Baxter site) and not actual “pictures” of subsurface objects, interpretation of the survey data was necessary. Using the subsurface anomalies data, Norcal mapped their interpretations of the subsurface objects at the site (Figure 3-1). Anomalies were interpreted as follows:

- Concrete Pads and Foundations. These were found along the north central boundary of the geophysical investigation area, and in the center and southeast corner of the geophysical investigation area.

- Footings. The footings were suspected to be supports for a former aboveground storage tank that was located in the southeast corner of the geophysical investigation area.

- Railroad Spurs. These were found throughout the site, including several main lines that trend through the site as well as individual spurs related to specific former operations. Small sections of some of the spurs appear to have been removed.

- Utilities. The subsurface utilities were found generally in the center of the survey area. The utilities probably represent water, electric, and natural gas lines. There may be deeper utilities (e.g., stormdrain lines) that were not detected during the survey.

- Buried Debris and Non-Interpreted Anomalies. These items were found generally beneath the asphalt cap and are believed to represent buried debris, former facility subsurface floors and structures, imported soils, and the fill material used in the cap construction.

Additional details can be found in the geophysical survey report (Norcal 1999).

3.3 SCAPS GEOTECHNICAL AND STRATIGRAPHIC DATA

The SCAPS CPT unit consists of strain gauges that measure cone pressure and sleeve friction in accordance with ASTM Standard D3441. The electromechanical responses of the strain gauges are translated into a soil classification number. A complete description of the SCAPS CPT system and results are given in the SCAPS field investigation report (USACE 1999b). The soil classification numbers and associated material descriptions produced by the SCAPS CPT unit are as follows:

- 0: Peats
- 0-1: Clays
- 1-2: Silt mixtures
- 2-3: Sand mixtures
- 3-4: Sands
- 4-5: Sands and gravels

A soil classification number is assigned every 0.1 foot to the material penetrated.

3.3.1 SCAPS Soil Classification and Visual Observation Comparability

Confirmation soil samples were collected using the SCAPS rig adjacent to CPT/LIF push locations, typically within 2 feet of the original push location. Contingency soil borings using the Resonant Sonic rig were typically drilled within 10 feet of the associated SCAPS CPT/LIF push. The CPT results, SCAPS confirmation soil sampling results, and laboratory grain size analyses from SCAPS and rotosonic borings are compared in Table 3-2. The SCAPS soil classification agrees with the visual soil sample descriptions and grain size analyses with only a few exceptions. Contradictory soil descriptions between the CPT results and visual descriptions are most likely due to the natural spatial variability of subsurface materials. The material reported by the lab to be a clayey silt was visually identified as clay in the field due to the high clay content of the silt. The visual and laboratory descriptions for the silt material are not considered contradictory since the clay content of the silt was generally high and estimating percentages of clays versus silts is extremely difficult using visual/manual procedures.

Soil descriptions for the portions of rotosonic borings that were coincident with SCAPS CPT data are not included in Table 3-2 because the length of SCAPS CPT push and rotosonic boring soil description overlap is too large to present in a table. The results of the two methods were compared when geologic cross sections were developed. Agreement between the two methods is excellent.

The SCAPS CPT and soil classification interpretation provides an accurate measurement of grain size distribution at the McCormick and Baxter site.

3.4 SCAPS LIF DATA

The in situ laser-induced fluorescence system collected peak intensity and peak wavelength for each LIF spectrum. The intensity of the return signal is related to the magnitude of the PAH compounds that are components of the petroleum hydrocarbon contamination. Data were collected continuously at each of the 104 push locations, with a total of 9,600 feet of depth pushed. LIF data for all the SCAPS CPT pushes are presented in the SCAPS field investigation report (USACE 1999b).

The in situ LIF data were used to identify contaminated areas at the site and to refine the NAPL CSM. In situ LIF data were also compared with ex situ LIF (as defined in 3.5.5) and on-site laboratory TRPH analyses of soil samples collected by the SCAPS from locations adjacent to the LIF push locations. This evaluation concluded that the intensity limit of detection for the in situ SCAPS LIF at the McCormick and Baxter site was approximately 300 counts, which was determined to be equivalent to 450 mg/kg of TRPH.

Additional details on the SCAPS LIF effort, including Groundwater Monitoring System (GMS) figures that display the LIF data, can be found in the SCAPS field investigation report (USACE 1999b).

3.5 SCAPS SOIL SAMPLING DATA

3.5.1 FASP TPH Data

TPH was detected above the method detection limit of 100 mg/kg (wet weight) in 42 of 74 SCAPS soil samples. All TPH data is summarized in Table A-2 of Appendix A. The TPH detections in the SCAPS soil samples are presented in Table A-4 of Appendix A. The SCAPS soil sample results are discussed in more detail in Section 5.0.

3.5.2 PAH/PCP Data

Naphthalene was detected above the method detection limit of 100 mg/kg (dry weight) in 17 of 74 SCAPS soil samples. PCP was detected above the method detection limit of 50 mg/kg (dry weight) in 10 of 74 SCAPS soil samples. All PAH/PCP data are summarized in Table A-2 of Appendix A. The SVOC detections in the SCAPS soil samples are presented in Table A-4 of Appendix A. The SCAPS soil sample results are discussed in more detail in Section 5.0.

3.5.3 SCAPS TRPH Data

TRPH was detected above the method detection limit of 50 mg/kg (wet weight) in 40 of 74 SCAPS soil samples. All TRPH data are summarized in Table A-2 of Appendix A. The TRPH detections in the SCAPS soil samples are presented in Table A-4 of Appendix A. The SCAPS soil sample results are discussed in more detail in Section 5.0.

3.5.4 Cellon Process Area PCB Soil Data

A total of six soil samples, plus one blind quality control (QC) duplicate, were collected from the Cellon Process Area for PCB analysis by EPA Method 8082. PCBs were not detected in any of these samples. The results are given in Table 3-3.

3.5.5 LIF Measurement and Soil Chemical Data Comparability

Soil samples were collected using the SCAPS to accomplish the following objectives:

- Obtain LIF verification samples representative of different soil types, different emission spectra, and different emission intensities throughout the site within SCAPS depth limitations.
- Obtain soil samples to verify apparent anomalous LIF sensor responses.
- Identify locations for continuous rotosonic soil borings.
- Confirm the maximum depth of POL and PAH/PCP contamination.
- Assess the percent saturation of NAPL contamination.

Soil sampling sites for verification were chosen in the field based on the following decision criteria:

- Select intervals to confirm threshold limit of SCAPS LIF. Push location intervals where contamination is suspected but not found should be targeted to confirm low LIF response.
- Select soil samples to evaluate intervals with different wavelength signatures.
- Select soil samples to assist with evaluating the LIF response threshold above which NAPL may be present.

- Select soil samples in locations where non-target fluorescence is suspected.

After the soil sample target intervals were selected, the SCAPS unit was positioned near a previous LIF/CPT location—usually within 1 to 2 feet of the original probe location. This procedure was followed to obtain representative samples from depths of interest corresponding to the adjacent LIF/CPT location. A closer location was not desired since the original sensor push-point hole had been grouted, and samples influenced by the grout material were not desired.

Fluorescence emission spectra of the homogenized soil samples were obtained in the field by pressing the soil against the sapphire window of the SCAPS LIF/CPT probe and collecting three or four replicate emission spectra. The replicate measurements were averaged for each sample. This procedure was used to obtain the ex situ LIF response for the interval of interest. The in situ LIF response at the depth of interest was determined by estimating the peak response from the LIF panel plots. To enhance quality control, the LIF/CPT in situ and bench (ex situ) LIF responses were compared to the SCAPS TRPH analytical results.

Seventy-four soil samples were collected and analyzed by the field-modified TRPH method. Interpretation of the associated in situ LIF response for each soil sample was made by obtaining the highest count from the ".gos" file generated by the SCAPS data acquisition software. The ".gos" file is one of five data files generated by the SCAPS LIF/CPT computer software that contains depth-discrete intensities and corresponding wavelengths to the nearest 0.01 ft. Sixty of the 74 measurements reported in situ values above the LIF detection threshold of 300 counts. Results were evaluated regarding the frequency of LIF sensor false positive and false negative responses based on the TRPH analyses (USACE 1995). A false positive response designation was assigned to a sample that yielded an LIF response greater than the level of detection (LOD) (300 counts), while the TRPH analysis reported values less than the calculated TRPH LOD (15 mg/kg). A false negative response was assigned for samples with TRPH above 450 mg/kg, while the LIF analysis reported responses less than 300 counts. It is assumed that the TRPH method expresses greater linearity than the SCAPS LIF sensor.

A summary of the in situ LIF responses and the TRPH results is tabulated in Table 3-4.

An evaluation of the data indicates that 20 of the 60 reported in situ LIF detects were noted as being false positives. Many factors affect the high bias of the SCAPS LIF sensor. For example, naturally occurring materials, such as calcium carbonate (calcite), and wood fragments tend to give a false positive response to the LIF sensor. The presence of calcite was confirmed in the field by performing the reactive HCl test on several samples collected. The LIF in situ data used in this comparison are considered to be biased high due to the method of obtaining the "high count" from the in situ data acquisition files. In addition, the soil samples collected were homogenized prior to containerization, and NAPL contamination traveling in veins and stringers may have been diluted below detection levels in the soil samples.

The false negative result identified in Table 3-4 occurred in sample SS008-48-50. It is believed that there was an error in determining the sample interval, because the ex situ LIF response (2,349 counts) was much greater than the in situ LIF response (37 counts). This field sampling error explains the one false negative response.

The false positive and false negative results are attributed to anomalies inherent in the sample collection and handling technique as well as to the inherent statistical probability of such events occurring.

A similar evaluation was performed with regard to the bench LIF responses (ex situ) and related TRPH results. A total of 74 SCAPS and 12 rotosonic soil samples were collected and analyzed by both the field TRPH and bench ex situ LIF methods. Interpretation of the associated bench ex situ LIF response for each soil sample was made by scanning spectrum wavelengths 440 through 674 and noting the highest LIF count. Thirty-four of the 86 measurements reported ex situ values above the LIF detection threshold of 300 counts. The bench ex situ LIF responses and the TRPH results are summarized in Table 3-5.

No false positive ex situ LIF signals were observed, and only two false negative results were reported. The false negatives were seen in samples SS002 (14.3- to 15.1-foot interval) and SS047 (10- to 12-foot interval), both of which contained moderate levels of TRPH and in situ LIF responses near the LIF threshold detection limit of 300 counts. Given that both samples are from shallow depth intervals, it is suspected that the contamination may be that of a fuel product not detectable by LIF.

It is important to point out that the in situ LIF response was consistently greater than the ex situ LIF response. Correspondingly, one would expect the soil chemical data to be biased low when compared to actual in situ soil chemical concentrations. The low bias in the ex situ soil data set is believed to be influenced by three primary factors:

1. NAPL at the site travels in veins and residual NAPL is in the form of globules. The LIF can measure these directly in situ, but the soil sample collection procedure can result in dilution to the point that individual chemical constituents are below detection levels.

2. When some soil cores were collected, mobile NAPL was lost from the core during the sampling process.

3. Evaluation of field duplicate results for samples that contained NAPL indicates that the precision for these results is very poor. The way in which the laboratory subsamples the soil and how much product is included in the aliquot used for extraction and analysis have a significant influence on the end result.

3.5.6 Interpretation of LIF Data

The SCAPS LIF data were evaluated to identify zones of probable high concentrations of contaminants and likely pathways of NAPL transport. The following criteria were used as lines of evidence to identify intervals of probable NAPL contamination within each SCAPS push.

- LIF counts above 500 were considered an indication of NAPL presence. Intervals with LIF counts between 300 and 500 were considered questionable and may be considered, with other lines of evidence, as an indication of NAPL presence.
- Spectral profiles across the site, which were associated with confirmed creosote NAPL observations during soil sampling, were common at peak wavelengths between 467 and 476 nanometers. LIF spectral profiles for pushes located within and near the Main Processing Area, which were associated with confirmed creosote NAPL observations during soil sampling, were common at peak wavelengths between 480 and 499 nanometers. This information was used to screen the LIF data set and identify intervals associated with creosote contamination.
- Collocated SCAPS soil sampling results were evaluated to determine whether NAPL was reported in the interval of interest as odor, visible, or mobile NAPL.
- The location of each LIF push and its proximity to confirmed NAPL presence was considered.

Table 3-6 summarizes the SCAPS LIF data analysis and identifies intervals of significant creosote contamination or other unique petroleum hydrocarbon contamination within each SCAPS push.

3.6 ROTOSONIC BORINGS SOIL SAMPLING DATA

All rotosonic soil boring soil data are identified on the report tables located in this section and in Appendix A using the “SB” prefix.

3.6.1 FASP TPH Data

A total of 395 soil samples were collected from 18 locations (Figure 3-2) using rotosonic drilling methods and analyzed for TPH by the EPA FASP laboratory in accordance with the EPA Region 9 FASP standard operating procedure (SOP) for modified SW846 Method 8015. Rotosonic boreholes were drilled at locations where the SCAPS unit was refused before contamination was completely defined. The initial sample collection depth was located at or below the SCAPS refusal depth. At four locations, TPH was not detected at any depth: SB-007, SB-018 (TPH was detected at one depth at 1 mg/kg), SB-025, and SB-047; however, the LIF indicated contamination at shallower depths in the same push/borehole locations. TPH was not detected at the end depth of any soil borings. Concentrations were not corrected for soil moisture (i.e., reported as wet weight).

TPH was detected at the highest concentration at the greatest depth in SB-099 (212.6 feet bgs [1,500 mg/kg]). TPH was detected in concentrations greater than 1,000 mg/kg at seven locations: SB-006 (162 to 162.3 feet bgs [6,900 mg/kg]); SB-027 (69 to 69.3 feet bgs [1,300 mg/kg], 115.9 to 116.3 feet bgs [5,100 mg/kg], and 122.8 to 123.1 feet bgs [15,000 mg/kg]; SB-028 (28.3 to 29.4 feet bgs [2,600 mg/kg], 31 to 33 feet bgs [1,300 mg/kg], and 53.5 to 55 feet bgs [6,500 mg/kg]); SB-057 (eight depth intervals [2,100 to 30,000 mg/kg]); SB-086 (seven depth intervals [1,900 to 11,000 mg/kg]); SB-092 (139.5 to 139.8 feet bgs [1,100 mg/kg]); and SB-099 (nine depth intervals [1,200 to 18,000 mg/kg]). TPH was detected at the greatest concentration on the site in SB-057 at 30,000 mg/kg at 36 to 38 feet bgs.

All TPH detections in the soil boring samples collected are presented in Table A-3 of Appendix A.

3.6.2 PAH/PCP Data

A total of 221 soil samples were collected from 18 locations using rotosonic drilling methods and analyzed by the EPA Region 9 laboratory in accordance with the EPA Region 9 SOP 315 for analysis of SVOCs by EPA SW846 Method 8270. Rotosonic boreholes were drilled at locations where the SCAPS unit was refused before contamination was completely defined. The initial sample collection depths were located at or below the SCAPS refusal depth or at selected depth intervals to confirm the SCAPS LIF responses. At six locations, SVOCs were not detected at any depth: SB-007, SB-018, SB-019, SB-030, SB-047, and SB-052. SVOCs were not detected at the end depth of any soil boring. All PAH/PCP concentrations were corrected for soil moisture (i.e., reported as dry weight).

Pentachlorophenol was detected in the shallow (i.e., less than 20 feet bgs) soil column at seven locations: SB-027 (13.3 to 13.7 feet bgs [530 mg/kg] and 19.7 to 20.0 feet bgs [230 mg/kg]); SB-028 (8.0 to 8.4 feet bgs [140 mg/kg]); SB-047 (12 to 14 feet bgs [140 mg/kg] and 14 to 15 feet bgs [330 mg/kg]); SB-057 (2.7 to 3.0 feet bgs [200 mg/kg]); SB-084 (11.0 to 11.4 feet bgs [120 mg/kg]); SB-086 (17 to 17.3 feet bgs [2,100 mg/kg]); and SB-099 (3.1 to 4.6 feet bgs [100 and 200 mg/kg]). PCP was detected at the deepest depth in SB-061 at 100 mg/kg at 138.2 to 138.6 feet bgs and at the greatest concentration in SB-086 at 2,100 mg/kg at 17 to 17.3 feet bgs. All PCP detections in the soil boring samples collected during the 1999 NAPL investigation are presented in Table A-3 of Appendix A.

Naphthalene was detected at concentrations greater than 1,000 mg/kg at six locations: SB-006 (162 to 162.3 feet bgs [4,100 mg/kg]); SB-027 (122.8 to 123.1 feet bgs [2,700 mg/kg]); SB-028 (53.5 to 55 feet bgs and the field duplicate at the same depth [1,200 and 1,900 mg/kg, respectively]); SB-029 (53.5 to 55 feet bgs [2,000 mg/kg]; SB-057 (36 to 38 feet bgs and the field duplicate at the same depth [3,100 and 5,400 mg/kg, respectively]); SB-057 (40 to 50 feet bgs [5,800 mg/kg]); SB-086 (21.6 to 23.3, 27 to 28.5, and 36.3 to 38 feet bgs [3,500, 1,200, and 1,800 mg/kg, respectively]); and SB-099 at 27.5 to 29.5, the field duplicate at the same depth, and 41 to 42.5 feet bgs [2,000, 1,900, and 1,200 mg/kg, respectively]). All naphthalene detections in the soil boring samples collected during the investigation are presented in Table A-3 of Appendix A.

3.6.3 Dioxins and Furans Data

Twenty-three soil samples were collected from September 29 through October 9, 1999, and analyzed for dioxins and furans using EPA Method 1613B. Appendix A presents the chlorinated furan and dioxin data. All values are reported as dry weight. The calculated toxicity equivalent concentrations (TECs, also known as toxicity equivalents [TEQs]) were greater than 50 nanograms per kilogram (ng/kg) 2,3,7,8-TCDD (U/2) in 13 soil samples, including SB-028 (12 to 12.5 feet bgs [264 ng/kg]), SB-028 (28.3 to 29.4 feet bgs [192 ng/kg]), SB-028 (31 to 33 feet bgs [93 ng/kg]), SB-028 (53.5 to 55 feet bgs [109 ng/kg]), SB-057 (2.7 to 3 feet bgs [25,207 ng/kg]), SB-057 (18 to 19.8 [173 ng/kg]), SB-057 (28 to 29.8 feet bgs [505 ng/kg]), SB-057 (51 to 52 feet bgs [131 ng/kg]), SB-057 (65 to 66 feet bgs [58 ng/kg]), SB-099 (13.4 to 14.7 feet bgs [191 ng/kg]), SB-099 (31 to 33 feet bgs [381 ng/kg]), SB-099 (41 to 42.5 feet bgs [194 ng/kg]), and SE-008 (0.0 to 0.2 feet bgs [923,750 ng/kg]).

Chlorinated dioxin and furan congeners were detected at concentrations greater than 1,000 ng/kg in four borehole/push locations: SB-028, SB-057, SB-099, and SE-008. 2,3,7,8-Tetrachlorinated dibenzofurans (TCDFs) were detected at concentrations greater than 1,000 ng/kg in SE-008 (0.0 to 0.2 feet bgs [1,500 ng/kg]).

1,2,3,7,8-Pentachlorodibenzofuran was detected at concentrations greater than 1,000 ng/kg in SE-008 (0.0 to 0.2 feet bgs [11,000 ng/kg]).

2,3,4,7,8-Pentachlorodibenzofuran was detected at concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3 feet bgs [2,400 ng/kg]) and SE-008 (0.0 to 0.2 feet bgs [8,400 ng/kg]).

1,2,3,4,7,8-Hexachlorodibenzofuran was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3 feet bgs [8,900 ng/kg]) and SE-008 (0.0 to 0.2 feet bgs [300,000 ng/kg]).

1,2,3,6,7,8-Hexachlorodibenzofuran was detected at concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3 feet bgs [6,200 ng/kg]) and SE-008 (0.0 to 0.2 feet bgs [220,000 ng/kg]).

1,2,3,7,8,9-Hexachlorodibenzofuran was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [3,600 ng/kg]) and in SB-008 (0.00 to 0.2 feet bgs [5,000 ng/kg]).

1,2,3,4,6,7,8-Heptachlorodibenzofuran was detected in concentrations greater than 1,000 ng/kg in SB-028 (12 to 12.5 feet bgs [1,200 ng/kg]), SB-028 (28.3 to 29.4 feet bgs [1,000 ng/kg]), SB-28 (53.5 to 55 feet bgs [1,600 ng/kg]), SB-057 (2.7 to 3 feet bgs [170,000 ng/kg]), SB-057 (28 to 29.8 feet bgs [5,700 ng/kg]), SB-057 (51 to 52 feet bgs [1,500 ng/kg]), SB-099 (13.4 to 14.7 feet bgs [1,400 ng/kg]), SB-099 (31 to 33 feet bgs [2,600 ng/kg]), SB-099 (41 to 42.5 feet bgs [1,200 ng/kg]), and SE-008 (0.00 to 0.2 feet bgs [9,200,000 ng/kg]).

1,2,3,4,7,8,9-Heptachlorodibenzofuran was detected at concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [10,000 ng/kg]) and SE-008 (0.00 to 0.2 feet bgs [670,000 ng/kg]).

Octachlorodibenzofuran was detected in concentrations greater than 1,000 ng/kg in SB-028 (12 to 12.5 feet bgs [2,300 ng/kg]), SB-028 (28.3 to 29.4 feet bgs [6,200 ng/kg]), SB-028 (31 to 33 feet bgs [3,000 ng/kg]), SB-028 (48 to 49.7 feet bgs [2,000 ng/kg]), SB-28 (53.5 to 55 feet bgs [3,800 ng/kg]), SB-057 (2.7 to 3 feet bgs [3,100 ng/kg]), SB-057 (18 to 19.8 feet bgs [5,500 ng/kg]), SB-057 (28 to 29.8 feet bgs [42,000 ng/kg]), SB-057 (51 to 52 feet bgs [3,700 ng/kg]), SB-057 (65 to 66 feet bgs [1,100 ng/kg]), SB-099 (13.4 to 14.7 feet bgs [3,700 ng/kg]), SB-099 (31 to 33 feet bgs [9,000 ng/kg]), SB-099 (41 to 42.5 feet bgs [4,800 ng/kg]), and SE-008 (0.00 to 0.2 feet bgs [17,000,000 ng/kg]).

2,3,7,8-Tetrachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SE-008 (0.0 to 0.2 feet bgs [2,400 ng/kg]). 1,2,3,7,8-Pentachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [3,500 ng/kg]) and SE-008 (0.00 to 0.2 feet bgs [56,000 ng/kg]). 1,2,3,4,7,8-Hexachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [8,300 ng/kg]). 1,2,3,6,7,8-Hexachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [43,000 ng/kg]) and SE-008 (0.00 to 0.2 feet bgs [2,600,000 ng/kg]). 1,2,3,,7,8,9-Hexachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-057 (2.7 to 3.0 feet bgs [11,000 ng/kg]) and SE-008 (0.00 to 0.2 feet bgs [370,000 ng/kg]).

1,2,3,4,6,7,8-Heptachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-028 (12 to 12.5 feet bgs [7,500 ng/kg]), SB-028 (28.3 to 29.4 feet bgs [5,900 ng/kg]), SB-028 (31 to 33 feet bgs [2,500 ng/kg]), SB-028 (48 to 49.7 feet bgs [1,200 ng/kg]), SB-28 (53.5 to 55 feet bgs [3,000 ng/kg]), SB-057 (2.7 to 3 feet bgs [630,000 ng/kg]), SB-057 (18 to 19.8 feet bgs [9,400 ng/kg]), SB-057 (28 to 29.8 feet bgs [14,000 ng/kg]), SB-057 (51 to 52 feet bgs [4,100 ng/kg]), SB-057 (65 to 66 feet bgs [1,200 ng/kg]), SB-099 (13.4 to 14.7 feet bgs [6,300 ng/kg]), SB-099 (31 to 33 feet bgs [14,000 ng/kg]), SB-099 (41 to 42.5 feet bgs [7,100 ng/kg]), and SE-008 (0.00 to 0.2 feet bgs [40,000,000 ng/kg]).

Octachlorodibenzodioxin was detected in concentrations greater than 1,000 ng/kg in SB-028 (12 to 12.5 feet bgs [56,000 ng/kg]), SB-028 (28.3 to 29.4 feet bgs [70,000 ng/kg]), SB-028 (31 to 33 feet bgs [33,000 ng/kg]), SB-028 (48 to 49.7 feet bgs [7,000 ng/kg]), SB-28 (53.5 to 55 feet bgs [27,000 ng/kg]), SB-028 (55 to 56 feet bgs [2,200 ng/kg]), SB-028 (100.6 to 101.5 feet bgs [2,600 ng/kg]), SB-057 (2.7 to 3 feet bgs [5,900,000 ng/kg]), SB-057 (18 to 19.8 feet bgs [40,000 ng/kg]), SB-057 (28 to 29.8 feet bgs [130,000 ng/kg]), SB-057 (51 to 52 feet bgs [38,000 ng/kg]), SB-057 (65 to 66 feet bgs [12,000 ng/kg]), SB-099 (13.4 to 14.7 feet bgs [70,000 ng/kg]), SB-099 (31 to 33 feet bgs [76,000 ng/kg]), SB-099 (41 to 42.5 feet bgs [74,000 ng/kg]), and SE-008 (0.00 to 0.2 feet bgs [23,000,000 ng/kg]).

3.6.4 Metals Data

A total of 21 soil samples were collected from 3 locations and analyzed for arsenic, chromium, copper, and zinc by the EPA Region 9 laboratory using the Contract Laboratory Program (CLP) RAS SOW. These soil samples were collected at the same locations where laboratory treatability samples were collected (i.e., at location where significant contamination was strongly suspected) , and analyzed to potentially assess the potential impact of thermal treatment on metals mobility. All detected concentrations were corrected for soil moisture (i.e., dry weight). Arsenic, copper, chromium, and zinc were detected at each location and at each depth. Arsenic was detected at concentrations greater than the 16 to 100 mg/kg background arsenic concentrations (ICF Kaiser 1998) in SB-057 (2.7 to 3.0 feet bgs [290 mg/kg]) and SB-099 (13.4 to 14.7 feet bgs [77 mg/kg]). The highest chromium, copper, and zinc concentrations were also detected in SB-057 (2.7 to 3.0 feet bgs). Chromium concentrations ranged from 9.3 mg/kg in SB-028 (55 to 56 feet bgs) to 88 mg/kg in SB-057 (2.7 to 3.0 feet bgs). Copper concentrations ranged from 5.5 mg/kg in SB-028 (53.5 to 55 feet bgs) to 420 mg/kg in SB-057 (2.7 to 3.0 feet bgs). Zinc concentrations ranged from 21 mg/kg in SB-028 (55 to 56 feet bgs) to 120 mg/kg in SB-057 (2.7 to 3.0 feet bgs).

Within the SB-057 borehole from beginning depth at 2.7 to 3.0 feet bgs to final depth at 65 to 66 feet bgs, arsenic concentrations decreased from 290 to 3.2 mg/kg, chromium decreased from 88 to 31 mg/kg, copper decreased from 420 to 17 mg/kg, and zinc decreased from 120 to 38 mg/kg.

Within the SB-028 borehole from the beginning depth at 12 to 12.5 feet bgs to the final depth at 141 to 142 feet bgs, arsenic ranged from 8.3 to 5.1 mg/kg. Chromium decreased from 48 mg/kg at the beginning depth to 9.3 mg/kg at 55 to 56 feet bgs, increased to 49 mg/kg at 100.6 to 101.5 feet bgs, and then decreased to 18 mg/kg at the end depth. Copper decreased from 48 mg/kg at the beginning depth to 5.5 mg/kg at 55 to 56 feet bgs, increased to 45 mg/kg at 100.6 to 101.5 feet bgs, and then decreased to 12 mg/kg at the end depth. Zinc decreased from 62 mg/kg at the beginning depth to 21 mg/kg at 55 to 56 feet bgs, increased to 58 mg/kg at 100.6 to 101.5 feet bgs, and then decreased to 29 mg/kg at 141 to 142 feet bgs.

Within the SB-099 borehole from the beginning 13.4 to 14.7 feet bgs depth to the final 41 to 42.5 feet bgs depth, arsenic decreased from 77 to 4.6 mg/kg, chromium decreased from 75 to 40 mg/kg, copper decreased from 35 to 23 mg/kg, and zinc decreased from 66 to 43 mg/kg.

All metals detected in the soil boring samples collected are presented in Table 3-7.

3.7 PHYSICAL SOIL SAMPLING DATA

3.7.1 Permeability and Hydraulic Conductivity Data

Permeability was calculated from the hydraulic conductivity measured in 31 soil samples collected from 15 locations (SS-010, SS-064, SS-088, SS-093, SB-047, SS-079, SS-035, SS-096, SS-097, SB-099, SB-052, SB-027, SB-025, SB-019, and SB-030) by PTS Laboratories, Inc. Native state hydraulic conductivity was measured at ambient temperatures (i.e., between 68°F and 76°F) using a soil core that had neither been dried nor extruded. Native-state hydraulic conductivity ranged from 5.000E-08 cm/s or (or 0.0001 ft/day) in SS-064 (67 to 69 feet bgs) to 3.083E-03 cm/s (or 8.73 ft/day) in SB-030 (161.7 to 162.2 feet bgs). In sands, hydraulic conductivity ranged from 6.065E-06 cm/s (0.0172 ft/day) in SB-052 (204 to 205 feet bgs) to 3.083E-03 cm/s (8.7390 ft/day) in SB-030 (161.7 to 162.2 feet bgs). In clays, hydraulic conductivity ranged from 5.00E-08 cm/s (0.0001 ft/day) in SS-064 (67 to 69 feet bgs) to 1.38E-04 cm/s (0.3912 ft/day) in SS-079 (63.9 to 65 feet bgs).

Calculated permeability ranged from 0.0490 millidarcy in SS-064 (67 to 69 feet bgs) to 3,015 millidarcies in SB-030 (161.7 to 162.2 feet bgs). In sands, permeability ranged from 5.937 millidarcies in SB-052 from 204 to 205 feet bgs to 3,015 millidarcies in SB-030 from 161.7 to 162.2 feet bgs. In clays, permeability ranged from 0.0490 millidarcy in SB-064 from 67 to 69 feet bgs to 135 millidarcies in SS-079 at 63.9 to 65 feet bgs.

Table 3-8 gives results for both permeability and hydraulic conductivity.

3.7.2 Grain Size, Density, and Porosity Data

A total of 20 soil samples were collected from 10 locations (SS-010, SB-030, SB-047, SB-052, SS-064, SS-079, SS-088, SS-096, SS-097, and SB-099) and analyzed for grain size by PTS Laboratories, Inc., using ASTM D4464M (i.e., hydrodynamic sieve) for fine-grained sediments and ASTM D422 (i.e., mechanical sieve) for coarser sediments. Grain size of collected samples ranged from coarse sand in SB-047 (244.0 to 245.0 feet bgs [1.202 mm median grain size]) to silt in SB-052 (156.0 to 156.6 feet bgs [0.007 mm median grain size]). Grain size results are presented in Table 3-9.

Eighteen soil samples were collected from nine locations (SB-030, SB-047, SB-099, SS-010, SS-064, SS-079, SS-088, SS-096, and SS-097) and analyzed for bulk density by PTS Laboratories, Inc., using ASTM D2937/API RP40. Bulk density ranged from 1.46 g/cc in SB-047 (209.1 to 209.6 feet bgs) to 1.94 g/cc in SB-047 (244.0 to 245.0 feet bgs). In sands, density ranged from 1.4 g/cc in SB-010 (30 to 31.2 feet bgs) to 1.75 g/cc in SB-099 (193 to 194 feet bgs). In clays, density ranged from 1.46 g/cc in SB-047 (209.1 to 209.6 feet bgs) to 1.79 g/cc in SB-047 (117.2 to 117.9 feet bgs).

Effective porosity was calculated for 30 soil samples collected from 12 locations (SB-028, SB-030, SB-047, SB-052, SB-086, SB-099, SS-010, SS-064, SS-079, SS-088, SS-096, and SS-097). All sand samples were repacked and reformed before porosity measurements were conducted. Effective porosity ranged from 25.9 percent in SB-052 (156 to 156.6 feet bgs) to 48.6 percent in SS-010 (30 to 31.2 feet bgs). In sands, porosity ranged from 29.6 percent in SB-052 (122 to 123 feet bgs) to 48.6 percent in SS-010 (30 to 31.2 feet bgs). In clays, porosity ranged from 25.9 percent in SB-052 (156 to 156.6 feet bgs) to 48.4 percent in SB-028 (100.6 to 101.5 feet bgs). Density and porosity results are presented in Table 3-10.

3.7.3 TOC Data

A total of 29 soil samples were collected from 11 locations (SS-010, SS-064, SS-088, SS-093, SB-047, SS-079, SS-035, SS-096, SS-097, SS-018, and SB-099) and analyzed for TOC by PTS Laboratories, Inc., using the Walkley-Black Method. These samples were collected at locations where TPH was not detected at concentrations greater than the method detection limit. TOC ranged from 170 mg/kg in SS-079 (48.7 to 48.9 feet bgs) and SS-096 (78 to 78.7 feet bgs) to 1,900 mg/kg in SB-099 (172.5 to 172.6 feet bgs). In sands, TOC ranged from 170 mg/kg in SS-079 (48.7 to 48.9 feet bgs) and SS-096 (78 to 78.7 feet bgs) to 1,900 mg/kg in SB-099 (172.5 to 172.6 feet bgs). In clays, TOC ranged from 210 mg/kg in SB-018 (183.4 to 183.7 feet bgs) to 1,400 mg/kg in SB-099 (118.8 to 119.8 feet bgs). Table 3-11 presents the TOC results.

3.7.4 Cation Exchange Capacity Data

A total of 20 soil samples from 10 locations (SS-010, SB-030, SB-047, SB-052, SS-064, SS-079, SS-096, SS-088, SS-097, and SB-099) were collected and analyzed for cation exchange capacity (CEC) by PTS Laboratories, Inc., using SW846 Method 9081. CEC ranged from 1.0 milliequivalents (meq) per 100 grams in SB-047 (244 to 245 feet bgs) to 35 meq/100 grams in SB-047 (209.1 to 209.6 feet bgs). In sands, CEC ranged from 4.9 meq/100 grams in SB-030 (161.7 to 162.2 feet bgs) to 14.4 meq/100 grams in SB-096 (78.7 to 79.5 feet bgs). In clays, CEC ranged from 16 meq/100 grams in SB-052 (156 to 156.6 feet bgs) to 35 meq/100 grams in SB-047 (209.1 to 209.6 feet bgs). Cation exchange capacity results are given in Table 3-12.

3.8 GROUNDWATER SAMPLING DATA

3.8.1 Groundwater Elevations

The depths to groundwater at monitoring wells associated with the site were measured during 1999 on April 5 and 6 and on July 22 and 28. Groundwater depths were converted to NVD88 elevations using the most recent survey elevation data collected as a part of this investigation. The groundwater elevations for the April and July 1999 measurement events are listed in Table 3-13. Groundwater elevations were contoured by aquifer zone (A, B, C, D, and E) for each measurement event. Vertical hydraulic gradients were calculated where wells screened at different depths in the aquifer were clustered closely together. Vertical hydraulic gradient data are listed in Table 3-14. Horizontal and vertical gradients were similar for the April and July measurement events. The July 1999 water level elevations were on average approximately 2 feet lower than the April 1999 elevations.

3.8.1.1 April 1999 Data

Groundwater elevation contours for the April 1999 measurement event are shown in Figures 3-3 through 3-7. The horizontal component of groundwater flow in the A-zone was to the southeast, with a gradient of 0.0035 ft/ft. The vertical gradient between the A- and B-zones was downward and averaged –0.075 and –0.036 ft/ft for shallow and deep A-zone wells, respectively. The horizontal component of groundwater flow in the B-zone was to the east-southeast for the central and eastern portions of the study area, with a gradient of 0.0016 ft/ft. The horizontal gradient was reversed in the northwestern portion of the site so that horizontal flow was toward the northwest. The vertical gradient between the B- and C-zones was generally downward, with an average gradient of –0.0056 ft/ft. However, an upward vertical gradient between the B- and C-zones occurs at well clusters OS-1, OS-6, and OS-5 approximately 1,000 feet southeast of the site and at well cluster DSW-3 in the northwest corner of the site.

The horizontal component of groundwater flow in the C-zone was eastward with a slight southeastern component and a gradient that varied from 0.0033 to 0.00083 ft/ft. The vertical gradient between the C- and D-zones was downward, with an average gradient of –0.0078 ft/ft. The horizontal component of groundwater flow in the D-zone was east-southeast, with a gradient of 0.0013 ft/ft. The vertical gradient between the D- and E-zones was downward, with an average gradient of –0.017 ft/ft. The horizontal component of groundwater flow in the E-zone was east-northeast, with a gradient of 0.0011 ft/ft.

3.8.1.2 July 1999 Data

Groundwater elevation contours for the July 1999 measurement event are shown in Figures 3-8 through 3-12. The horizontal component of groundwater flow in the A-zone was to the southeast, with a gradient of 0.0037 ft/ft. The vertical gradient between the A- and B-zones was downward and averaged –0.086 and –0.042 ft/ft for shallow and deep A-zone wells, respectively. The horizontal component of groundwater flow in the B-zone was to the east-southeast, with a gradient of 0.0012 ft/ft. The horizontal gradient was reversed in the northwestern portion of the site so that horizontal flow was toward the northwest. The vertical gradient between the B- and C-zones was generally downward, with an average gradient of –0.0056 ft/ft. However, an upward vertical gradient between the B- and C-zones occurs at well clusters OS-1 and OS-5 approximately 1,000 feet southeast of the site and at well cluster DSW-3 in the northwest corner of the site.

The horizontal component of groundwater flow in the C-zone was eastward with a slight southeastern component and a gradient that varied from 0.0030 to 0.0009 ft/ft. The vertical gradient between the C- and D-zones was downward, with an average gradient of –0.012 ft/ft.

The horizontal component of groundwater flow in the D-zone was east-southeast, with a gradient of 0.001 ft/ft. The vertical gradient between the D- and E-zones was downward, with an average gradient of –0.025 ft/ft. The horizontal component of groundwater flow in the E-zone was eastward, with a gradient of 0.00059 ft/ft.

3.8.1.3 Comparison With Previous Water Level Measurements

Groundwater elevation data from August 1993 through August 1997 were presented in the Remedial Investigation (RI) report (ICF Kaiser 1998). The horizontal and vertical gradients and flow directions presented in the RI report are qualitatively similar to the April and July 1999 measurement events. The direction and gradient of groundwater flow within and between the aquifer zones do not appear to change significantly with time or season.

Groundwater elevations have been rising with time since August 1993. Between August 1993 and July 1999, water levels observed in monitoring wells have increased on average 12, 17, 16, 20, and 22 feet for the A-, B-, C-, D-, and E-zones, respectively.

3.8.2 Analytical Data Summary

Groundwater was collected from 15 well locations: A-8, A-5, DSW-7A, and OS-4A completed in the A-zone of the aquifer; DSW-4B, DSW-6B, DSW-7B, OFS-3B, and OS-4B completed in the B-zone of the aquifer; DSW-4C, DSW-6C, DSW-7C, and OS-4C completed in the C-zone of the aquifer; DSW-4D completed in the D-zone of the aquifer; and OS-4E completed in the E-zone of the aquifer. Sampling locations are shown in Figure 3-13.

3.8.2.1 Groundwater Density

Fifteen groundwater samples were collected and five (i.e., DSW-7A, ONS-1B, A-8, ONS-4A, and DSW-6C) were analyzed for density by the EPA Kerr Laboratory in Ada, Oklahoma. Three replicate groundwater density measurements were made at 10 degree intervals over the 10^{o}C to 90^{o}C range. As the data in Table 3-15 show, good reproducibility was demonstrated over the entire temperature range. Density values decreased in each sample: from 1.0 to 0.9676 g/mL in DSW-7A (i.e., 3.2 percent change), from 0.9996 to 0.9656 g/mL in ONS-4B (i.e., 3.4 percent change), from 1.0 to 0.9664 g/mL in A-8 (i.e., 3.4 percent change), from 1.0 to 0.9648 g/mL in ONS-4A (i.e., 3.5 percent change), and from 0.9996 to 0.9668 in DSW-6C (i.e., 3.28 percent change). Groundwater density results are shown in Figure 3-14.

3.8.2.2 Naphthalene

Fifteen groundwater samples were collected from July 12 through 15, 1999, and analyzed for SVOCs using the EPA Region 9 laboratory SOP 315 for analysis of SVOCs by SW846 Method 8270. Naphthalene was detected in five groundwater monitoring wells: A-8 (4,000 µg/L), DSW-4B (11,000 µg/L), DSW-4C (10,000 µg/L), DSW-6B (14,000 µg/L), and DSW-6C (800 µg/L). Naphthalene concentrations detected in these groundwater samples are presented in Table 3-16.

3.8.2.3 Pentachlorophenol

Fifteen groundwater samples were collected from July 12 through 15, 1999, and analyzed for SVOCs using the EPA Region 9 laboratory SOP 315 for analysis of SVOCs by SW846 Method 8270. Pentachlorophenol was detected in three groundwater monitoring wells: A-5 (30 µg/L), A-8 (40,000 µg/L), and DSW-4B (110 µg/L). Pentachlorophenol concentrations detected in these groundwater samples are presented in Table 3-16.

3.8.2.4 Carcinogenic PAHs

Fifteen groundwater samples were collected from July 12 through 15, 1999. Chrysene was the only carcinogenic PAH (cPAH) detected. The cPAHs include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, chrysene, and indeno(1,2,3-c,d)pyrene). All detected PAH concentrations are presented in Table 3-16.

3.8.2.5 Dioxins and Furans

Seven groundwater samples were collected from July 12 through 15, 1999, and analyzed for dioxins and furans using EPA Method 1613B. Because dioxin and furan congeners were detected in every groundwater sample at concentrations greater than 1.0 pg/L, 1,000 pg/L was selected as an indication of significant contamination. Chlorinated dioxin and furan congeners were detected at concentrations greater than 1,000 pg/L in two groundwater monitoring wells: DSW-4B (i.e., 1,2,3,4,6,7,8-HpCDD [8,500 pg/L] and 1,2,3,4,6,7,8-HpCDF [3,200 pg/L]) and DSW-6B (i.e., 1,2,3,4,6,7,8-HpCDD [23,000 pg/L], 1,2,3,4,6,7,8-HpCDF [8,900 pg/L], and 1,2,3,6,7,8-HxCDD [1,500 pg/L]). Dioxin 2,3,7,8-TCDD TEC was greater than 30 ng/L, which is the current groundwater maximum contaminant level (MCL), in the groundwater samples collected from DSW-4B, DSW-4C, and DSW-6B. All chlorinated dioxin and furan congener concentrations detected in these groundwater samples are presented in Table 3-17.

3.8.2.6 Water Quality and Natural Attenuation Properties

Fifteen groundwater samples plus two field duplicates were collected and analyzed for water quality and natural attenuation properties, including trace metals (total and dissolved manganese), miscellaneous inorganics (common anions and total organic carbon), and micropurging stability indicators. Water quality and natural attenuation data are presented in Table 3-18.

Dissolved manganese was detected at concentrations that ranged from 20 to 4,900 mg/L in A-5 and A-8, respectively. Chloride concentrations ranged from 110 mg/L in OFS-3B to 550 mg/L in OS-3E. Total manganese was detected at concentrations that ranged from 20 to 5,500 mg/L in A-5 and A-8, respectively. Nitrate was detected at concentrations that ranged from 0.06 to 19 mg/L in DSW-4B and A-5, respectively. Nitrate also was detected in A-8 (at 16 mg/L). Nitrate was not detected in the remaining groundwater samples. Nitrite was not detected in the groundwater samples. Sulfate was detected at concentrations that ranged from 0.5 mg/L in OS-4C and DSW-6B to 510 mg/L in A-8. Sulfate was not detected in the remaining groundwater wells. TOC concentrations ranged from 2 mg/L in OS-4E to 140 mg/L in A-8.

Measurements made in the field included alkalinity (Hach® test kit), conductivity (YSI® 3560 meter), dissolved oxygen (Chemettes® test kit and YSI 3560 meter), hardness (Hach® test kit), total iron (Hach® test kit), oxygen reduction potential (YSI® 3560 meter), pH (YSI® 3560 meter), and temperature (YSI® 3560 meter). Turbidity was noted by visual observation. Natural attenuation data are presented in Table 3-18.

Alkalinity of groundwater is the measure of the acid-neutralizing capacity and is the sum of all the titratable bases. Alkalinity ranged from 144 mg/L $CaCO_3$ in OS-3E to 769 mg/L $CaCO_3$ in A-8.

Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current, which is dependent on temperature, ion concentration, and the mobility, valence, and relative concentration of those ions. Conductivity in the groundwater collected at the McCormick and Baxter site ranged from 968 mS/cm in OS-4B to 2,510 mS/cm in A-8.

Dissolved oxygen was measured in the groundwater collected at the site with a portable meter and with the Chemettes® test kit. Dissolved oxygen measured in the field ranged from 0.36 mg/L in DSW-7B to 2.71 mg/L in OS-4A. Dissolved oxygen measured in the laboratory ranged from 0.1 mg/L in A-5 to 3.5 mg/L in OS-4A.

Hardness is a measure of the capacity of a water to precipitate soap. Hardness concentration in the groundwater collected at the site ranged from 146 mg/L $CaCO_3$ in DSW-4D to 632 mg/L $CaCO_3$ in A-8.

Iron was measured in the field using a Hach® test kit. Total iron in the groundwater collected at the site ranged from 0.6 mg/L in OS-4C to 2.1 mg/L in DSW-7B.

Groundwater pH is the measure of the hydrogen ion concentration. At the McCormick and Baxter site, groundwater pH ranged from 6.88 (slightly acidic) in A-5 to 8.46 (basic) in DSW-4D.

Groundwater temperature was measured at each wellhead and was used to indicate well stability for groundwater sample collection. Temperature values ranged from 68.2^{o}F in OS-3E to 76.6^{o}F in A-8.

Groundwater turbidity was measured by visual observation. Seven groundwater samples were clear: DSW-4B, DSW-4C, DSW-6B, DSW-7A, OFS-3B, OFS-3E, and OFS-4C. Color was observed in five groundwater samples, specifically A-8 (rusty orange), DSW-7B (rusty particles), DSW-7C (blackish cloudy), OS-4A (rust color), and OS-4B (black particles).

3.8.3 Groundwater Contamination Trends

Data from the 1999 sampling event were assembled along with data from groundwater sampling events dating back to 1992. This larger data set was used to develop trend plots for three indicator contaminants: naphthalene, pentachlorophenol, and TCDD TEC. (Note that TCDD TEC is presented using one half the detection limit for congeners that were reported as nondetected.) The following discussion of the trend analysis results is limited to the 15 wells that were sampled in 1999.

Trend plots were not prepared for contaminants and wells when there were primarily nondetected levels for that particular indicator contaminant at that well.

3.8.3.1 Naphthalene Trends

Trend plots for naphthalene were prepared for wells A-8, DSW-4B, DSW-4C, DSW-6B, and DSW-6C. These trend plots are shown in Figures 3-15 through 3-19.

3.8.3.2 Pentachlorophenol Trends

Trend plots for pentachlorophenol were prepared for wells A-8, DSW-4B, DSW-4C, and DSW-6B. These trend plots are shown in Figures 3-20 through 3-23.

3.8.3.3 TCDD TEC Trends

Trend plots for TCDD TEC were prepared for wells DSW-4B, DSW-4C, DSW-6B, and DSW-6C. These trend plots are shown in Figures 3-24 through 3-27.

3.9 NAPL SAMPLING DATA

3.9.1 Chemical Composition Data

NAPL was collected from ONS-1B, A-10, and DSW-6B and analyzed for petroleum hydrocarbons and SVOCs. Petroleum hydrocarbons were identified in these samples as diesel-range organics, which ranged from 92 percent in ONS-1B to 13 percent in DSW-6B. SVOCs were detected in percent levels at each sampling location. Naphthalene was detected at concentrations that ranged from 3.2 to 13 percent in DSW-6B and ONS-1B, respectively. Pentachlorophenol was detected (at 0.18 percent) in A-10 only. Samples collected from DSW-6B and A-10 were not pure product and contained a significant amount of water, which could not be separated in the field. All NAPL chemistry results are presented in Table 3-19.

3.9.2 Physical Properties Summary

Samples were analyzed for density, viscosity, boiling point distribution/distillation, NAPL saturation, wettability, solubility, and oil-water interfacial tension. The analysis of these samples is not yet complete, so only partial results are presented in this report. In addition, the results presented here should be considered preliminary since the data quality review has not been completed. All analyses were performed at the EPA Kerr Environmental Laboratory, with the exception of boiling point distribution/distillation and NAPL saturation, which were performed at PTS Laboratories, Inc.

3.9.2.1 Density

Density as a function of temperature for groundwater and NAPL was measured using 25-mL volumetric flasks suspended in a water bath using the Kerr Laboratory SOP. Density measurements were made in triplicate. Measurements were started by determining the empty weight of the flask to the nearest 0.01 gram. The flasks were then filled to below the volumetric line with the fluid and were suspended in the water bath. The fluids were allowed to equilibrate to the highest temperature at which density measurements were to be made (in this case, 90°C).

After the fluids equilibrated to temperature, the volume was adjusted to approximately the volumetric line with additional fluid that also was at the measurement temperature, and the flasks were resuspended in the water bath to ensure that they remained at the desired temperature. After this second equilibration period, the volume in the flasks was double checked; if needed, volume adjustments were again made. If the volume was correct, the flasks were thoroughly dried on the outside, and on the inside of the flask above the volumetric line, then weighed to the nearest 0.01 gram. The weight of fluid in the flask and the volume (25 mL) was used to calculate the density in grams per milliliter. The temperature in the water bath was adjusted for the next measurement, and the flasks were resuspended in the water bath. By working from the highest to the lowest temperature for which measurements were made, fluid was always added to the flasks, and volumes were easily adjusted. Standard deviation of the three replicate measurements was expected to generally be about 0.001 g/mL.

NAPL samples were collected from three locations and analyzed for density at the EPA Robert S. Kerr Laboratory in Ada, Oklahoma. NAPL samples were analyzed for density using the Kerr Laboratory SOP. Density was measured in triplicate at nine 10ºC temperature intervals beginning at 10^{o}C and ending at 90^{o}C. The density of each sample decreased as temperature was increased. Density measurements in A-10 and DSW-6B decreased to less than 1.0 g/mL at the 90^{o}C endpoint. Density in DSW-6B decreased to less than 1.0 g/mL at 20^{o}C. Field duplicate samples were collected from locations A-10 and ONS-1B. The ONS-1B triplicate density measurement demonstrated expected reproducibility. Sample A-10 and the field duplicate sample were reanalyzed due to unexpectedly poor reproducibility. The resulting density data were in good agreement, and were closer to that of the A-10 sample than the field duplicate sample. Table 3-20 presents the density measurement results for all sample analyses.

3.9.2.2 Viscosity

NAPL samples were analyzed for viscosity using the Kerr Laboratory SOP based on ASTM D1296. Viscosity was measured with a Brookfield viscometer with a small sample adapter and water jacket. The water jacket was hooked up to a water bath so that the temperature could be adjusted in the range of 10ºC to 90°C. Triplicate viscosity measurements were taken at 60, 30, and 12 rpm in 10ºC increments beginning at 10^{o}C. Triplicate measurements were made to demonstrate reproducibility. Viscosity decreased as the temperature was increased in each sample and at all viscometer speeds, and viscosity decreased regardless of viscometer speed. Table 3-21 presents the viscosity data for all samples.

Viscosities less than 5 centipoise (cP) should be considered approximate as 5 cP is the practical lower limit of measurement for the equipment used. However, the reproducibility of the measurements indicates that these estimates are reasonable.

3.9.2.3 Boiling Point Distribution/Distillation

Three NAPL samples (from ONS-1B, A-10, and DSW-6B) were collected and analyzed by PTS Laboratories, Inc., for percent distillation fractions using ASTM 2887. The NAPL recovered from ONS-1B boiled at the lowest temperature (322ºF), whereas the NAPL recovered from A-10 and DSW-6B initially boiled at 334^{o}F and 331^{o}F, respectively. The final fraction of NAPL recovered from A-10 boiled at the highest temperature (1058^{o}F). Fifty percent of each sample volume was distilled at 494^{o}F in DSW-6B, 527^{o}F in ONS-1B, and 562^{o}F in A-10.

Table 3-22 presents the boiling point ranges for each NAPL sample.

3.9.2.4 NAPL Saturation

Ten soil samples were collected from three locations (SB-099, SB-086, and SB-028) and analyzed for hydrocarbon saturation by PTS Laboratories, Inc., using API RP 40. Hydrocarbon saturation was calculated as a function of percent volume of water and hydrocarbon in the soil sample as measured from the extracted and dried sample core and the total available pore space in the soil core. Hydrocarbon saturation ranged from less than 0.1 percent in SB-028 (48 to 49.7 feet bgs) and SB-099 (13.4 to 14.7 feet bgs) to 77.0 percent in SB-099 (31 to 33 feet bgs). NAPL saturation results are presented in Table 3-23.

3.9.2.5 Wettability

Wettability data will be reported in the Treatability Study Report.

3.9.2.6 Solubility

Solubility data will be reported in the Treatability Study Report..

3.9.2.7 Oil-Water Interfacial Tension

The surface and interfacial tension of NAPL samples and groundwater from the site were measured using a Fisher surface tensiometer, Model 20. The procedure used basically follows ASTM Method D971. The samples were set into a jacketed beaker that was connected to a water bath to bring the fluid(s) to the desired temperature. Surface and interfacial tension measurements were collected at 10°C intervals in the range of 10ºC to 90°C.

These data will be reported in the Treatability Study Report.

Table 3-1
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
A-1	2169318.40	6327088.59		12.01	12.15		Yes	Yes
A-2	2169042.40	6329505.65		10.58	10.86		Yes	Yes
A-3	2168753.37	6327372.41		15.37	15.41		Yes	Yes
A-4	2168724.96	6327604.80		12.45	12.95		Yes	Yes
A-5	2168498.44	6327782.39		11.19	11.65		Yes	Yes
A-6	2168637.23	6328558.96		10.63	11.01		Yes	Yes
A-7	2169012.65	6328736.77		10.83	11.43		Yes	Yes
A-8	2168825.45	6328233.52		13.51			Yes	Yes
A-10	2169070.92	6327416.75		12.32	12.96		Yes	Yes
DSW-1B	2168927.26	6328774.42		10.49	10.87		Yes	Yes
DSW-1C	2168903.31	6328778.58		10.12	10.54		Yes	Yes
DSW-1D	2168915.88	6328776.60		10.98	11.07		Yes	Yes
DSW-2A	2169044.56	6329494.83		10.79	10.90		Yes	Yes
DSW-2B	2169056.61	6329504.72		10.80	10.86		Yes	Yes
DSW-2C	2169055.65	6329492.03		10.41	10.56		Yes	Yes
DSW-2D	2169057.89	6329513.84		10.65	10.99		Yes	Yes
DSW-2E	2169049.45	6329514.40		10.61	11.03		Yes	Yes
DSW-3B	2169301.11	6327103.23		11.43	11.83		Yes	Yes
DSW-3C	2169287.20	6327100.85		12.66	13.12		Yes	Yes
DSW-4B	2168567.25	6328462.94		9.97		10.25	Yes	Yes
DSW-4C	2168567.39	6328469.05		9.75		10.08	Yes	Yes
DSW-4D	2168569.43	6328483.13		13.15	13.11		Yes	Yes
DSW-4E	2168571.06	6328496.87		11.01	11.11		Yes	Yes
DSW-5B	2168852.87	6328471.67		11.19	11.49		Yes	Yes
DSW-6B	2168534.00	6327805.10		13.05	13.52		Yes	Yes
DSW-6C	2168500.00	6327907.60		13.40	13.68		Yes	Yes
DSW-7A	2168749.39	6329119.81		9.43		9.753	Yes	Yes

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
DSW-7B	2168758.43	6329136.26		9.35		9.77	Yes	Yes
DSW-7C	2168749.75	6329134.11		9.15		9.768	Yes	Yes
MW-1A	2168857.78	6327864.36		11.44	15.23	11.888	Yes	Yes
MW-2E	2168532.12	6327812.34		11.02	14.65	11.5	Yes	Yes
OFS-1A	2168509.87	6327233.96				7.435	Yes	Yes
OFS-1B	2168504.92	6327242.88				7.397	Yes	Yes
OFS-1C	2168499.36	6327252.54				7.386	Yes	Yes
OFS-1D	2168493.45	6327264.32				7.446	Yes	Yes
OFS-2A	2168048.44	6327551.81				7.645	Yes	Yes
OFS-2C	2168062.35	6327548.48				7.666	Yes	Yes
OFS-2D	2168082.57	6327545.26				7.477	Yes	Yes
OFS-3A	2167994.11	6328084.09				8.137	Yes	Yes
OFS-3B	2167984.29	6328085.91				8.15	Yes	Yes
OFS-3C	2167973.02	6328088.06				8.18	Yes	Yes
OFS-3D	2167959.33	6328090.57				8.221	Yes	Yes
OFS-3E	2167945.60	6328092.90				8.282	Yes	Yes
OFS-4A1	2168373.50	6328867.20				7.854	Yes	Yes
OFS-4A2	2168364.72	6328872.76				7.698	Yes	Yes
OFS-4C	2168355.02	6328878.29				7.715	Yes	Yes
OFS-4D	2168342.33	6328885.80				7.573	Yes	Yes
OFS-4E	2168329.33	6328893.17				7.713	Yes	Yes
OFS-5A	2169903.74	6327941.65				12.633	Yes	Yes
OFS-5C	2169904.00	6327960.24				12.602	Yes	Yes
OFS-5E	2169903.89	6327980.99				12.559	Yes	Yes
ONS-1B	2168787.85	6328317.77		10.84		11.198	Yes	Yes
ONS-1C	2168768.06	6328320.30		10.58		11.109	Yes	Yes
ONS-1D	2168748.08	6328322.50		10.72		11.032	Yes	Yes

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
ONS-2A	2168909.03	6327584.89		12.71		12.957	Yes	Yes
ONS-2B	2168888.48	6327586.02		12.76		13.086	Yes	Yes
ONS-2C	2168868.65	6327586.77		12.44		12.804	Yes	Yes
ONS-2D	2168849.55	6327588.08		12.65		12.914	Yes	Yes
OS-1A	2168285.78	6330356.25				9.512	Yes	Yes
OS-1B	2168278.99	6330357.12				9.52	Yes	Yes
OS-1C	2168272.20	6330353.44				9.20	Yes	Yes
OS-1E	2168276.51	6330352.24				8.87	Yes	Yes
OS-2E	2167231.59	6328302.82				7.954	Yes	Yes
OS-3E	2168101.58	6329492.62				6.427	Yes	Yes
OS-4A	2167878.28	6329127.54				8.209	Yes	Yes
OS-4B	2167876.44	6329121.01				8.263	Yes	Yes
OS-4C	2167875.43	6329115.33				8.084	Yes	Yes
OS-5B	2167697.99	6330604.48				11.695	Yes	Yes
OS-5C	2167692.85	6330605.69				11.704	Yes	Yes
OS-5D	2167702.42	6330603.61				11.556	Yes	Yes
OS-6B	2168035.80	6330471.70				9.756	Yes	Yes
OS-6C	2168030.88	6330466.78				9.692	Yes	Yes
OS-6D	2168025.06	6330475.34				9.84	Yes	Yes
SB-004	2168530.00	6327814.00	11				No	No
SB-006	2169011.96	6328377.65	14.166				Yes	Yes
SB-007	2169073.72	6328649.30	10.728				Yes	Yes
SB-018	2168790.07	6327641.54	11.79				Yes	Yes
SB-019	2168770.14	6328253.20	11.408				Yes	Yes
SB-025	2168934.16	6327760.78	11.972				Yes	Yes
SB-027	2168923.73	6328116.43	15.439				Yes	Yes
SB-028	2168832.28	6328158.98	13.965				Yes	Yes
SB-030	2168594.50	6328483.28	9.315				Yes	Yes

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
SB-047	2168536.11	6328360.48	8.599				Yes	Yes
SB-051	2168616.19	6327801.41	11.238				Yes	Yes
SB-052	2168497.80	6327907.56	9.765				Yes	Yes
SB-057	2168863.69	6327880.42	11.483				Yes	Yes
SB-061	2168677.21	6328074.10	10.695				Yes	Yes
SB-084	2169059.97	6327407.89	12.591				Yes	Yes
SB-086	2168998.18	6327539.97	12.345				Yes	Yes
SB-092	2168822.59	6328562.41	10.223				Yes	Yes
SB-099	2168958.55	6328347.32	15.023				Yes	Yes
SE-001	2169104.00	6327335.00	11.9				No	No
SE-001A	2169104.00	6327333.00	11.9				No	No
SE-002	2168955.23	6327617.18	12.222				Yes	Yes
SE-002A	2168958.37	6327615.65	12.277				Yes	Yes
SE-002B	2168957.95	6327616.88	12.363				Yes	Yes
SE-003	2168514.00	6327854.00	10.5				No	No
SE-003A	2168516.00	6327854.00	10.5				No	No
SE-005	2168896.87	6328152.49	14.842				Yes	Yes
SE-008	2168911.44	6327851.57	13.697				Yes	Yes
SE-009	2168857.19	6327995.79	11.322				Yes	Yes
SE-010	2168941.79	6328036.85	13.358				Yes	Yes
SE-011	2168927.96	6327936.39	14.051				Yes	Yes
SE-012	2168714.00	6328408.00	11				No	No
SE-013	2168722.99	6327782.53	11.48				Yes	Yes
SE-014	2168590.57	6328133.40	9.961				Yes	Yes
SE-015	2168647.66	6328235.42	10.653				Yes	Yes
SE-016	2168705.00	6327950.00	11.2				No	No
SE-017	2168916.87	6328514.94	11.425				Yes	Yes
SE-020	2168812.00	6327854.00	11.3				No	No

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
SE-021	2168970.00	6327392.00	12.3				No	No
SE-022	2168827.51	6327506.27	12.473				Yes	Yes
SE-023	2168808.56	6327733.62	12.028				Yes	Yes
SE-024	2169030.00	6327475.00	12.2				No	No
SE-026	2168667.52	6327862.24	11.037				Yes	Yes
SE-029	2168678.85	6328491.20	9.845				Yes	Yes
SE-031	2168632.93	6328663.07	9.782				Yes	Yes
SE-032	2168934.30	6327486.85	12.66				Yes	Yes
SE-033	2168854.34	6327326.83	13.192				Yes	Yes
SE-034	2168631.00	6327454.00	14.2				No	No
SE-035	2168729.81	6327380.27	14.311				Yes	Yes
SE-036	2168542.00	6327969.00	10.6				No	No
SE-037	2168680.72	6328281.65	10.546				Yes	Yes
SE-038	2168594.54	6328406.53	9.297				Yes	Yes
SE-039	2169174.00	6327250.00	11.2				No	No
SE-040	2169260.00	6327108.00	127.2				No	No
SE-041	2168740.82	6327610.22	12.435				Yes	Yes
SE-042	2169106.00	6328818.00	11.5				No	No
SE-043	2168547.69	6328304.42	9.839				Yes	Yes
SE-044	2168728.00	6328111.00	11.4				No	No
SE-045	2168625.25	6327743.05	11.634				Yes	Yes
SE-046	2168494.00	6327820.00	10				No	No
SE-048	2169080.00	6327188.00	12.2				No	No
SE-049	2168508.19	6328038.64	9.979				Yes	Yes
SE-050	2168859.01	6327827.34	12.08				Yes	Yes
SE-053	2169218.00	6327158.00	11.8				No	No
SE-054	2169202.00	6329122.00	10				No	No
SE-054A	2169198.00	6329122.00	10				No	No

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
SE-055	2169356.00	6329072.00	10.5				No	No
SE-056	2168785.48	6327934.34	11.36				Yes	Yes
SE-058	2168813.62	6328016.72	11.461				Yes	Yes
SE-059	2168806.84	6327567.63	12.76				Yes	Yes
SE-060	2168900.29	6327537.30	12.282				Yes	Yes
SE-062	2168934.77	6327990.17	13.959				Yes	Yes
SE-063	2168927.44	6327883.28	14.113				Yes	Yes
SE-064	2168928.51	6327857.23	14.016				Yes	Yes
SE-064A	2168928.23	6327859.39	13.99				Yes	Yes
SE-065	2169082.00	6328900.00	11.1				No	No
SE-066	2169075.00	6328718.00	11.5				No	No
SE-067	2169054.67	6328500.60	12.202				Yes	Yes
SE-068	2168722.54	6328231.39	11.462				Yes	Yes
SE-069	2168734.33	6328301.78	10.946				Yes	Yes
SE-070	2168776.48	6328556.34	11.203				Yes	Yes
SE-071	2168873.20	6328476.03	10.991				Yes	Yes
SE-072	2168944.83	6328453.94	11.722				Yes	Yes
SE-073	2168865.24	6328637.21	10.41				Yes	Yes
SE-074	2168900.45	6327664.80	12.692				Yes	Yes
SE-075	2168896.30	6327415.09	12.452				Yes	Yes
SE-076	2169004.88	6327296.21	12.426				Yes	Yes
SE-077	2169126.00	6327213.00	12.2				No	No
SE-078	2168916.46	6327337.17	12.945				Yes	Yes
SE-079	2168788.69	6328643.96	10.169				Yes	Yes
SE-080	2168719.84	6328616.33	10.079				Yes	Yes
SE-081	2168764.87	6328687.23	9.611				Yes	Yes
SE-082	2168301.00	6327696.00	8.5				No	No
SE-083	2168290.00	6327736.00	8.5				No	No

Table 3-1 (Continued)
Summary of Survey Data

Location ID	Northing (feet NAD83)	Easting (feet NAD83)	Elevation (feet NVD88)				Surveyed Location?	Surveyed Elevation?
			Ground Surface	Inner Casing	Outer Casing	Monument		
SE-085	2169144.00	6327150.00	12.3				No	No
SE-087	2169169.00	6327266.00	12.1				No	No
SE-088	2169137.00	6327350.00	12.1				No	No
SE-089	2169061.55	6327490.59	12.499				Yes	Yes
SE-089A	2169061.21	6327493.28	12.63				Yes	Yes
SE-089B	2169049.80	6327512.22	12.531				Yes	Yes
SE-090	2168951.92	6327700.58	12.168				Yes	Yes
SE-091	2168978.00	6328633.00	11.1				No	No
SE-093	2168693.48	6328686.73	9.652				Yes	Yes
SE-094	2168655.29	6328444.56	9.685				Yes	Yes
SE-095	2168547.23	6327878.62	10.937				Yes	Yes
SE-096	2168624.22	6327961.35	10.637				Yes	Yes
SE-097	2168506.38	6327802.38	10.893				Yes	Yes
SE-097A							No	No
SE-098	2168567.13	6328454.03	9.927				Yes	Yes

Table 3-2
Comparison of SCAPS CPT Soil Classification to Visual Soil Descriptions and Laboratory Grain Size Analysis

Location ID	Sample ID[1]	Soil Description					
		SCAPS CPT					
		Soil Classification Number			Equivalent Grain Size[2]	Visual	Grain Size Analysis Description[3]
		Average	Min	Max			
SB-030	SB030-161.7-162.2	NA	NA	NA	NA	Sand	Sand with silt
SB-047	SB047-117.2-117.9	NA	NA	NA	NA	Clay	Silt
SB-047	SB047-141.3-142.1	NA	NA	NA	NA	Sand	Sand with silt
SB-047	SB047-167.5-168.4	NA	NA	NA	NA	Clay	Silt
SB-047	SB047-209.1-209.6	NA	NA	NA	NA	Clay	Silt
SB-047	SB047-244.0-245.0	NA	NA	NA	NA	Sand and gravel	Sand with silt and gravel
SB-052	SB052-122-123	NA	NA	NA	NA	Sand	Sand with silt
SB-052	SB052-156-156.6	NA	NA	NA	NA	Clay	Silt
SB-099	SB099-111.5-112.5	NA	NA	NA	NA	Sand	Sandy silt
SB-099	SB099-118.8-119.8	NA	NA	NA	NA	Clay	Silt
SB-099	SB099-176.9-177.6	NA	NA	NA	NA	Clay	Silt
SB-099	SB099-193-194	NA	NA	NA	NA	Sand	Silty sand
SE-002	SS002-14.3-15.1	0.93	0.65	1.41	Clays	Silty/clay	
SE-002	SS002-15.1-16.0	0.61	0.35	0.90	Clays	Silty/clay	
SE-002	SS002-24.5-25.6	2.10	1.23	3.07	Sand mixtures	Clay	
SE-002	SS002-25.6-26.5	2.89	2.31	3.11	Sand mixtures	Sand	
SE-002	SS002-84-86	1.98	0.30	3.07	Silt mixtures	Sand	
SE-005	SS005-29.5-30.5	2.68	1.79	3.25	Sand mixtures	Sand	
SE-005	SS005-30.5-31.6	2.41	1.87	3.08	Sand mixtures	Clay	
SE-005	SS005-43-45	3.62	3.18	3.85	Sands	Sand	
SE-005	SS005-67-69	3.75	3.07	3.92	Sands	Clay/sand	
SE-005	SS005-86-87.5	3.65	2.76	4.00	Sands	Sand	
SE-008	SS008-10.5-11.7	1.75	1.37	2.58	Silt mixtures	Clay	
SE-008	SS008-19-21	1.82	1.62	2.32	Silt mixtures	Clay	
SE-008	SS008-40-41.5	4.20	4.10	4.24	Sands & gravels	Sand	
SE-008	SS008-42-44	3.84	3.43	4.11	Sands	Sand	
SE-008	SS008-45-45.9	2.15	1.17	2.43	Sand mixtures	Sand	
SE-008	SS008-48-50	3.94	3.68	4.06	Sands	Sand	
SE-009	SS009-21-23	1.97	0.55	2.52	Silt mixtures	Silty/sand	
SE-009	SS009-55-57	4.14	3.99	4.26	Sands & gravels	Sand	
SE-009	SS009-69-70	2.85	2.52	3.24	Sand mixtures	Sand	
SE-010	SS010-12-14	1.62	1.03	2.22	Silt mixtures	Clay	
SE-010	SS010-30-31.2	3.71	3.19	4.21	Sands	Sand	Silty sand
SE-010	SS010-59-59.8	3.35	3.17	3.56	Sands	Sand and gravel	
SE-010	SS010-61.5-63	1.81	0.75	2.51	Silt mixtures	Silt	
SE-010	SS010-61-61.5	1.78	1.62	2.10	Silt mixtures	Sandy/clay	
SE-020	SS020-29-31	ND	ND	ND	ND	Sandy/clay	
SE-020	SS020-47-49	1.62	0.00	2.73	Silt mixtures	Silty/sand	
SE-020	SS020-51-51.8	3.06	2.78	3.38	Sands	Sand	
SE-020	SS020-56-58	3.87	3.63	4.03	Sands	Sand	
SE-020	SS020-60-62	3.82	2.81	4.21	Sands	Sand	
SE-028	SS028-10.1-11	0.65	0.44	0.80	Clays	Clay	

Table 3-2 (Continued)
Comparison of SCAPS CPT Soil Classification to Visual Soil Descriptions and Laboratory Grain Size Analysis

Location ID	Sample ID[1]	Soil Description					
		SCAPS CPT					
		Soil Classification Number			Equivalent Grain Size[2]	Visual	Grain Size Analysis Description[3]
		Average	Min	Max			
SE-028	SS028-9.0-10.1	0.36	0.20	0.47	Clays	Clay	
SE-035	SS035-50-52	0.81	0.44	1.45	Clays	Clay	
SE-035	SS035-54.4-55.2	2.55	2.08	3.03	Sand mixtures	Sand	
SE-035	SS035-54-54.4	2.26	2.02	2.54	Sand mixtures	Sand	
SE-035	SS035-58-59.2	1.26	0.70	2.24	Silt mixtures	Clay	
SE-035	SS035-59.2-60	0.91	0.75	1.56	Clays	Clay	
SE-037	SS037-31-32.6	2.17	0.84	3.80	Sand mixtures	Sand	
SE-037	SS037-56-57	3.46	2.66	3.68	Sands	Sand	
SE-037	SS037-93-95	1.21	0.53	2.89	Silt mixtures	Silt	
SE-039	SS039-10-12	0.93	0.45	1.27	Clays	Clay	
SE-039	SS039-19-20.6	3.26	1.90	3.83	Sands	Sand	
SE-039	SS039-22-22.4	4.33	4.31	4.34	Sands & gravels	Sand	
SE-039	SS039-40-42	0.89	0.36	1.81	Clays	Silty/clay	
SE-043	SS043-13-15	1.18	0.64	1.73	Silt mixtures	Silty/sand	
SE-043	SS043-23-25	1.44	0.68	2.08	Silt mixtures	Silty/sand	
SE-043	SS043-27-29	2.07	0.96	2.91	Sand mixtures	Silt	
SE-043	SS043-7-8.6	0.80	0.53	1.25	Clays	Clay	
SE-047	SS047-10-12	1.50	1.25	1.70	Silt mixtures	Silt	
SE-047	SS047-12-14	1.70	1.14	2.68	Silt mixtures	Silt	
SE-047	SS047-14-15	2.52	2.01	2.84	Sand mixtures	Sand/silt	
SE-047	SS047-20-22	1.13	0.90	1.40	Silt mixtures	Silt/sand	
SE-047	SS047-21.6-22	1.23	1.15	1.34	Silt mixtures	Silt/sand	
SE-064	SS064-31-33	3.30	3.07	3.51	Sands	Sand/silt	
SE-064	SS064-34-36	3.19	2.27	3.63	Sands	Sand	
SE-064	SS064-41-43	1.26	0.35	2.16	Silt mixtures	Clay	Sandy silt
SE-064	SS064-50-51	2.03	0.43	3.17	Sand mixtures	Sand	
SE-064	SS064-62-63.3	3.20	2.13	3.72	Sands	Sand	
SE-064	SS064-67-69	0.51	0.41	0.69	Clays	Clay	
SE-079	SS079-48.7-48.9	3.55	3.50	3.62	Sands	Sand	
SE-079	SS079-48-48.7	3.64	3.55	3.67	Sands	Sand	
SE-079	SS079-51-52	3.63	3.22	3.85	Sands	Sand	
SE-079	SS079-54.2-55	1.43	0.80	1.82	Silt mixtures	Clay	
SE-079	SS079-54-54.2	1.12	1.02	1.23	Silt mixtures	Sand	
SE-079	SS079-58-60	1.15	0.44	2.93	Silt mixtures	Clay/silt	
SE-079	SS079-63.9-65	0.72	0.47	1.00	Clays	Clay	Sandy silt
SE-079	SS079-63-63.9	0.52	0.23	1.00	Clays	Clay	
SE-079	SS079-80-81	2.90	2.46	3.51	Sand mixtures	Sand	
SE-081	SS081-50-50.6	4.02	3.92	4.11	Sands & gravels	Clay/gravel	
SE-081	SS081-50-52	3.01	0.47	4.11	Sands	Clay/gravel	
SE-088	SS088-10.3-11	0.63	0.49	0.69	Clays	Clay	
SE-088	SS088-14-15.4	1.26	1.05	1.35	Silt mixtures	Clay	
SE-088	SS088-20-21	2.32	0.70	3.39	Sand mixtures	Clay/sand/silt	

Table 3-2 (Continued)
Comparison of SCAPS CPT Soil Classification to Visual Soil Descriptions and Laboratory Grain Size Analysis

Location ID	Sample ID[1]	Soil Description					
		SCAPS CPT					
		Soil Classification Number			Equivalent Grain Size[2]	Visual	Grain Size Analysis Description[3]
		Average	Min	Max			
SE-088	SS088-24-25.8	3.47	1.27	4.24	Sands	Sand/clay	
SE-088	SS088-30-31.3	3.55	3.23	3.88	Sands	Sand	Silty sand
SE-088	SS088-36-38	0.65	0.50	0.88	Clays	Clay/silt	Silt
SE-088	SS088-5.4-5.8	ND	ND	ND	ND	Silty/sand	
SE-088	SS088-9-10.3	0.75	0.37	1.20	Clays	Clay	
SE-093	SS093-25-26.7	0.78	0.43	1.67	Clays	Clay	
SE-093	SS093-26.7-27	0.68	0.55	0.79	Clays	Clay	
SE-093	SS093-45-46	2.89	0.58	3.79	Sand mixtures	Sand	
SE-093	SS093-63-65	3.79	3.58	3.94	Sands	Sand	
SE-093	SS093-66-67	3.21	2.06	3.53	Sands	Clay/sand	
SE-093	SS093-67-68	2.48	1.78	3.52	Sand mixtures	Sandy/clay	
SE-096	SS096-63-65	1.64	0.32	3.49	Silt mixtures	Sand/silt/clay	
SE-096	SS096-66-67.6	3.51	3.38	3.62	Sands	Sand	
SE-096	SS096-73-74.2	0.46	0.39	0.53	Clays	Clay	
SE-096	SS096-74.2-75	0.57	0.47	0.73	Clays	Clay	Sandy silt
SE-096	SS096-78.7-79.5	3.17	3.03	3.25	Sands	Sand	Silty sand
SE-096	SS096-78-78.7	3.00	2.91	3.11	Sand mixtures	Sand	
SE-096	SS096-81-82.4	2.79	1.53	3.16	Sand mixtures	Sand	
SE-096	SS096-84.5-84.8	3.93	3.76	4.04	Sands	Sand/gravel	
SE-096	SS096-94-96	0.84	0.49	1.75	Clays	Silty/clay	
SE-097	SS097-100-102	1.06	0.26	2.07	Silt mixtures	Silty/clay	
SE-097	SS097-75.0-76.2	3.46	2.80	3.68	Sands	Sand/silt/clay	Sandy silt
SE-097	SS097-76.2-76.6	3.50	3.46	3.56	Sands	Sand	
SE-097	SS097-87-89	0.29	0.06	0.64	Clays	Silty/clay	
SE-097	SS097-90-92	0.48	0.22	0.73	Clays	Clay/silt	
SE-097	SS097-92.6-94	0.79	0.28	1.26	Clays	Silty/sand	

[1]Sample ID shows depth interval of soil sample.
[2]Based on the average soil classification number for the sampled interval.
[3]Abbreviated description using ASTM D2487. Plasticity data are not available for classification of fines.

Notes:
NA - SCAPS CPT data not available for this depth interval (greater than SCAPS total depth) or no associated SCAPS push (i.e., SB099)
ND - not detected. SCAPS CPT malfunction and no soil classification number available.

Table 3-3
PCB Soil Sampling Results From the Cellon Process Area

Location ID	SE-008	SE-008	SE-008	SE-008	SE-008	SE-008	SE-008
Sample ID	SS008-10.5-11.7	SS508-10.5-11.7	SS008-19-21	SS008-40-41.5	SS008-42-44	SS008-45-45.9	SS008-48-50
Sample Date	8/8/99	8/8/99	8/8/99	8/8/99	8/8/99	8/8/99	8/8/99
Field QC		Field Duplicate					
Soil Description	Clay	Clay	Clay	Sand	Sand	Sand	Sand
NAPL Description	Odor	Odor	Nothing	Visible	Mobile	Nothing	Mobile
PCBs (µg/kg)							
Aroclor 1016	300 U	300 U	300 U	300 U	300 U	300 U	300 U
Aroclor 1221	600 U	600 U	600 U	600 U	600 U	600 U	600 U
Aroclor 1232	300 U	300 U	300 U	300 U	300 U	300 U	300 U
Aroclor 1242	300 U	300 U	300 U	300 U	300 U	300 U	300 U
Aroclor 1248	300 U	300 U	300 U	300 U	300 U	300 U	300 U
Aroclor 1254	300 U	300 U	300 U	300 U	300 U	300 U	300 U
Aroclor 1260	300 U	300 U	300 U	300 U	300 U	300 U	300 U

Notes:
Results are dry weight.
U - undetected

Table 3-4
In Situ LIF/TRPH Evaluation of False Positive/False Negative Responses

Method	False Positive	False Negative
In situ LIF	20	1

Table 3-5
Ex Situ LIF/TRPH Evaluation of False Positive/False Negative Responses

Method	False Positive	False Negative
Bench LIF	0	2

Table 3-6
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-1 and SE-1a	10-13	470	NAPL suspected based on LIF wavelength and response.
	50-60	470	NAPL suspected based on LIF wavelength and response.
SE-2 and SE-2a	23-50	471	NAPL confirmed with soil sample.
	64-66	471	NAPL confirmed with soil sample.
	84-86		Sheen and odor noted in soil sample no significant LIF response.
SE-3			No data.
SE-4	100-104	470	Sheen confirmed in SB04.
SE-5	8-12	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
	15-20	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
	22-28	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
	30-35	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
	54-60	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
	66-70	494-499	Unique peak shape with two humps. NAPL confirmed with soil sample.
SE-6	44	410	Spike at 44 feet bgs had wavelength of 410 nanometers; not target contamination.
	53-60	468	NAPL suspected based on LIF wavelength and response. Odor noted in SB06-54.
	75-80	468	NAPL suspected based on LIF wavelength and response.
SE-7	30-37	466	NAPL suspected based on LIF wavelength and response.
	42-44	470	NAPL suspected based on LIF wavelength and response.
	47-50	470	NAPL suspected based on LIF wavelength and response.
	61-68	468	NAPL suspected based on LIF wavelength and response.
SE-8	24-26	454	NAPL suspected based on LIF wavelength and response.
	40-42	468	NAPL suspected based on LIF wavelength and response.
	42-44	468	NAPL suspected based on LIF wavelength and response.
	44-45	468	NAPL suspected based on LIF wavelength and response.
	45-47	404	Low wavelength for site target contamination.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-8 (Continued)	48-50	468 (ex situ)	Low LIF in situ response; however, mobile NAPL present in soil sample. Ex situ LIF was 2,349 counts at 469 nanometers. The difference in these results may be due to heterogeneity of soil contamination or mistake on sample interval. NAPL should be considered to be present from 40-50 feet bgs.
SE-9			Clean push that was confirmed with soil sampling.
SE-10	59-65	473-480	Confirmed visible NAPL. Slightly higher wavelength similar to other samples collected near asphalt cap area.
SE-11	50-52	468	NAPL suspected based on LIF wavelength and response.
SE-12			Clean push.
SE-13	60-68	468	NAPL suspected based on LIF wavelength and response.
SE-14			Clean push. Peak at 20.2 feet bgs had a wavelength of 420 nanometers and unlikely to be site contamination of concern.
SE-15	35-37	464	Barely above 300 count threshold; however, SE-15 is located west of the office building near SE-37. NAPL was confirmed in soil sample collected from SE-37.
	47-50		Irregular peak shape and low wavelength unlikely to be site target contamination.
	65-66	467	Barely above 300 count threshold; however, SE-15 is located west of the office building near SE-37. NAPL was confirmed in soil sample collected from SE-37.
SE-16	43-44	460	NAPL suspected based on LIF wavelength and response.
SE-17			Clean push.
SE-18	50-52	472	NAPL suspected based on LIF wavelength and response.
	60-63	468	NAPL suspected based on LIF wavelength and response.
SE-19	7-11	473	NAPL suspected based on LIF wavelength and response.
	33-40	435	Odor noted in SB019 from 37-54 feet bgs. Soil samples collected from SB019 were ND for PAH and PCP; however, TPH was above detection level. Contamination in this interval is questionable due to low wavelength.
	50-60	476	NAPL suspected based on LIF wavelength and response.
SE-20	29-32	467-476	Sheen confirmed 29-31 feet bgs. Low level response; however, curve has correct shape and wavelength.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-20 (Continued)	40-47	467-476	Low level response; however, curve has correct shape and wavelength.
	47-50	471	Mobile NAPL confirmed in soil sample.
	51-63	470	Mobile NAPL confirmed in soil sample.
SE-21	50-57	468	NAPL suspected based on LIF wavelength and response.
	64-66	468	NAPL suspected based on LIF wavelength and response.
SE-22	30-37	470	This push is located just north of stormwater ponds. The LIF counts in all intervals are just barely above the 300 count threshold limit. NAPL presence at this location is questionable.
	39-41	471	NAPL suspected based on LIF wavelength and response.
	76-80	469	NAPL suspected based on LIF wavelength and response.
SE-23	28-30	448	NAPL suspected based on LIF wavelength and response.
	52-56	470	NAPL suspected based on LIF wavelength and response.
	80-83	469	NAPL suspected based on LIF wavelength and response.
SE-24	6-11	467	All LIF results for this push location are just above threshold; however, located in main OWP Area, and peak shape and wavelength are consistent with site target contamination, so NAPL presence is likely.
	22-30	467	NAPL suspected based on LIF wavelength and response.
	42-54	467	NAPL suspected based on LIF wavelength and response.
	70-73	468	NAPL suspected based on LIF wavelength and response.
SE-25	18-26	448-468	Unique peak shape with broad two-hump peak.
	42-43	403	Single 436 count peak; should not be considered site target contamination due to low wavelength.
	59-70	466	NAPL suspected based on LIF wavelength and response.
	77-83	469	NAPL suspected based on LIF wavelength and response.
SE-26	37-38	471	NAPL suspected based on LIF wavelength and response.
	60-67	470	NAPL suspected based on LIF wavelength and response.
	71-76	467	NAPL suspected based on LIF wavelength and response.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-27	35-37	481	This push is located under asphalt cap and wavelength is slightly higher, similar to other pushes in this area.
	50-57	476-487	NAPL suspected based on LIF wavelength and response.
	98.6	434	428 count spike at this depth is not likely to be site target contamination due to low wavelength.
SE-28	6-11	487	This push is located under asphalt cap and wavelength is slightly higher, similar to other pushes in this area.
	26-32	476	NAPL suspected based on LIF wavelength and response.
	36-38	487	NAPL suspected based on LIF wavelength and response.
	50-60	487-491	NAPL suspected based on LIF wavelength and response.
SE-29			Clean push.
SE-30			Clean push.
SE-31			Clean push.
SE-32	40-50	473	NAPL suspected based on LIF wavelength and response.
SE-33			Clean push.
SE-34			Clean push.
SE-35			Clean push. Single peak at 51.5 feet bgs of 471 nanometers; however, soil sample collected at 50-52 feet bgs was ND for both PAH/PCP and TPH. No contamination or odor noted in soil sample. It is possible that the LIF picked up a NAPL stringer that was diluted out during soil sampling. Soil discoloration was noted in a sample collected from 58-60 feet bgs; however, no LIF response was recorded in this interval.
SE-36			Clean push. Some minor background peaks did not match target contamination wavelength.
SE-37	32-33	446	Soil sample collected 31-32.6 feet was ND for PAH/PCP and TPH. Interval did have odor and it is possible that soil contamination was diluted during soil homogenization. The wavelength is outside the target spectral profile.
	56-60	484	Mobile NAPL confirmed in soil sample.
	90-100		Confirmed to be non-target contamination; fluorescence likely due to calcite.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-38			Clean push.
SE-39	10-11	470	NAPL suspected based on LIF wavelength and response.
	18-25	468	NAPL suspected based on LIF wavelength and response.
SE-40			Clean push.
SE-41			Clean push.
SE-42			Clean push.
SE-43	0-10	477	Note lower wavelength in this boring. Soil sampling results indicate that LIF response at this location is due to a unique petroleum hydrocarbon type not creosote. All PAHs were below detection level. Soil sample had fuel odor but no visible NAPL. SE-43 has unique peak shape.
	10-20	455	Note lower wavelength in this boring. Soil sampling results indicate that LIF response at this location is due to a unique petroleum hydrocarbon type not creosote. All PAHs were below detection level. Soil sample had fuel odor but no visible NAPL. SE-43 has unique peak shape.
	20-30	454	Note lower wavelength in this boring. Soil sampling results indicate that LIF response at this location is due to a unique petroleum hydrocarbon type not creosote. All PAHs were below detection level. Soil sample had fuel odor but no visible NAPL. SE-43 has unique peak shape.
SE-44			Clean push with minor exception. Very low level response between 90-102 feet bgs at 470 nanometers may be picking up a stringer. Some contamination detected at a similar depth in SB-61, which is very close.
SE-45			Clean push.
SE-46			Clean push.
SE-47	7-18	437-447	Note lower wavelength. Soil sample results indicate LIF response at this push location is due to a unique petroleum hydrocarbon product type not creosote. PCP was detected at two depths: 12-14 and 14-15 feet bgs. The only PAH reported was phenanthrene at very low levels. Total TPH reported as diesel was very high, up to 9,200 ppm.
SE-48			Clean push.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-49			Clean push.
SE-50	4-10	468-479	Push located in Main Processing Area, mobile NAPL confirmed nearby.
	20-61	468-479	NAPL suspected based on LIF wavelength and response.
SE-51	50-57	468	Sheen and visible NAPL confirmed in SB051 at 52.4-52.9 and 56-56.3 feet.
	65-70	469	NAPL suspected based on LIF wavelength and response.
	79-83	468	NAPL suspected based on LIF wavelength and response.
SE-52			Refusal hit at 16 feet bgs.
SE-53			Clean push.
SE-54 and 54a			Refusal hit at 16 feet bgs.
SE-55			Clean push.
SE-56	26-31	468	NAPL suspected based on LIF wavelength and response.
	40-48	468	NAPL suspected based on LIF wavelength and response.
	59-61	472	NAPL suspected based on LIF wavelength and response.
SE-57	10-14	430	This may not be target contamination; questionable because of low wavelength.
	25-60	468-475	NAPL suspected based on LIF wavelength and response.
SE-58	35-38	468	NAPL suspected based on LIF wavelength and response.
	84-88	470	NAPL suspected based on LIF wavelength and response.
SE-59			Clean push. Spike at 118.6 feet bgs is at 497 nanometers and is probably not due to site target contamination. Most target contamination in the OWP Area is probably in the 477 nanometers range.
SE-60	36-40		Nontarget contamination.
	45-50	471	NAPL suspected based on LIF wavelength and response.
	54-66	470	NAPL suspected based on LIF wavelength and response.
	92-94		Wavelength of 403-404 nanometers indicates that this is nontarget contamination.
SE-61	124-125	468	Odor and low level of PAHs and TPH reported in SB061 at 126-126.3 feet bgs. Deep contamination (90-102 feet bgs) was also reported in SE-44, which is less than 100 feet northeast of SE-61.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-62			Clean push.
SE-63	26-30	476	NAPL suspected based on LIF wavelength and response.
	35-37	479	NAPL suspected based on LIF wavelength and response.
	40-50	468-471	NAPL suspected based on LIF wavelength and response.
SE-64	30-38	468	Odor confirmed 31-33 feet bgs, and mobile NAPL confirmed 34-36 feet bgs
	50-52	412	Wavelength of 412 nanometers indicates that this is nontarget contamination. Soil sample collected at 50-51 feet bgs, which had a slight odor but all PAHs and TPH were ND.
	60-62	471	Visible NAPL at 62 feet bgs confirmed in soil sample.
	108	432	Wavelength of 432 nanometers indicates that this is nontarget contamination.
SE-65			Clean push.
SE-66			Clean push.
SE-67	25.5-26.5	487	Wavelength pattern similar to SE-05 and other samples under asphalt cap.
SE-68			Clean push.
SE-69	4-12	414	NAPL suspected based on LIF wavelength and response.
	15-41	412-419	The wavelength signature in this area is unusually low; however, because of high counts and proximity to other confirmed contamination source areas, this interval should be considered a NAPL interval. No soil samples were collected for confirmation; however, the contaminant makeup in this area may be different.
	57-58	482	Contaminant wavelength signature is similar to other samples within asphalt cap area.
SE-70	53-63	497	Similar wavelength pattern to SE-05 and other samples under asphalt cap.
SE-71			Clean push.
SE-72			Clean push.
SE-73			Clean push

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-74	12-16	446	Contamination in this depth interval questionable due to low wavelength.
	23-30	466-470	NAPL suspected based on LIF wavelength and response.
	32-35	471	NAPL suspected based on LIF wavelength and response.
	38-39	472	NAPL suspected based on LIF wavelength and response.
	43-43.2	475	NAPL suspected based on LIF wavelength and response.
	58-64	469-476	NAPL suspected based on LIF wavelength and response.
	65-67	469-473	NAPL suspected based on LIF wavelength and response.
SE-75			Clean push.
SE-76			Clean push. Spike at 61.5-62 feet bgs was at 55 nanometers, which is not a target wavelength signature.
SE-77	25-27	471	NAPL suspected based on LIF wavelength and response.
SE-78			Clean push.
SE-79	50-60	488	NAPL confirmed in soil sample.
	80-80.5	497	NAPL confirmed in soil sample.
SE-80			Clean push.
SE-81	50-52	494	This is a questionable result. Soil sample collected 50-50.6 feet bgs had odor, but all analyses were ND. The ex situ soil sample had a much lower wavelength and may be different then what was measured in situ.
SE-82			Clean push.
SE-83			Clean push.
SE-84	10-16	468	NAPL suspected based on LIF wavelength and response.
	43-53	477	NAPL suspected based on LIF wavelength and response.
SE-85			Clean push.
SE-86	9-20	476	NAPL suspected based on LIF wavelength and response.
	21-37	477	NAPL suspected based on LIF wavelength and response.
	42-49	476	NAPL suspected based on LIF wavelength and response.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-87	4-10	475	NAPL suspected based on LIF wavelength and response.
	10-20	476	NAPL suspected based on LIF wavelength and response.
	20-28	475	NAPL suspected based on LIF wavelength and response.
SE-88	4-8	467	Visible NAPL confirmed in soil sample 5.4-5.8 feet bgs.
	9-12	468	Visible NAPL confirmed in soil sample 10.3-11 feet bgs.
	13-18	470	Visible NAPL confirmed in soil sample 14-14.5 feet bgs.
	20-28	478	Visible NAPL confirmed in soil sample 20-21 and 24-25.8 feet bgs.
SE-89 and 89a			Clean push with refusal at 12 feet bgs.
SE-89b	14-20	475	NAPL suspected based on LIF wavelength and response.
	20-32	468-473	NAPL suspected based on LIF wavelength and response.
SE-90	22-25	477	NAPL suspected based on LIF wavelength and response.
	29.5-30.5	477	NAPL suspected based on LIF wavelength and response.
	44-49	477	NAPL suspected based on LIF wavelength and response.
	50-60	476	NAPL suspected based on LIF wavelength and response.
SE-91			Clean push. Spike at 13 feet bgs is not real due to irregular peak shape.
SE-92	50-54	489	NAPL suspected based on LIF wavelength and response.
	78-80	489	NAPL suspected based on LIF wavelength and response.
	88-90	486	NAPL suspected based on LIF wavelength and response.
SE-93	62-70	410	Visible NAPL seen is soil core from 66-68 feet bgs. Wavelength is unusually low and all TPH and PAH results were ND; stringers could have been diluted below detection level prior to analysis.
SE-94	8-10	487	NAPL suspected based on LIF wavelength and response.
	12-17	476-488	NAPL suspected based on LIF wavelength and response.
SE-95			Clean push with refusal at 16 feet bgs.
SE-96	63-68	473	Mobile NAPL confirmed in soil sample at 63-65 and 66-67.6 feet bgs.
	82-88	475	Odor confirmed in soil sample at 84.5-84.8 and 94-96 feet bgs.
	92-97	466	NAPL suspected based on LIF wavelength and response.

Table 3-6 (Continued)
Identification of Soil Intervals Containing NAPL

Push Location	Depth Interval (feet bgs)	In Situ Wavelength (nanometers)	Comments
SE-97	87-90	471	NAPL suspected based on LIF wavelength and response.
	90-95	477	NAPL confirmed in soil sample at 90-92 and 92.6-94 feet bgs.
	100-102	468	NAPL confirmed in soil sample at 100-102 feet bgs.
SE-98			Clean push.

Notes:
OWP - Oily Waste Ponds
ND - not detected

Table 3-7
Summary of Metals in Soil

Location ID	Quadrant	Sample ID	Date	Field QC	Soil Description	NAPL Description	Concentration (mg/kg)			
							Arsenic	Chromium	Copper	Zinc
SB-028	C2	SB028-12-12.5	9/29/99		Clay	Odor	8.3	48	48	62
SB-028	C2	SB028-28.3-29.4	9/29/99		Sand & gravel	Sheen	12	27	33	45
SB-028	C2	SB028-31-33	9/29/99		Sand	Sheen	6.2	25	23	38
SB-028	C2	SB028-48-49.7	9/29/99		Sand	Sheen	4.1	25	13	22
SB-028	C2	SB028-53.5-55	9/29/99		Sand	Sheen	12	13	11	31
SB-028	C2	SB528-53.5-55	9/29/99	Field dup	Sand	Sheen	7.8	12	8.3	29
SB-028	C2	SB028-55-56	9/29/99		Sand	Nothing	5.6	9.3	5.5 J	21
SB-028	C2	SB028-79.5-79.8	9/29/99		Clay	Odor	1.1 J	18	14	29
SB-028	C2	SB028-82.2-83.7	9/29/99		Sand	Odor	2.5	20	14	30
SB-028	C2	SB028-100.6-101.5	9/29/99		Clay	Sheen	5.7	49	45	58
SB-028	C2	SB028-141-142	9/30/99		Sand	Odor	5.1	18	12	29
SB-057	C2	SB057-2.7-3	10/9/99		Sand and gravel	Nothing	290	88	420	120
SB-057	C2	SB057-18-19.8	10/9/99		Clay	Odor	9.8	43	28	49
SB-057	C2	SB057-28-29.8	10/9/99		Clay	Odor	8.1	57	39	66
SB-057	C2	SB057-36-38	10/9/99		Sand	Sheen	3.3	55	23	43
SB-057	C2	SB057-51-52	10/9/99		Sand	Sheen	6.2	40	16	33
SB-057	C2	SB057-65-66	10/9/99		Sand	Odor	3.8	31	17	38
SB-057	C2	SB557-65-66	10/9/99	Field dup	Sand	Odor	3.2	27	13	32
SB-099	C3	SB099-13.4-14.7	9/30/99		Clay	Odor	77	75	35	66
SB-099	C3	SB099-31-33	9/30/99		Sand	Visible	5.9	20	12	30
SB-099	C3	SB099-41-42.5	10/6/99		Silt/sand	Sheen	4.6	40	23	43

Note:
J - estimated

Table 3-8
Permeability and Hydraulic Conductivity Results

Location ID	Sample Interval (feet bgs)	Permeability (millidarcy)	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (ft/day)	Visual Soil Description
SS-010	12-14	6.300E-02	6.450E-08	0.0002	Clay
SS-010	30-31.2	1.681E+03	1.720E-03	4.8756	Sand
SB-019	93.4	9.896E+00	1.013E-05	0.0287	Sand
SB-025	92-92.5	1.454E+01	1.479E-05	0.0419	Sand
SB-027	93-93.5	4.827E+02	4.942E-04	1.4008	Sand
SB-030	161.7-162.2	3.015E+03	3.083E-03	8.7390	Sand
SS-035	54.4-55.2	6.190E+02	6.280E-04	1.7802	Sand
SS-035	59.2-60	2.340E-01	2.380E-07	0.0007	Clay
SB-047	20-22	8.340E-01	8.430E-07	0.0024	Silt/sand
SB-047	117.2-117.9	1.445E-01	1.477E-07	0.0004	Clay
SB-047	141.3-142.1	9.020E+01	9.230E-05	0.2616	Sand
SB047	167.5-168.4	2.780E-01	2.846E-07	0.0008	Clay
SB-047	244.0-245.0	2.846E+01	2.920E-05	0.0828	Sand and gravel
SB-052	122-123	2.737E+01	2.809E-05	0.0796	Sand
SB-052	156-156.6	3.587E-01	3.681E-07	0.0010	Clay
SB-052	164-165	1.108E+02	1.136E-04	0.3219	Sand
SB-052	204-205	5.937E+00	6.065E-06	0.0172	Sand
SS-064	41-43	2.080E-01	2.100E-07	0.0006	Clay
SS-064	67-69	4.900E-02	5.000E-08	0.0001	Clay
SS-079	48-48.7	1.190E+02	1.210E-04	0.3430	Sand
SS-079	63.9-65	1.350E+02	1.380E-04	0.3912	Clay
SS-088	30-31.3	1.390E+02	1.420E-04	0.4025	Sand
SS-088	36-38	1.050E-01	1.070E-07	0.0003	Clay/silt
SS-093	25-26.7	7.870E+00	8.060E-06	0.0228	Clay
SS-096	74.2-75	4.920E+00	5.030E-06	0.0143	Clay
SS-096	78.7-79.5	4.120E+01	4.200E-05	0.1191	Sand
SS-097	75-76.2	9.120E+00	9.280E-06	0.0263	Sand/silt/clay
SB-099	111.5-112.5	1.024E+02	1.042E-04	0.2954	Sand
SB-099	176.9-177.6	8.488E-01	8.688E-07	0.0025	Clay
SB-099	193-194	2.158E+01	2.193E-05	0.0622	Sand
SB-099	247-248	2.360E+02	2.421E-04	0.6862	Silt/sand/gravel

Table 3-9
Grain Size Distribution

Sample ID	Depth (feet bgs)	Median Grain Size (mm)	Particle Size Distribution (weight percent)						
			Gravel	Sand Size			Silt	Clay	Silt & Clay
				Coarse	Medium	Fine			
SS010	30.00-31.20	0.282	0.00	0.00	24.86	57.80	13.20	4.15	17.34
SB-030	161.70-162.20	0.581	0.00	0.00	67.63	23.69	No data	No data	8.68
SB-047	117.2-117.9	0.011	0.00	0.00	0.04	4.15	68.75	27.06	95.81
SB-047	141.30-142.10	0.594	0.00	5.46	59.58	25.15	No data	No data	9.80
SB-047	167.5-168.4	0.010	0.00	0.00	0.00	3.56	68.92	27.52	96.44
SB-047	209.1-209.6	0.012	0.00	0.00	0.00	1.98	71.15	26.87	98.02
SB-047	244.0-245.0	1.202	25.00	17.54	28.85	16.82	No data	No data	11.79
SB-052	122.0-123.0	0.647	0.00	5.43	62.10	22.96	No data	No data	9.50
SB-052	156.0-156.6	0.007	0.00	0.00	0.82	14.02	44.80	40.37	85.16
SS-064	41.00-43.00	0.023	0.00	0.00	9.88	21.96	50.89	17.27	68.16
SS-079	63.90-65.00	0.057	0.00	0.00	0.67	41.98	46.89	10.47	57.36
SS-088	30.00-31.30	0.300	0.00	0.00	30.99	43.11	20.41	5.49	25.90
SS-088	36.00-38.00	0.008	0.00	0.00	0.00	3.41	62.48	34.12	96.59
SS-096	74.20-75.00	0.034	0.00	0.00	3.53	29.55	53.85	13.07	66.92
SS-096	78.70-79.50	0.256	0.00	0.00	24.66	44.43	23.20	7.72	30.92
SS-097	75.00-76.20	0.071	0.00	0.00	3.74	45.50	40.81	9.96	50.76
SB-099	111.5-112.5	0.018	0.00	0.00	5.12	25.27	48.28	21.33	69.61
SB-099	118.8-119.8	0.013	0.00	0.00	0.00	5.11	70.09	24.80	94.89
SB-099	176.9-177.6	0.008	0.00	0.00	0.00	1.10	64.72	34.19	98.90
SB-099	193-194	0.194	0.00	0.00	28.17	36.17	26.74	8.91	35.66

Notes:
ASTM - American Society for Testing and Materials
USCS - Unified Soil Classification System

Table 3-10
Bulk Density and Effective Porosity in Soils

Location ID	Sample ID	Bulk Density (g/cc)	Effective Porosity (percent Vb)	Visual Soil Description
SB-028	SB028-31-33	1.50	44.4	Sand[1]
SB-028	SB028-48-49.7	1.74	35.3	Sand[1]
SB-028	SB028-100.6-101.5	1.40	48.4	Clay
SB-030	SB030-161.7-162.2	1.71	35.8	Sand[1]
SB-047	SB047-117.2-117.9	1.79	32.8	Clay
SB-047	SB047-141.3-142.1	1.73	35.8	Sand[1]
SB-047	SB047-167.5-168.4	1.76	33.8	Clay
SB-047	SB047-209.1-209.6	1.46	45.4	Clay
SB-047	SB047-244.0-245.0	1.94	28.4	Sand/gravel
SB-052	SB052-122-123	1.88	29.6	Sand[1]
SB-052	SB052-156-156.6	1.95	25.9	Clay
SB-086	SB086-33.6-35	1.76	35.6	Sand[1]
SB-086	SB086-36.3-38	1.67	37.8	Sand[1]
SB-099	SB099-13.4-14.7	1.53	41.4	Clay
SB-099	SB099-27.5-29.5	1.49	43.4	Sand[1]
SB-099	SB599-27.5-29.5	1.52	44.2	Sand[1]
SB-099	SB099-31-33	1.66	38.5	Sand[1]
SB-099	SB099-41-42.5	1.64	39.6	Silty/sand
SB-099	SB099-111.5-112.5	1.73	36.1	Sand[1]
SB-099	SB099-118.8-119.8	1.62	39.5	Clay
SB-099	SB099-176.9-177.6	1.67	35.6	Clay
SB-099	SB099-193-194	1.75	35.86	Sand[1]
SE-010	SS010-30-31.2	1.4	48.6	Sand
SE-064	SS064-41-43	1.73	35.7	Clay
SE-079	SS079-63.9-65	1.58	41.6	Clay
SE-088	SS088-30-31.3	1.68	38.8	Sand
SE-088	SS088-36-38	1.82	31.8	Clay/silt
SE-096	SS096-74.2-75	1.59	41.1	Clay
SE-096	SS096-78.7-79.5	1.72	36.3	Sand
SE-097	SS097-75.0-76.2	1.71	36.2	Sand/silt/clay

[1]Sands from rotosonic soil borings were replaced and reformed prior to measurement.

Note:
Vb - bulk volume of the sample

Table 3-11
Total Organic Carbon in Soil

Location ID	Sample ID	Visual Soil Description	NAPL Description	TOC (mg/kg)
SB-018	SB018-80.5-80.8	Sand	Nothing	320 J
SB-018	SB018-91.3-91.6	Sand	Nothing	180 J
SB-018	SB018-109.5-109.8	Sand	Nothing	280 J
SB-018	SB018-183.4-183.7	Clay	Nothing	210 J
SB-047	SS047-21.6-22	Silt/sand	Nothing	330
SB-047	SB047-102.0-103.0	Sand	Nothing	580
SB-047	SB047-117.0-117.2	Clay	Nothing	340
SB-047	SB047-161.0-162.0	Sand	Nothing	630
SB-047	SB047-209.6-209.7	Clay	Nothing	1,300
SB-047	SB047-244.0-245.0	Sand/gravel	Nothing	800
SB-099	SB099-111.5-112.5	Sand	Odor	430
SB-099	SB099-118.8-119.8	Clay	Nothing	1,400
SB-099	SB099-172.5-172.6	Sand	Odor	1,900
SB-099	SB099-193.1-193.3	Sand	Nothing	880
SB-099	SB099-247.8-248.0	Sand	Odor	940
SE-010	SS010-12-14	Clay	Nothing	660
SE-010	SS010-30-31.2	Sand	Nothing	310
SE-035	SS035-54-54.4	Sand	Odor	280 J
SE-035	SS035-58-59.2	Clay	Odor	250 J
SE-064	SS064-41-43	Clay	Odor	450
SE-064	SS064-67-69	Clay	Nothing	390
SE-079	SS079-48.7-48.9	Sand	Odor	170 J
SE-079	SS079-63-63.9	Clay	Odor	330 J
SE-079	SS579-63-63.9	Clay	Odor	640 J
SE-088	SS088-36-38	Clay/silt	Nothing	470
SE-093	SS093-26.7-27	Clay	Odor	240 J
SE-096	SS096-73-74.2	Clay	Odor	250 J
SE-096	SS096-78-78.7	Sand	Nothing	170 J
SE-097	SS097-76.2-76.6	Sand	Nothing	310

Note:
J - estimated

Table 3-12
Cation Exchange Capacity

Sample ID	Depth (feet bgs)	Cation Exchange Capacity (meq/100 grams)	Visual Soil Description
SS-010	30-31.2	9.0	Sand
SB-030	161.7-162.2	4.9	Sand
SB-047	117.2-117.9	18.0	Clay
SB-047	141.3-142.1	7.5	Sand
SB-047	167.5-168.4	23.0	Clay
SB-047	209.1-209.6	35.0	Clay
SB-047	244.0-245.0	1.0	Sand and gravel
SB-052	122-123	12.0	Sand
SB-052	156-156.6	16.0	Clay
SS-064	41-43	20.4	Clay
SS-079	63.9-65.0	22.0	Clay
SS-096	74.2-75.0	31.0	Clay
SS-096	78.7-79.5	14.4	Sand
SS-088	30-31.3	10.0	Sand
SS-088	36-38	17.4	Clay/silt
SS-097	75-76.2	8.4	Sand/silt/clay
SB-099	111.5-112.5	7.0	Sand
SB-099	118.8-119.8	24.0	Clay
SB-099	176.9-177.6	26.0	Clay
SB-099	193-194	11.0	Sand

Table 3-13
Summary of Groundwater Elevations

	April 1999				July 1999			
Well ID	**MW Measurement Point Elevation (feet NVD88)**	**Depth to Water (feet)**	**GW Elevation (feet NVD88)**	**GW Measured From:**	**MW Measurement Point Elevation (feet NVD88)**	**Depth to Water (feet)**	**GW Elevation (feet NVD88)**	**GW Measured From:**
A-1	12.15	9.67	2.5	Outer casing	12.15	12.2	!0.049	Outer casing
A-2	10.86	14.95	!4.1	Outer casing	10.86	16.22	!5.4	Outer casing
A-3	—	—	—	—	15.41	16.3	!0.89	Outer casing
A-4	12.95	10.58	2.4	Outer casing	12.95	14.28	!1.3	Outer casing
A-5	11.65	10.56	1.1	Outer casing	11.65	12.07	!0.42	Outer casing
A-6	11.01	12.58	!1.6	Outer casing	11.01	14.75	!3.7	Outer casing
A-7	11.43	13.78	!2.4	Outer casing	11.43	15.38	!4	Outer casing
A-8	—	—	—	—	13.51	16.55	!3	Inner casing
A-10	12.96	10.42	2.5	Outer casing	12.96	13.17	!0.21	Outer casing
DSW-1B	10.87	15.14	!4.3	Outer casing	10.87	17.27	!6.4	Outer casing
DSW-1C	—	—	—	—	10.54	1.16	9.4	Outer casing
DSW-1D	11.07	17	!5.9	Outer casing	11.07	19.53	!8.5	Outer casing
DSW-2A	10.90	15.39	!4.6	Outer casing	10.90	16.22	!5.3	Outer casing
DSW-2B	10.86	15.63	!4.8	Outer casing	10.86	17.45	!6.6	Outer casing
DSW-2C	10.56	15.92	!5.5	Outer casing	10.56	17.89	!7.3	Outer casing
DSW-2D	11.00	16.63	!6	Outer casing	11.00	18.61	!7.6	Outer casing
DSW-2E	11.03	17.85	!7.2	Outer casing	11.03	20.24	!9.2	Outer casing
DSW-3B	11.83	15.55	!3.7	Outer casing	11.83	18.31	!6.5	Outer casing
DSW-3C	13.12	15.01	!1.9	Outer casing	13.12	17.48	!4.4	Outer casing
DSW-4B	9.97	14.35	!4.4	Inner Casing	9.97	16.65	!6.7	Inner casing
DSW-4C	9.75	14.28	!4.5	Inner Casing	9.75	16.36	!6.6	Inner casing
DSW-4D	13.11	18.05	!4.9	Outer casing	13.11	20.48	!7.4	Outer casing
DSW-4E	—	—	—	—	11.11	20.3	!9.2	Outer casing

Table 3-13 (Continued)
Summary of Groundwater Elevations

Well ID	April 1999				July 1999			
	MW Measurement Point Elevation (feet NVD88)	Depth to Water (feet)	GW Elevation (feet NVD88)	GW Measured From:	MW Measurement Point Elevation (feet NVD88)	Depth to Water (feet)	GW Elevation (feet NVD88)	GW Measured From:
DSW-5B	—	—	—	—	11.49	17.79	!6.3	Outer casing
DSW-6B	13.53	16.61	!3.1	Outer casing	13.53	19.05	!5.5	Outer casing
DSW-6C	13.68	18.09	!4.4	Outer casing	13.68	20.52	!6.8	Outer casing
DSW-7A	9.75	13.18	!3.4	Outer casing	9.75	14.86	!5.1	Monument
DSW-7B	9.77	14.78	!5	Outer casing	9.77	16.65	!6.9	Monument
DSW-7C	9.77	15	!5.2	Outer casing	9.77	16.97	!7.2	Monument
OFS-1A	7.44	7.15	0.28	Outer casing	7.44	10.14	!2.7	Monument
OFS-1B	7.40	10.2	!2.8	Outer casing	7.40	12.85	!5.5	Monument
OFS-1C	7.39	11.33	!3.9	Outer casing	7.39	14.1	!6.7	Monument
OFS-1D	7.45	11.68	!4.2	Outer casing	7.45	14.32	!6.9	Monument
OFS-2A	7.65	7.49	0.15	Outer casing	7.65	10.27	!2.6	Monument
OFS-2C	7.67	11.81	!4.1	Outer casing	7.67	14.23	!6.6	Monument
OFS-2D	7.48	11.9	!4.4	Outer casing	7.48	14.6	!7.1	Monument
OFS-3A	8.14	11.98	!3.8	Outer casing	8.14	14.06	!5.9	Monument
OFS-3B	8.15	12.58	!4.4	Outer casing	8.15	15.03	!6.9	Monument
OFS-3C	8.18	12.75	!4.6	Outer casing	8.18	15.22	!7	Monument
OFS-3D	8.22	13.69	!5.5	Outer casing	8.22	16.3	!8.1	Monument
OFS-3E	8.28	13.92	!5.6	Outer casing	8.28	16.66	!8.4	Monument
OFS-4A1	7.85	10.7	!2.8	Outer casing	7.85	12.37	!4.5	Monument
OFS-4A2	7.70	10.95	!3.3	Outer casing	7.70	12.83	!5.1	Monument
OFS-4C	7.72	12.95	!5.2	Outer casing	7.72	15.04	!7.3	Monument
OFS-4D	7.57	13.27	!5.7	Outer casing	7.57	15.6	!8	Monument
OFS-4E	7.71	14.52	!6.8	Outer casing	7.71	16.9	!9.2	Monument

Table 3-13 (Continued)
Summary of Groundwater Elevations

	April 1999				July 1999			
Well ID	**MW Measurement Point Elevation (feet NVD88)**	**Depth to Water (feet)**	**GW Elevation (feet NVD88)**	**GW Measured From:**	**MW Measurement Point Elevation (feet NVD88)**	**Depth to Water (feet)**	**GW Elevation (feet NVD88)**	**GW Measured From:**
OFS-5A	12.63	8.54	4.1	Outer casing	12.63	9.42	3.2	Monument
OFS-5C	12.60	17.15	!4.5	Outer casing	12.60	19.47	!6.9	Monument
OFS-5E	12.56	18.82	!6.3	Outer casing	12.56	21.6	!9	Monument
ONS-1B	11.20	15.47	!4.3	Outer casing	11.20	17.8	!6.6	Monument
ONS-1C	11.11	15.81	!4.7	Outer casing	11.11	18.02	!6.9	Monument
ONS-1D	11.03	15.87	!4.8	Outer casing	11.03	18.3	!7.3	Monument
ONS-2A	12.96	11.28	1.7	Outer casing	12.96	13.49	!0.5	Monument
ONS-2B	13.09	15.6	!2.5	Outer casing	13.09	18.21	!5.1	Monument
ONS-2C	12.80	17.01	!4.2	Outer casing	12.80	19.66	!6.9	Monument
ONS-2D	12.65	16.86	!4.2	Inner casing	12.91	19.78	!6.9	Monument
OS-1A	9.51	15.44	!5.9	Outer casing	9.51	16.98	!7.5	Monument
OS-1B	9.52	16.1	!6.6	Outer casing	9.52	17.58	!8.1	Monument
OS-1C	9.20	15.44	!6.2	Outer casing	9.20	16.98	!7.8	Monument
OS-1E	8.87	17.2	!8.3	Outer casing	8.87	19.48	!10.6	Monument
OS-2E	7.95	13.8	!5.8	Outer casing	—	—	—	—
OS-3E	6.43	13.46	!7	Outer casing	6.43	15.77	!9.3	Monument
OS-4A	8.21	11.7	!3.5	Outer casing	8.21	13.36	!5.2	Monument
OS-4B	8.26	13.56	!5.3	Outer casing	8.26	15.5	!7.2	Monument
OS-4C	8.08	13.44	!5.4	Outer casing	8.08	15.38	!7.3	Monument
OS-5B	11.70	19.89	!8.2	Outer casing	11.70	21.29	!9.6	Monument
OS-5C	11.70	19.61	!7.9	Outer casing	11.70	21	!9.3	Monument
OS-5D	11.56	10.65	0.91	Outer casing	11.56	22.16	!10.6	Monument
OS-6B	9.76	16.71	!7	Outer casing	9.76	18.17	!8.4	Monument

Table 3-13 (Continued)
Summary of Groundwater Elevations

Well ID	April 1999				July 1999			
	MW Measurement Point Elevation (feet NVD88)	Depth to Water (feet)	GW Elevation (feet NVD88)	GW Measured From:	MW Measurement Point Elevation (feet NVD88)	Depth to Water (feet)	GW Elevation (feet NVD88)	GW Measured From:
OS-6C	9.69	16.6	!6.9	Outer casing	9.69	18.17	!8.5	Monument
OS-6D	9.84	17.67	!7.8	Outer casing	9.84	18.79	!9	Monument

Notes:
GW - groundwater
MW - monitoring well

Table 3-14
Vertical Gradient Data

Well ID	Vertical Gradients Between Adjacent Aquifer Zones (ft/ft)											
	A_1 to A_2		A_1 to B		A_2 to B		B to C		C to D		D to E	
	Apr-99	Jul-99	Apr-99	Jul-99	Apr-99	Jul-99	Apr-99	Jul-99	Apr-99	Jul-99	Apr-99	Jul-99
A-2 DSW-2A	!0.0105	0.0008										
OFS-4A_1 OFS-4A_2	!0.0084	!0.0128										
A-1 DSW-3B			!0.1289	!0.1337								
A-2 DSW-2B			!0.1005	!0.1370								
A-5 DSW-6B			!0.0868	!0.1062								
A-6 DSW-4B			!0.0618	!0.0645								
A-7 DSW-1B			!0.0399	!0.0509								
A-8 ONS-1B			ND	!0.0741								
DSW-7A DSW-7B			!0.0329	!0.0369								
DSW-2A DSW-2B					!0.0036	!0.0264						
OFS-1A OFS-1B					!0.0642	!0.0572						
OFS-3A OFS-3B					!0.0122	!0.0199						
ONS-2A ONS-2B					!0.0872	!0.0954						
OS-1A OS-1B					!0.0135	!0.0123						
OS-4A OS-4B					!0.0376	!0.0434						
DSW-3B DSW-3C							0.0380	0.0440				
DSW-2B DSW-2C							!0.0124	!0.0155				
DSW-6B DSW-6C							!0.0275	!0.0273				
DSW-4B DSW-4C							!0.0081	!0.0044				
DSW-1B DSW-1C							ND	ND				
ONS-1B ONS-1C							!0.0089	!0.0064				
DSW-7B DSW-7C							!0.0046	!0.0067				
OFS-1B OFS-1C							!0.0237	!0.0262				
OFS-3B OFS-3C							!0.0029	!0.0033				
ONS-2B ONS-2C							!0.0352	!0.0362				

Table 3-14 (Continued)
Vertical Gradient Data

	Vertical Gradients Between Adjacent Aquifer Zones (ft/ft)											
	A_1 to A_2		A_1 to B		A_2 to B		B to C		C to D		D to E	
Well ID	**Apr-99**	**Jul-99**	**Apr-99**	**Jul-99**	**Apr-99**	**Jul-99**	**Apr-99**	**Jul-99**	**Apr-99**	**Jul-99**	**Apr-99**	**Jul-99**
OS-1B OS-1C							0.0070	0.0058				
OS-4B OS-4C							!0.0012	!0.0012				
OS-5B OS-5C							0.0060	0.0062				
OS-6B OS-6C							0.0010	!0.0013				
DSW-2C DSW-2D									!0.0057	!0.0059		
DSW-4C DSW-4D									!0.0002	!0.0067		
DSW-1C DSW-1D									ND	ND		
ONS-1C ONS-1D									!0.0028	!0.0074		
OFS-1C OFS-1D									!0.0060	!0.0033		
OFS-2C OFS-2D									!0.0058	!0.0116		
OFS-3C OFS-3D									!0.0187	!0.0216		
OFS-4C OFS-4D									!0.0096	!0.0146		
ONS-2C ONS-2D									!0.0023	ND		
OS-5C OS-5D									ND	!0.0272		
OS-6C OS-6D									!0.0192	!0.0098		
DSW-2D DSW-2E											!0.0247	!0.0333
DSW-4D DSW-4E											ND	!0.0378
OFS-3D OFS-3E											!0.0035	!0.0062
OFS-4D OFS-4E											!0.0231	!0.0241
Average	**!0.0095**	**!0.0060**	**!0.0751**	**!0.0862**	**!0.0364**	**!0.0424**	**!0.0056**	**!0.0056**	**!0.0078**	**!0.0120**	**!0.0171**	**!0.0254**

Note:
ND - no data available

Table 3-15
Groundwater Density

Well ID	Density (g/mL) at Various Temperatures								
	10°C	**20°C**	**30°C**	**40°C**	**50°C**	**60°C**	**70°C**	**80°C**	**90°C**
DSW-7A	1.0000	0.9980	0.9964	0.9916	0.9872	0.9848	0.9776	0.9724	0.9676
	1.0012	0.9996	0.9964	0.9928	0.9888	0.9844	0.9784	0.9724	0.9660
	1.0012	1.0004	0.9968	0.9940	0.9888	0.9848	0.9796	0.9740	0.9672
OS-4B	0.9996	0.9980	0.9960	0.9920	0.9880	0.9832	0.9784	0.9724	0.9656
	0.9992	0.9972	0.9948	0.9908	0.9876	0.9832	0.9784	0.9728	0.9652
	0.9992	0.9980	0.9960	0.9920	0.9884	0.9840	0.9780	0.9728	0.9660
A-8	1.0004	0.9992	0.9972	0.9932	0.9888	0.9840	0.9784	0.9724	0.9664
	0.9996	0.9976	0.9956	0.9916	0.9876	0.9836	0.9776	0.9712	0.9672
	1.0016	0.9996	0.9968	0.9928	0.9888	0.9840	0.9796	0.9740	0.9680
OS-4A	1.0000	0.9988	0.9960	0.9916	0.9884	0.9828	0.9780	0.9716	0.9648
	0.9996	0.9996	0.9964	0.9928	0.9884	0.9836	0.9780	0.9720	0.9664
	1.0004	1.0000	0.9968	0.9940	0.9900	0.9844	0.9788	0.9740	0.9680
DSW-6C	0.9996	0.9980	0.9964	0.9924	0.9892	0.9828	0.9788	0.9724	0.9668
	0.9992	0.9972	0.9944	0.9924	0.9880	0.9832	0.9788	0.9728	0.9652
	0.9984	0.9988	0.9956	0.9932	0.9884	0.9828	0.9788	0.9724	0.9660

Table 3-16
PAHs and PCP Detected in Groundwater

Location ID	A-5		A-8	DSW-4B	DSW-4C		DSW-6B	DSW-6C	DSW-7B	DSW-7C
Date Collected	7/12/99	7/12/99	7/12/99	7/15/99	7/15/99	7/15/99	7/12/99	7/12/99	7/13/99	7/13/99
Field QC		Field Duplicate				Field Duplicate				
SVOCs (mg/L)										
2,4,5-Trichlorophenol	10 U	10 U	500 U	110	10 U	10 U	100 U	10 U	10 U	10 U
2,4-Dichlorophenol	10 U	10 U	500 U	70	10 U	10 U	100 U	10 U	10 U	10 U
2,4-Dimethylphenol	10 U	10 U	500 U	210	70	60 J	400	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	300 J	1200	1100	1000 J	2000	100	10 U	10 U
2-Methylphenol	10 U	10 U	500 U	70	10 U	10 U	300	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	500 U	20	10 U	10 U	200	10 U	10 U	10 U
Acenaphthene	10 U	10 U	500 U	360	300	300	700	60	40	100
Acenaphthylene	10 U	10 U	500 U	8 J	7 J	7 J	100 U	10 U	10 U	10 U
Anthracene	10 U	10 U	500 U	40	20	20	200	10 U	10 U	10 U
Carbazole	10 U	10 U	700	900	700	700	1000 J	100	10 U	10 U
Chrysene	10 U	10 U	500 U	10	10 U	5 J	100 U	10 U	10 U	10 U
Dibenzofuran	10 U	10 U	500 U	200	160	200	400	30	10 U	7 J
Fluoranthene	10 U	10 U	500 U	60	20	30	200	10 U	10 U	10 U
Fluorene	10 U	10 U	500 U	170	130	100	400	30	10 U	6 J
Naphthalene	10 U	10 U	4,000	11,000	10,000	10,000	14,000	800	10 U	10 U
Pentachlorophenol	30	30	40,000	110	10 U	10 U	100 U	10 U	10 U	10 U
Phenanthrene	10 U	10 U	500 U	220	110	100	600	10	10 U	10 U
Phenol	10 U	10 U	500 U	110	20	20	200	10 U	10 U	10 U
Pyrene	10 U	10 U	500 U	40	10	20	200	10 U	10 U	10 U

Notes:
J - estimated
U - undetected

Table 3-17
Dioxin and Furan Congeners in Groundwater

Location ID	A-5	DSW-4B	DSW-4C		DSW-4D	DSW-6B	DSW-6C	OFS-3B
Date Collected	7/12/99	7/15/99	7/15/99	7/15/99	7/15/99	7/12/99	7/12/99	7/15/99
Field QC				Field Duplicate				
Dioxins/Furans (pg/L)								
1,2,3,4,6,7,8-HpCDD	74	8,500	710	440	65 J	23,000	160	16 J
1,2,3,4,6,7,8-HpCDF	30 J	3,200	190	130	10 U	8,900	27 J	10 U
1,2,3,4,7,8,9-HpCDF	7 J	220	20 J	21 J	10 U	[1]	5 U	10 U
1,2,3,4,7,8-HxCDD	5 U	80 J	10 U	5 U	10 U	53	5 U	10 U
1,2,3,4,7,8-HxCDF	18 J	170 J	35 J	28 J	5 U	420	5 U	5 U
1,2,3,6,7,8-HxCDD	7 J	200 J	25 J	19 J	10 U	1,500	5 U	10 U
1,2,3,6,7,8-HxCDF	5 U	97 J	10 U	8.5 J	5 U	60	5 U	5 U
1,2,3,7,8,9-HxCDD	5 U	120 J	10 U	10 J	10 U	250	5 U	10 U
1,2,3,7,8,9-HxCDF	5 U	32 J	10 U	5 U	5 U	50 U	5 U	5 U
1,2,3,7,8-PeCDD	5 U	140	6 J	9 J	5 U	28 J	5 U	5 U
1,2,3,7,8-PeCDF	10 J	150	5 J	4.8 J	10 U	110	5 U	10 U
2,3,4,6,7,8-HxCDF	5 U	48 J	10 U	5 U	5 U	50 U	5 U	5 U
2,3,4,7,8-PeCDF	6 J	150	7 J	5 U	10 U	96	5 U	10 U
2,3,7,8-TCDD	5 U	29	5 U	5 U	5 U	5 U	5 U	5 U
2,3,7,8-TCDF	5 U	30	5 U	5 U	5 U	42	5 U	5 U
HpCDDs (total)	74	3,800	1,700	1,100	65	23,000	160	50 U
HpCDFs (total)	50 U	650	880	630	50 U	21,000	50 U	50 U
HxCDDs (total)	50 U	600	79	72	50 U	5,200	50 U	50 U
HxCDFs (total)	50 U	4,300	120	200	50 U	13,000	50 U	50 U
OCDD	850	49,000	7,300	4,700	650	230,000	3,000	43 J
OCDF	87 J	8,500	880	570	47 J	17,000	190	9 J
PeCDDs (total)	50 U	150	50 U	50 U	50 U	150	50 U	50 U
PeCDFs (total)	50 U	530	64	50 U	50 U	2,000	50 U	50 U
TCDDs (total)	10 U	29	10 U	10 U	10 U	10 U	10 U	10 U
TCDFs (total)	19	54	11	10 U	10 U	140	10 U	10 U
TEC (U = 1/2)	13	436	35	27	11	874	12	10

[1] 1, 2, 3, 4, 7, 8, 9 - HpCDF was detected, but could not be quantified due to matrix interference.

Notes:
J - estimated
TEC - toxicity equivalent concentration
U - undetected