N62604.AR.000566
NCBC GULFPORT
5090.3a

WORK PLAN FOR DELINEATION OF THE DISSOLVED PHASE PLUME WITH TRANSMITTAL NCBC GULFPORT MS
7/2/2003
BATTELLE

NCBC Gulfport Administrative Record
Document Index Number

39501 - IRP
18.02.06.0012

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July 2, 2003

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Naval Facilities Engineering Command
Southern Division
2155 Eagle Drive
P.O. Box 190010
North Charleston, SC 29419-9010

Attention: Mr. Art Conrad

Dear Mr. Conrad:

CONTRACT NO. N47408-01-D-8207, TASK ORDER 003
WORK PLAN FOR DELINEATION OF THE DISSOLVED-PHASE PLUME AT NAVAL CONSTRUCTION BATTALION CENTER, GULFPORT, MISSISSIPPI

Attached is the *Work Plan for Delineation of the Dissolved-Phase Plume at Naval Construction Battalion Center, Gulfport, Mississippi* for your review. Please respond with any comments you have at your earliest convenience. As we discussed, we are not forwarding a copy of this document to the Mississippi Department for Environmental Quality (MDEQ) for review; however, we anticipate the need to present this material along with a summary of the bioslurping effort being undertaken at Site 6 to the MDEQ at a meeting proposed for early August. Please contact me at (614) 424-7289 or rosansky@battelle.org, or Lydia Cumming at (614) 424-7778 or cummingl@battelle.org, with any questions.

Sincerely,

Stephen H. Rosansky. P.E.
Principal Environmental Engineer
Environmental Restoration Dept.

Lydia Cumming
Geologist
Environmental Restoration Dept.

cc: Mr. Dan Wadill (SOUTHDIV)
Mr. Gordon Crane (CBC Gulfport)
Mr. Josh Fortenberry (NFESC) (electronic copy only)

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WORK PLAN

for

DELINEATION OF THE DISSOLVED-PHASE PLUME

at

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

Contract No. N47408-01-D-8207

Task Order No. 003

For Submission to

Southern Division NAVFAC
P.O. Box 190010
North Charleston, SC 29419-9010

Prepared by:

BATTELLE
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July 2, 2003

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ABBREVIATIONS AND ACRONYMS

ABB-ES	ABB Environmental Services
ALS	air/liquid separator
amsl	above mean sea level
AST	aboveground storage tank
bgs	below ground surface
CA	contamination assessment
COC	contaminant of concern
CPT	cone penetrometer testing
DI	deionized
DNAPL	dense, nonaqueous-phase liquid
DRO	diesel-range organics
GC/MS	gas chromatography/mass spectrometry
HCl	hydrochloric acid
IDW	investigation-derived waste
LNAPL	light, nonaqueous-phase liquid
LRP	liquid ring pump
MCL	maximum contaminant level
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
msl	mean sea level
NAVFAC	Naval Facilities Engineering Command
NCBC	Naval Construction Battalion Center
OCDD	octachlorodibenzodioxin
OWS	oil/water separator
PCB	polychlorinated biphenyls
PCP	progressive cavity pump
pg/L	picograms per liter
POTW	publicly owned treatment works
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RPD	relative percent difference
SVE	soil vapor extraction

SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzodioxin
TPH	total petroleum hydrocarbon
U.S. EPA	United States Environmental Protection Agency
VOA	volatile organic analysis
VOC	volatile organic compound

Section 1.0: INTRODUCTION

1.1 Purpose and Objectives

This work plan for dissolved-phase plume delineation describes the field investigation that will be performed at Site 6, Naval Construction Battalion Center (NCBC) Gulfport in the city of Gulfport, MS (Figure 1-1). This work plan is being developed and implemented by Battelle at the request of Southwest Division Naval Facilities Engineering Command (NAVFAC) under Contract No. N47408-01-D-8207, Task Order 0003.

The objectives of the work outlined in this work plan are as follows:

- Identify the contaminants of concern (COCs) in the source area and delineate the horizontal and vertical extent of the dissolved-phase VOC plume
- Collect additional geological information on the surficial aquifer and the underlying silty-clay unit
- Select locations for long-term groundwater monitoring wells, which will provide data for evaluating the effectiveness of the free-product removal action (bioslurping) initiated in November 2001.
- Use the results of the dissolved-phase plume delineation to support the development of an exit strategy and long-term monitoring plan for the site, including discontinuation of free-product removal activities and site closure.

1.2 Site History

Site 6 is a former fire-fighting training area that was operational from 1966 to 1975. The location of the site is shown in Figures 1-2 and 1-3. The site is bounded by Building 383 and Fifth Street to the north, Colby Avenue to the west, Simms Avenue to the east, and Building 391 to the south. Drainage ditches are located along the western and northern boundaries. The site is grass-covered with the exception of a small parking lot located south of Building 383.

Various flammable liquids were used in two burn pits at the site. Up to 500,000 gallons of waste oils, solvents, paint thinners, and cleaning compounds are suspected to have been burned in the pits. The pits were backfilled with sand and gravel when fire-fighting training activities were concluded in 1975.

A trench interceptor recovery system was installed at Site 6 in 1995 to recover light, nonaqueous-phase liquid (LNAPL). The system included a recovery trench located east of the drainage ditch on the east side of Colby Avenue and three recovery wells and associated pumps. The system was operated for approximately four years, until 1999. During the period of operation, the average LNAPL thickness in the extraction wells decreased by approximately 50 percent (TetraTech NUS, 2000). However, it was believed that the system was no longer an efficient or cost-effective method to recover the remaining LNAPL; and operation was discontinued.

In 2001, Battelle installed and began operating a vacuum-enhanced free-product recovery (bioslurper) system to extract the remaining recoverable LNAPL at the site. The installation and start-up of the bioslurper system were completed at the end of October 2001. From November 1, 2001, through May 16, 2003, the system has operated 8,400 hours and has recovered 1,900 gallons of free-phase product. The system was shut down for a period of four months while the groundwater table was high,

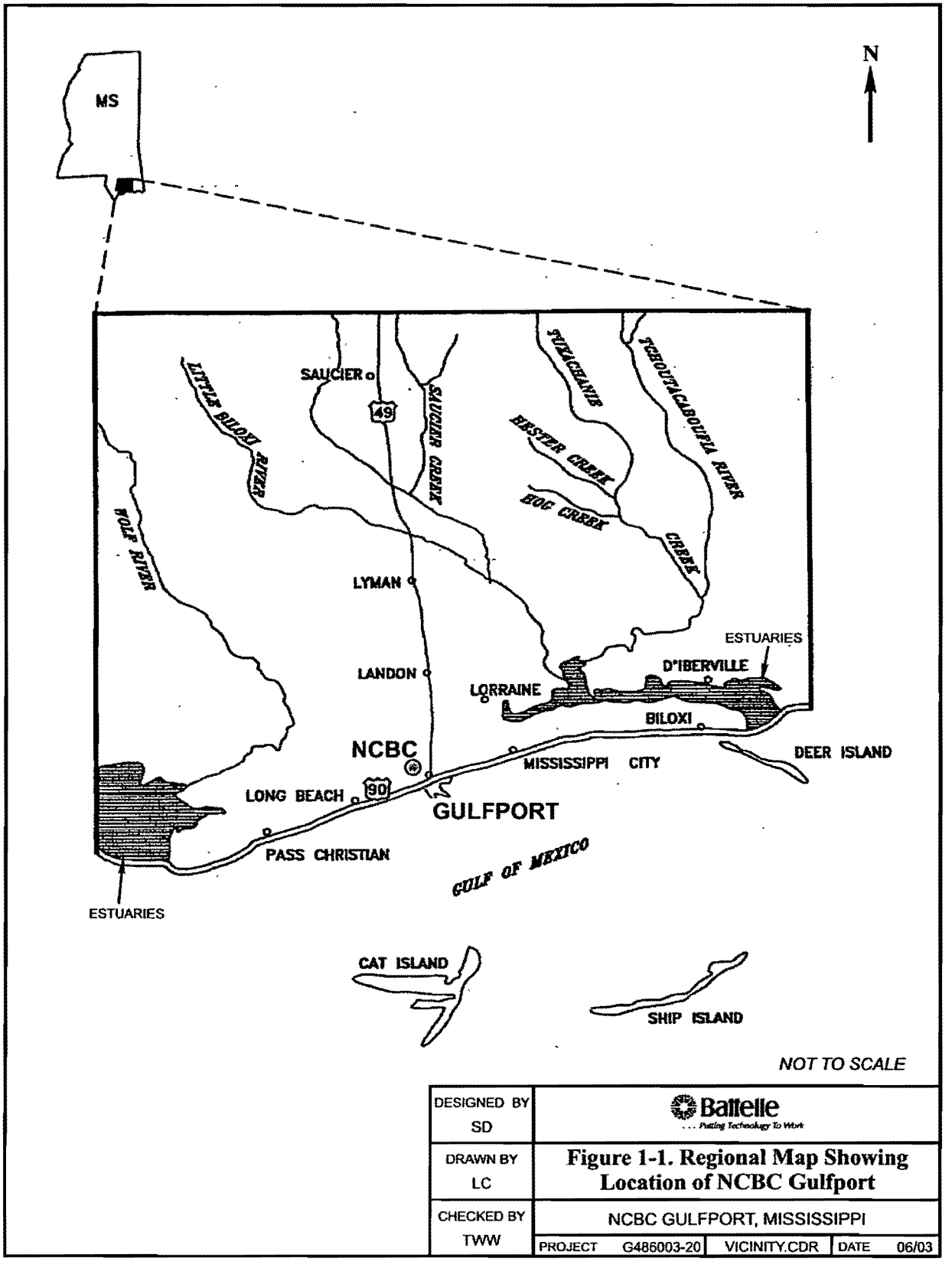


Figure 1-1. NCBC Gulfport Location Map

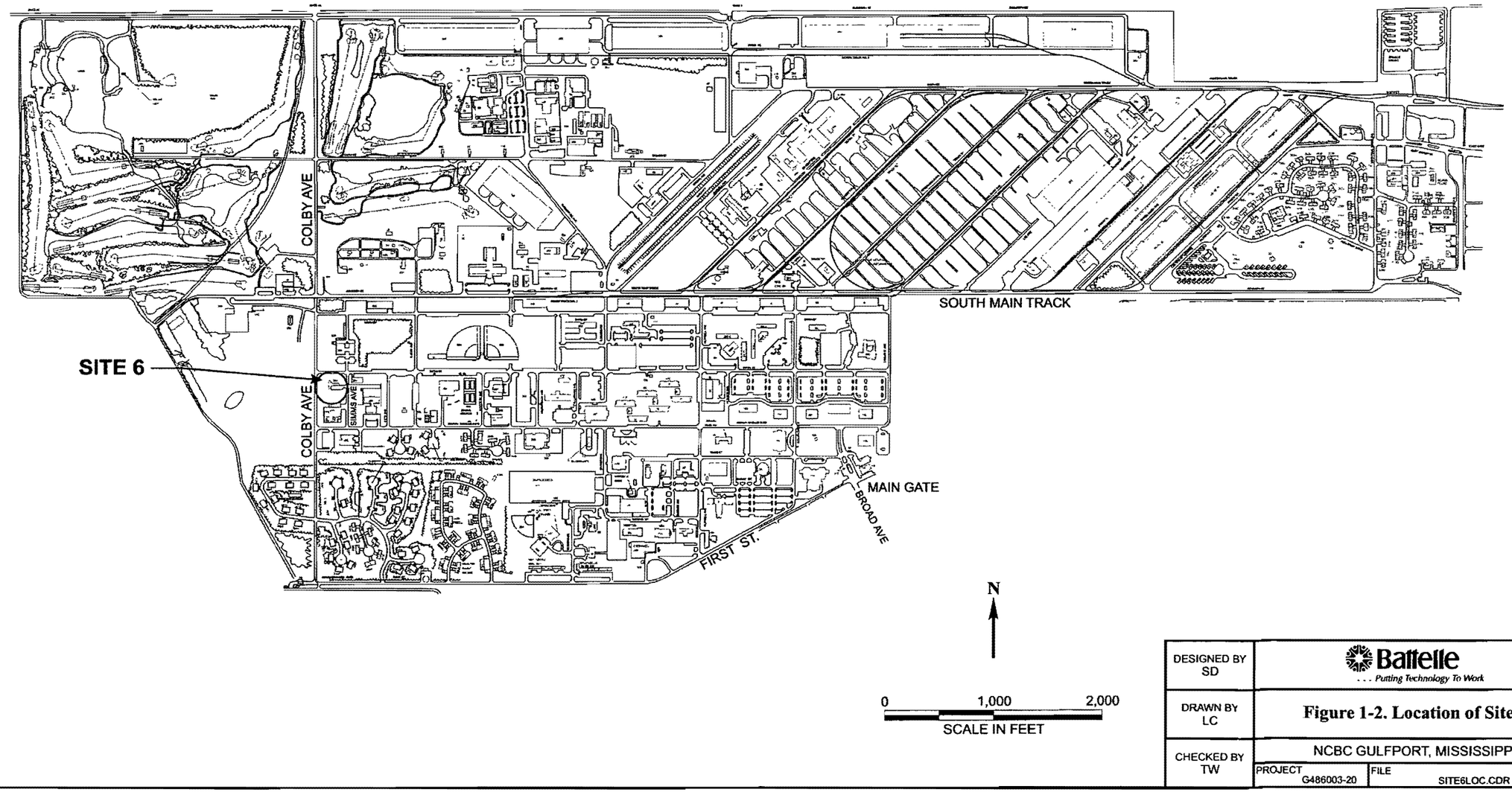


Figure 1-2. Location of Site 6 at NCBC Gulfport

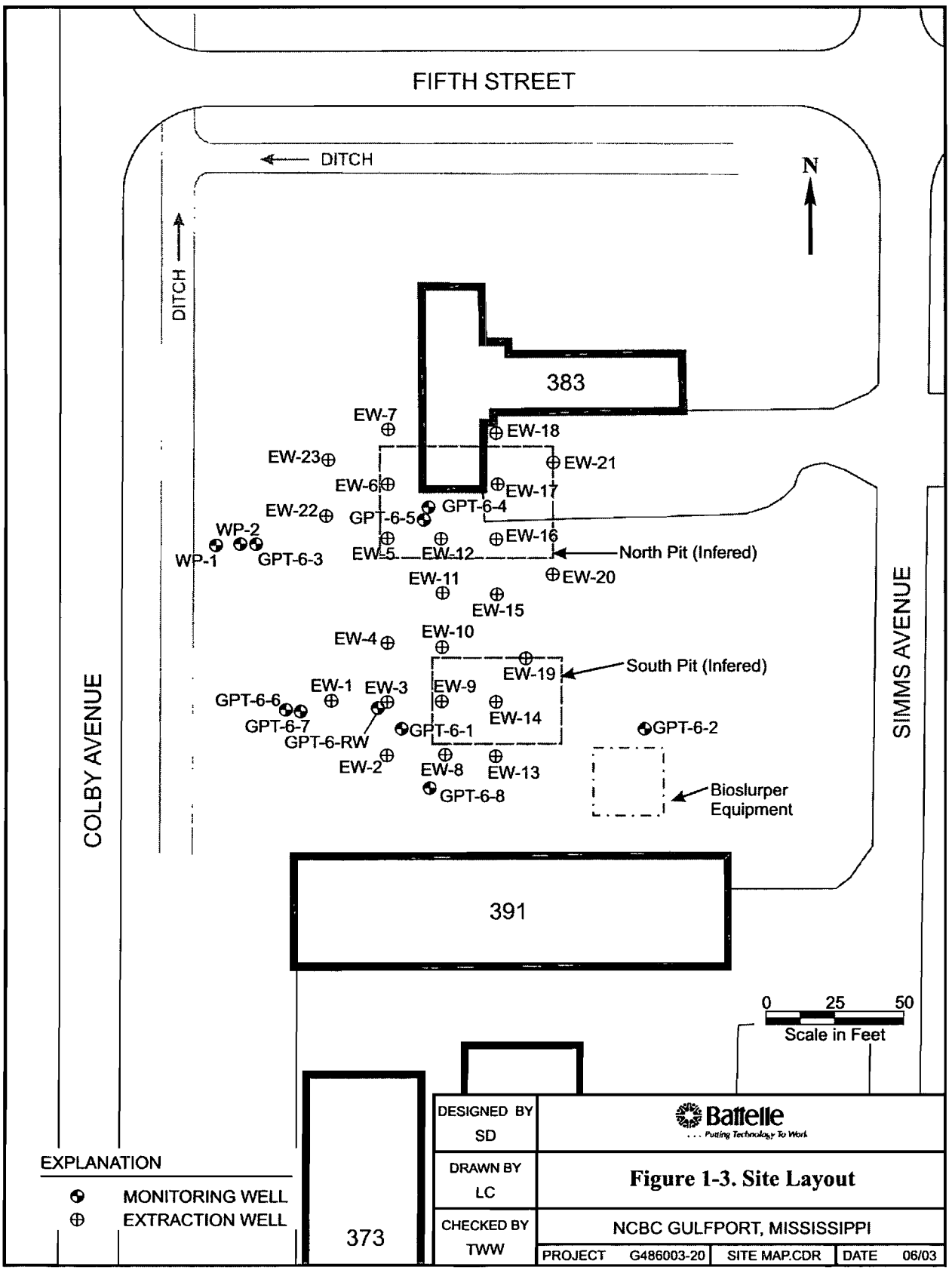


Figure 1-3. Site 6 Layout

inhibiting LNAPL recovery. The system was restarted on February 18, 2003. The remedial progress of the bioslurper system is discussed in detail in Section 3.0. Table 1-1 provides a chronological list of major events relating to the LNAPL contamination at Site 6.

Table 1-1. Site 6 Timeline, NCBC Gulfport

Date	Event
1966–1975	Fire-fighting training activities were conducted at two burn pits operated at Site 6.
1987	A site assessment was conducted by Harding Lawson Associates in 1987 (HLA, 1987). GPT-6-1, GPT-6-2, and GPT-6-3 were installed. No free-phase product was observed during this investigation.
1993 and 1994	A contamination assessment (CA) was conducted by ABB-Environmental Services, which included the sampling of free-phase product, soil, and groundwater media to delineate the extent of free-phase and dissolved phase contamination. Results of the CA were reported in *Free-Phase Product Assessment Report, Site 6, NCBC Gulfport* (ABB-ES, 1994)
1995–1999	A trench interceptor recovery system was installed and operated by Morrison Knudsen Corp. System installation is documented in the *Construction Completion Report* (Morrison Knudsen Corp., 1995).
2001–Present	Bioslurper system was installed and operated by Battelle to recover free-phase product remaining at the site. System installation is documented in the system installation report (Battelle, 2001).

Section 2.0: SITE 6 CONCEPTUAL MODEL

2.1 Geology and Hydrogeology

The topographic elevations at NCBC Gulfport range from 20 to 35 ft above the mean sea level (amsl), with an average elevation of approximately 23 ft amsl (ABB-ES, 1994). At Site 6, the average topographic elevation is approximately 29 ft, amsl. The site is relatively flat, with the exception of the drainage ditches that bound the site on the west and north. Surface water flows to the drainage ditches and flows north, eventually emptying into Canal No. 1 (ABB-ES, 1994).

The geologic units containing fresh water are of Miocene to recent age. The surficial aquifer (recent to Pleistocene) is unconfined and composed of sands and fine-grained gravel ranging from 13 to 50 ft thick, underlain by a clay layer that contains some silt and sand ranging from 28 ft to more than 150 ft thick (HLA, 1999; ABB-ES, 1994). Generally, this surficial aquifer is not used for potable water. Previous investigations conducted at Site 6 have shown that the surficial aquifer is composed of sand layers that extend to depths ranging from 35 to 47 ft below ground surface (bgs), underlain by a saturated silty-clay unit to an undetermined depth (Figures 2-1 and 2-2).

Beneath the surficial aquifer are what are collectively called the Miocene aquifers. The Miocene aquifers include the Citronelle Formation (Pliocene); the Graham Ferry Formation (Pliocene); and the Pascagoula, Hattiesburg, and Catahoula Formations. The Miocene aquifers are composed predominantly of sand beds that are irregular in thickness and extent, with no thick, consistently traceable, confining units between aquifers. The Miocene aquifers are a major source of potable water in the Gulfport area (ABB-ES, 1994). Regional groundwater flow in the Miocene aquifer system at NCBC has been interpreted to be to the south (ABB-ES, 1994).

Shallow aquifer groundwater flow in the vicinity of Site 6 is to the west-northwest. The depth to groundwater measured in site groundwater monitoring wells during bioslurper operation varied seasonally, and the average range was from 4 ft to 8 ft bgs. Figure 2-3 is a potentiometric surface map generated using data collected at Site 6 on February 18, 2003.

2.2 Contaminant Distribution

Three monitoring wells, GPT-6-1, GPT-6-2, and GPT-6-3, were installed and sampled as part of the Verification Study performed by Harding Lawson Associates in 1987 (HLA, 1987). No free-phase product contaminants were found during this study. During a subsequent site visit conducted by ABB Environmental Services in October 1991, free-phase product was observed in GPT-6-1 (ABB-ES, 1994). Consequently, a contamination assessment (CA) that involved direct push groundwater sampling was completed in November 1993, followed by the addition of permanent monitoring wells. Groundwater monitoring wells that were installed as part of this effort included three shallow wells (GPT-6-4, GPT-6-6, and GPT-6-8), two deep wells (GPT-6-5 and GPT-6-7), and one recovery well (GPT-6-RW). Soil and groundwater samples were analyzed for organic and inorganic compounds including target compound list volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), organochlorine pesticides and polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH), and target analyte list inorganics (including cyanide). Soil and groundwater samples were also analyzed for chlorinated herbicides, total organic carbon and polychlorinated dibenzo-furans and dioxins.

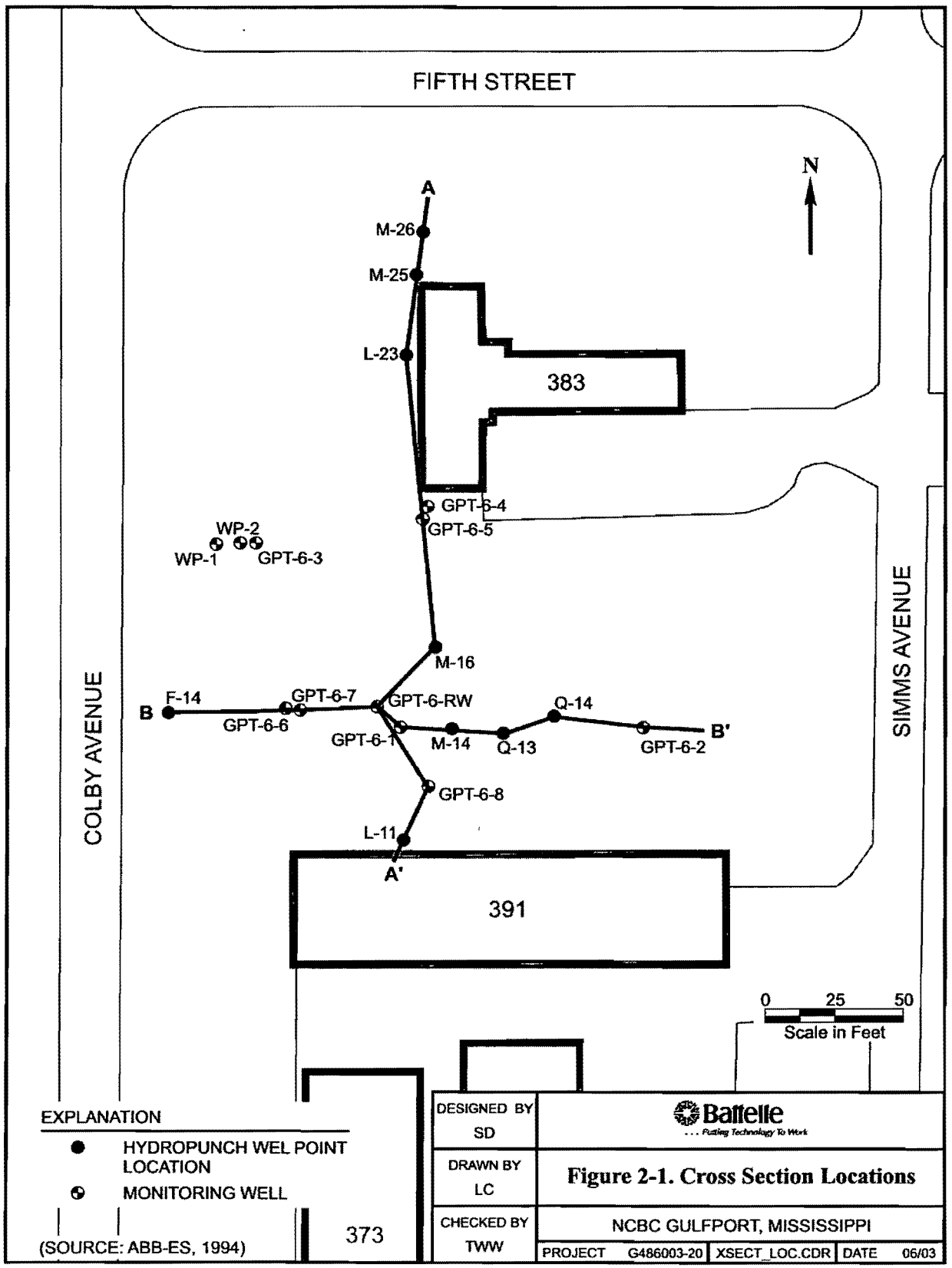


Figure 2-1. Cross Section Location Map

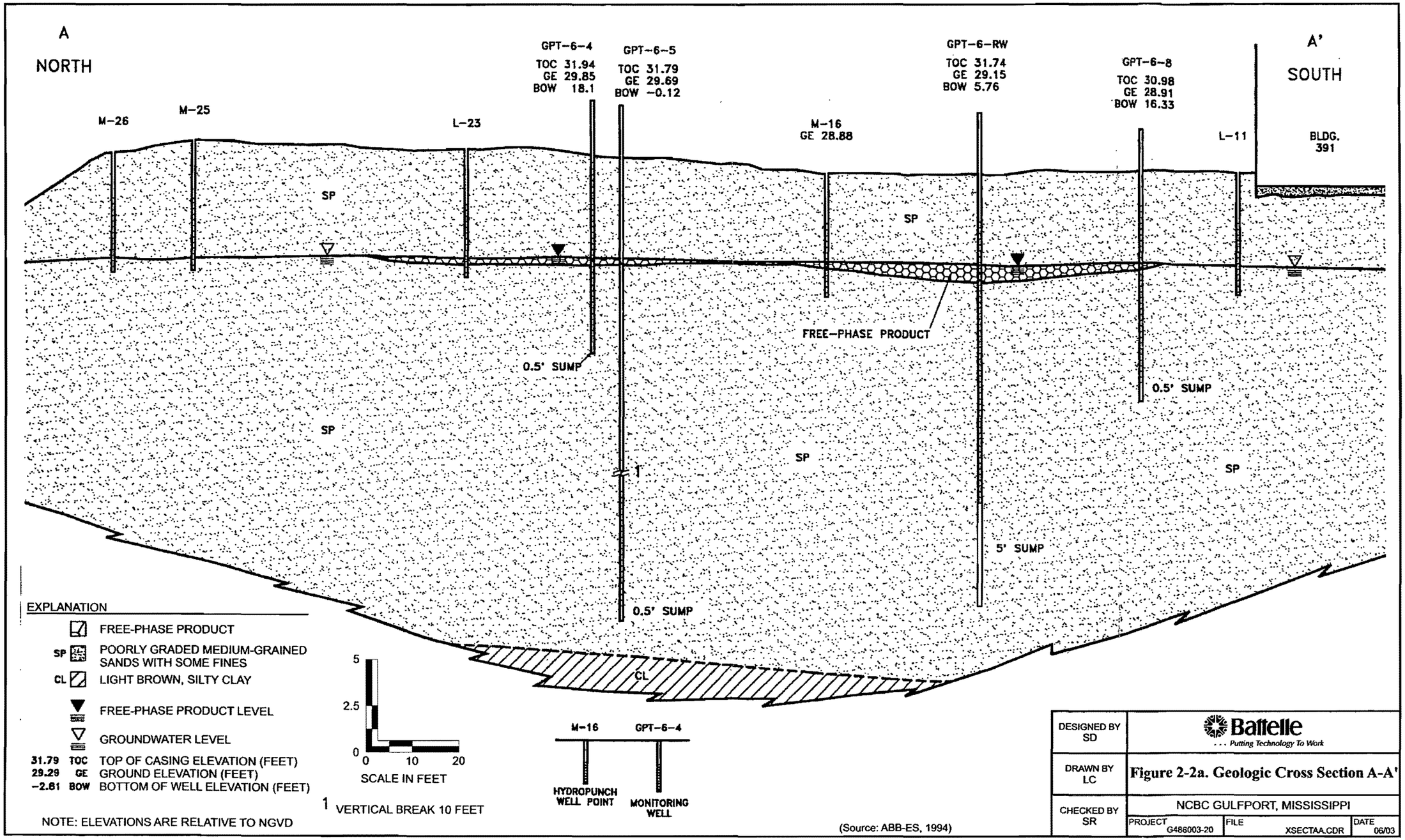


Figure 2-2a. Generalized Hydrogeologic Cross Section Site 6 A – A'

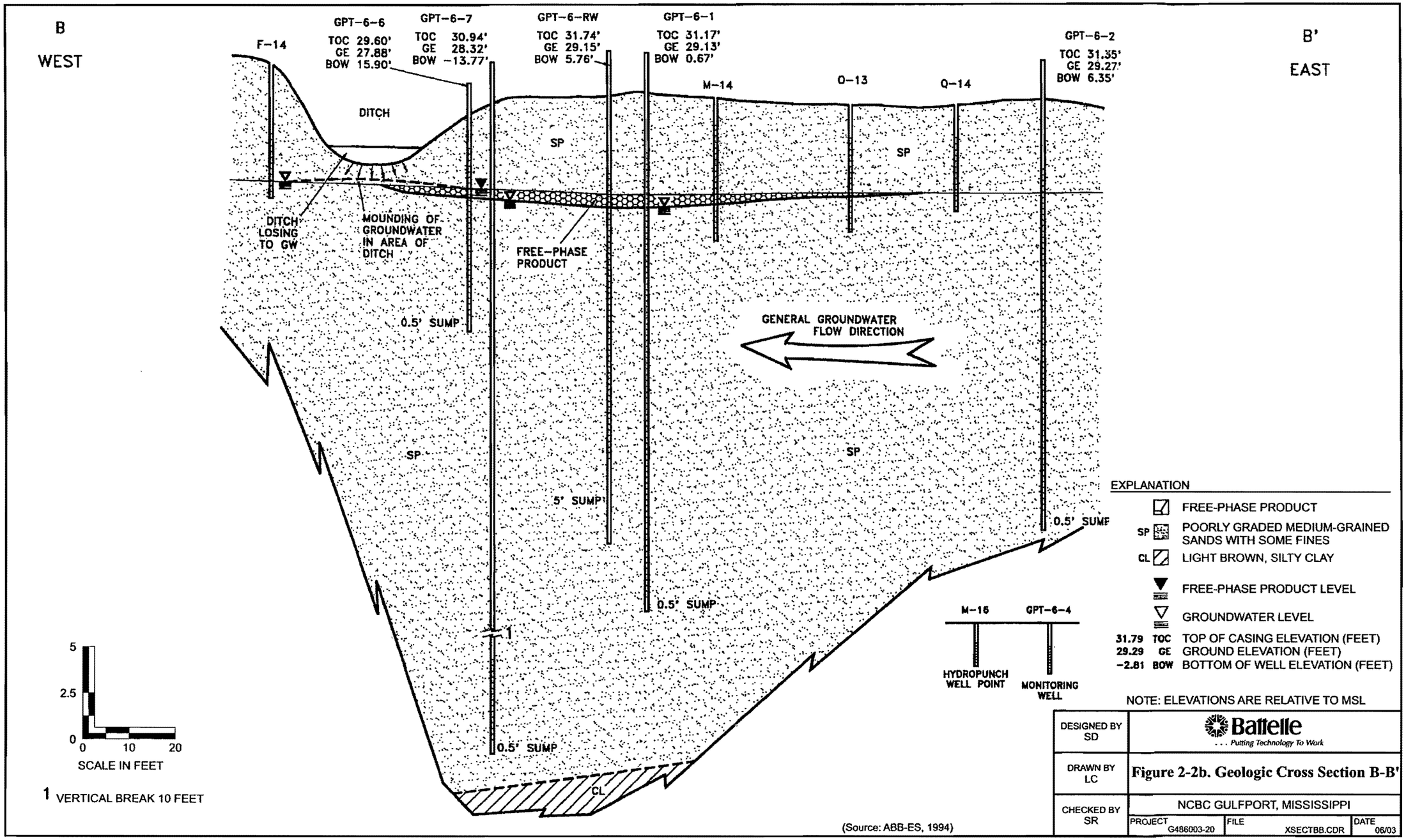


Figure 2-2b. Generalized Hydrogeologic Cross Section Site 6 B – B'

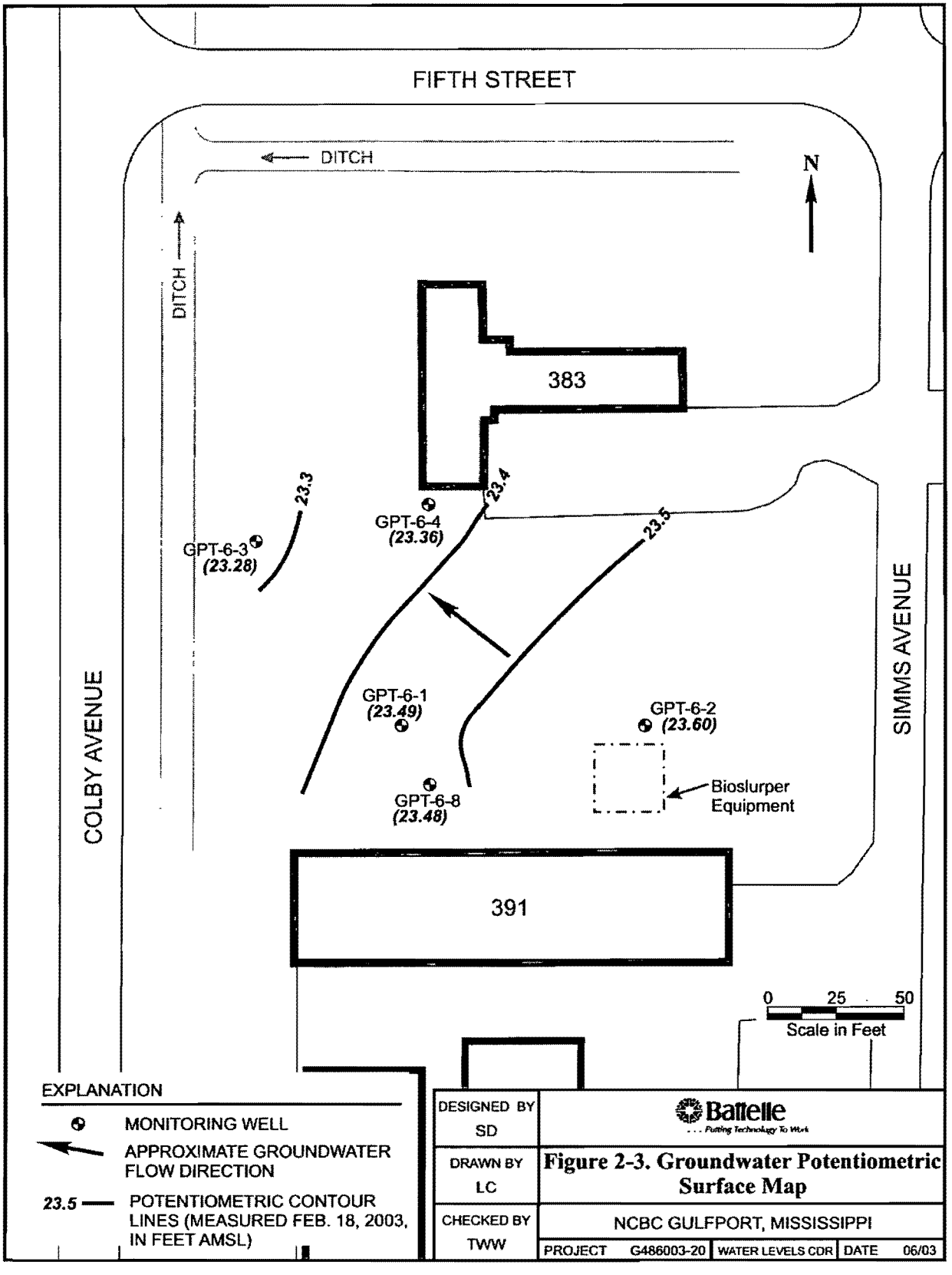


Figure 2-3. Potentiometric Surface Map, Site 6, February 18, 2003

The results of the CA indicated that free-phase and dissolved-phase contamination was present in groundwater and soil samples collected between Building 383, Building 391, and Colby Avenue. It should be noted that the primary objective of the 1993 direct push investigation was to delineate the extent of the free-phase product. The delineation of the dissolved-phase plume and possible dense, nonaqueous-phase liquid (DNAPL) contamination was not addressed during this investigation. However, two deep wells (GPT-6-5 and GPT-6-7) with screens nearly on top of the silty-clay unit were installed during this investigation to monitor the vertical extent of the contamination. The results of the CA were summarized in the CA report as follows (ABB-ES, 1994):

- A free-phase product plume extends nearly 170 ft north to south and 110 ft east to west (Figure 2-4). Groundwater flow is generally westward, except along the western edge where the gradients reversed, probably as a result of groundwater mounding near the ditch (Figure 2-2). This reversal of groundwater flow near the ditch may explain why further migration of the LNAPL plume did not occur. However, the magnitude of the mounding varies seasonally and with precipitation patterns.

- Groundwater sampling results confirmed the presence of VOCs and SVOCs. Trace amounts of OCDD were found in groundwater samples from two wells. Concentrations were well below federal maximum contamination level (MCL) for this compound. The inorganic constituents that may be present at concentrations of concern include chromium, lead, and iron. However, these inorganics appear to be present mainly in particulate form because filtered samples were observed to contain levels well below the Federal MCLs. Table 2-1 presents the maximum chemical concentrations in groundwater and the Federal MCLs.

- Groundwater samples collected near the clay layer did not contain any DNAPL contamination. This clay unit may be a locally confining layer, but the extent of the clay unit has not been confirmed by drilling or geophysical methods. As shown in Figure 2-4, contaminants, such as trichloroethylene (TCE), 1,1,1-trichloroethane, and 1,1-dichloroethane, are present at lower concentrations in the deep groundwater monitoring wells (i.e., GPT-6-5 and GPT-6-7), indicating a source that is near the water table surface rather than at depth.

During bioslurper operation (2001–present), groundwater elevation and LNAPL thickness measurements were collected from all the site wells on a periodic basis. The results of the system monitoring are presented in more detail in Section 3.4.

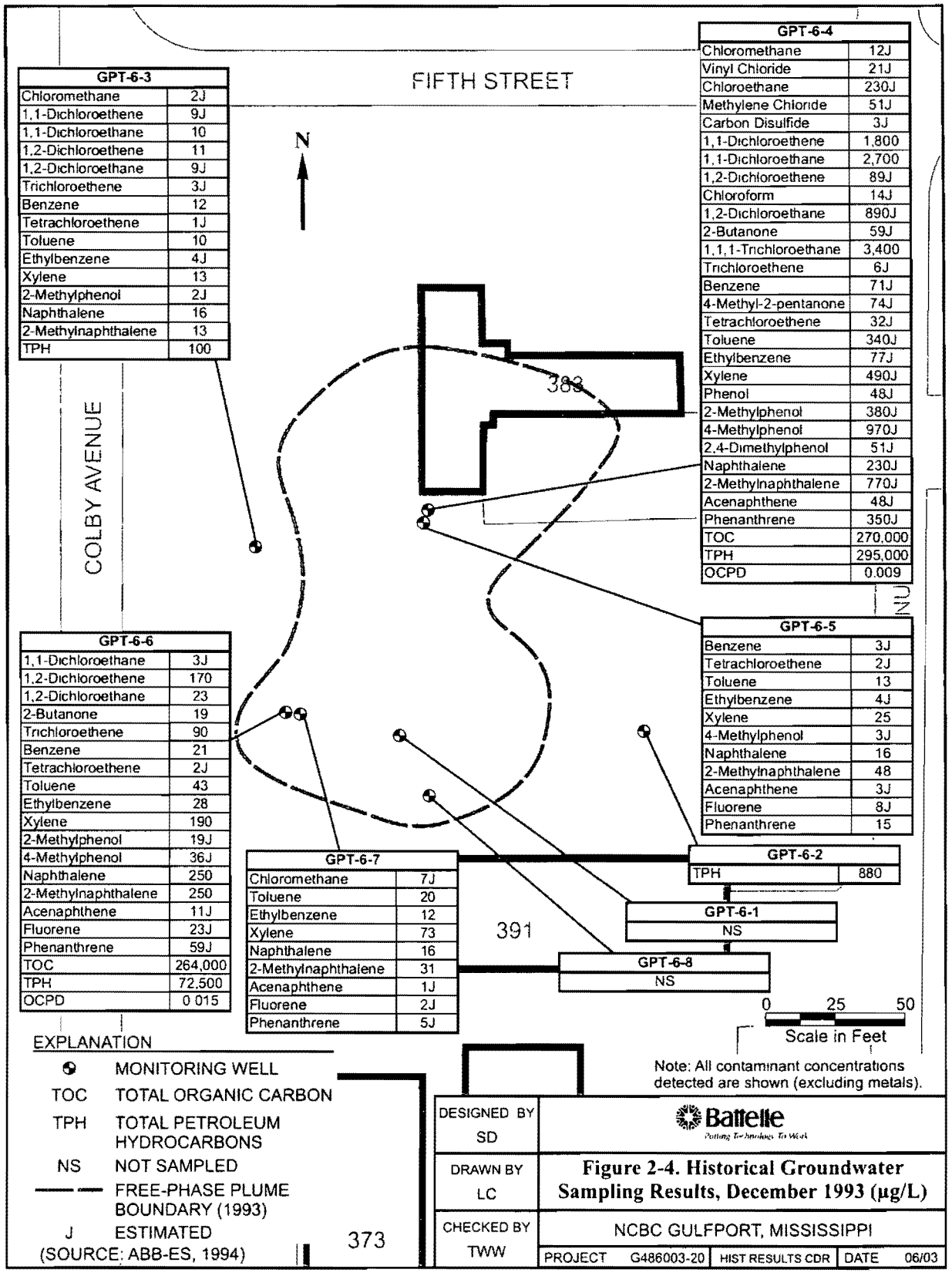


Figure 2-4. Historical Groundwater Sampling Results

Table 2-1. Maximum Chemical Concentrations Measured in Groundwater

Analyte	Maximum Concentration	Federal Drinking Water MCL
Total Petroleum Hydrocarbons	295,000 (μg/L)	NA
	VOCs (μg/L)[1]	
Chloromethane	12J	NA
Vinyl Chloride	35J	2
Chloroethane	310J	NA
Methylene Chloride	95J	5
Carbon Disulfide	4J	NA
1,1-Dichloroethene	3,100	7
1,1-Dichloroethane	4,900	NA
1,2-Dichloroethene (Total)	170	70-cis
		100-trans
Chloroform	20J	100
1,2-Dichloroethane	1,200	5
2-Butanone	80J	NA
1,1,1-Trichloroethane	5,900	200
Trichloroethene	90	5
Benzene	83J	5
4-Methyl-2-Pentanone	100J	NA
Tetrachloroethene	32J	5
Toluene	340J	1,000
Ethylbenzene	77J	700
Xylene (total)	490J	10,000
	SVOCs (μg/L)[1]	
Phenol	48J	NA
2-Methylphenol	380J	NA
4-Methylphenol	1,100	NA
2,4-Dimethylphenol	56J	NA
Naphthalene	250	NA
2-Methylnaphthalene	770J	NA
Acenaphthene	48J	NA
Fluorene	23J	NA
Phenanthrene	350J	NA
	Pesticides (μg/L)[2]	
Alpha-Chlordane	014J	NA
	Dioxins (pg/L)[2]	
OCDD	15[3]	30 [4]

Source: ABB-ES, 1994

(1) Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multimedia Multiconcentration, U.S. EPA Document No. OLM01.0

(2) Method: U.S. EPA Method 1613 (8290)

(3) Using the toxicity equivalent factor for the concentration of 15,000 picograms per liter (pg/L) for OCDD is equivalent to 15 pg/L of tetrachlorodibenzodioxin (TCDD)

(4) MCL for TCDD

J = estimated value

NA = not available

Table 2-1. Maximum Chemical Concentrations Measured in Groundwater (Continued)

Analyte	Maximum Concentration		Federal Drinking Water MCL
Inorganics (µg/L)[5]			
	Unfiltered	**Filtered**	
Aluminum	194,000	203	50-2000[6]
Arsenic	23.9	6.0	10
Barium	771	259	2,000
Beryllium	1.7 J	<1.0	4
Cadmium	5.4	<1.0	5
Calcium	145,000	127,000	NA
Chromium	238	<3.0	100
Cobalt	18.5 J	7.6	NA
Copper	79.8	<3.0	1,300[7]
Iron	34,100	11,200	NA
Lead	533	1.5	15
Magnesium	11,200	10,300	NA
Manganese	903	718	NA
Mercury	1.4	<0.20	2
Nickel	46.5	<13.0	Remanded
Potassium	6,130	4,690	NA
Selenium	36.0 J	21.7	50
Vanadium	108	2.7	NA
Zinc	247	62.3	NA
Cyanide	3.8 J	NA	200

Source: ABB-ES, 1994

(5) Method: Contract Laboratory Program Statement of Work for Inorganic Analysis, Multimedia Multiconcentration, U.S. EPA Document No. ILM02.0

(6) Secondary MCL

(7) Regulatory Action Level

J = estimated value

NA = not available

Section 3.0: BIOSLURPER IMPLEMENTATION

The primary objective of the bioslurper system is to remove LNAPL to the maximum extent practicable in accordance with Mississippi guidelines. The progress toward meeting this objective is being tracked by monitoring the mass of contaminants removed from the subsurface, the LNAPL remaining in site wells, and operation and maintenance costs. This section presents background information on the bioslurping technology and summarizes the activities and results through May 16, 2003, that have been realized during the 18 months of operation (including times of shutdown).

3.1 Technology Description

Bioslurping combines vacuum-assisted LNAPL recovery with bioventing and soil vapor extraction (SVE) to simultaneously recover LNAPL and bioremediate the unsaturated zone. Bioslurper systems are designed to extract LNAPL from the water table, along with groundwater and soil vapor, in one process stream, utilizing the air lift created by a single, aboveground, liquid ring pump (LRP). Recovered groundwater is separated from the LNAPL, treated (if required), and discharged. Recovered soil vapor is treated (if required) and discharged to the atmosphere (Place, et al., 2001).

Bioslurping produces an improved LNAPL recovery efficiency when compared with other technologies, including skimming and drawdown pumping. The bioslurper can pull a vacuum of up to 25 ft of water on a recovery well, inducing the pressure gradient necessary to force movement of LNAPL into the well. The system is operated to minimize drawdown of the water table, reducing the problem of LNAPL entrapment in the soil.

Bioventing of the unsaturated zone is achieved by extracting soil vapor via the recovery well. The slurping action of the bioslurper results in alternating recovery of liquid (LNAPL or groundwater) and soil vapor. The rate of soil vapor extraction is dependent on the recovery rate of liquid into the well, as well as other factors, including the length of the exposed screened interval and the permeability of the soil formation. When LNAPL recovery is complete, the bioslurper system can be converted to a conventional bioventing system to continue remediation of the vadose zone soils (Place, et. al., 2001).

3.2 System Design

As noted above, the bioslurper system was designed to extract LNAPL from the water table, along with groundwater and soil vapor, in one process stream, utilizing the airlift created by a single, aboveground LRP. The system is installed on an equipment pad located at the southeast corner of Site 6 and extracts fluids from 23 two-inch-diameter wells through an aboveground polyvinyl chloride (PVC) manifold.

A conceptual illustration of the system is included as Figure 3-1. The system uses a 20-hp Atlantic Fluidics LRP to extract the fluids via the subsurface via a number of extraction wells. The LRP is equipped with a seal water tank to supply a continuous flow of water to the pump and a heat exchanger to help maintain the temperature of the seal water below 125°F.

The process fluids enter an air/liquid separator (ALS) where the vapor phase is separated from the liquid phase. The vapor is drawn into the LRP, discharged into a seal water tank (an integral component of the LRP), and then discharged through a PVC stack to the atmosphere. The liquid inside the ALS is periodically pumped from the ALS to the oil/water separator (OWS) using a progressive cavity pump (PCP). The PCP is activated by float switches installed inside the ALS. It is designed to pump against the vacuum generated inside the ALS, which can be as high as 27 to 28 inch Hg.

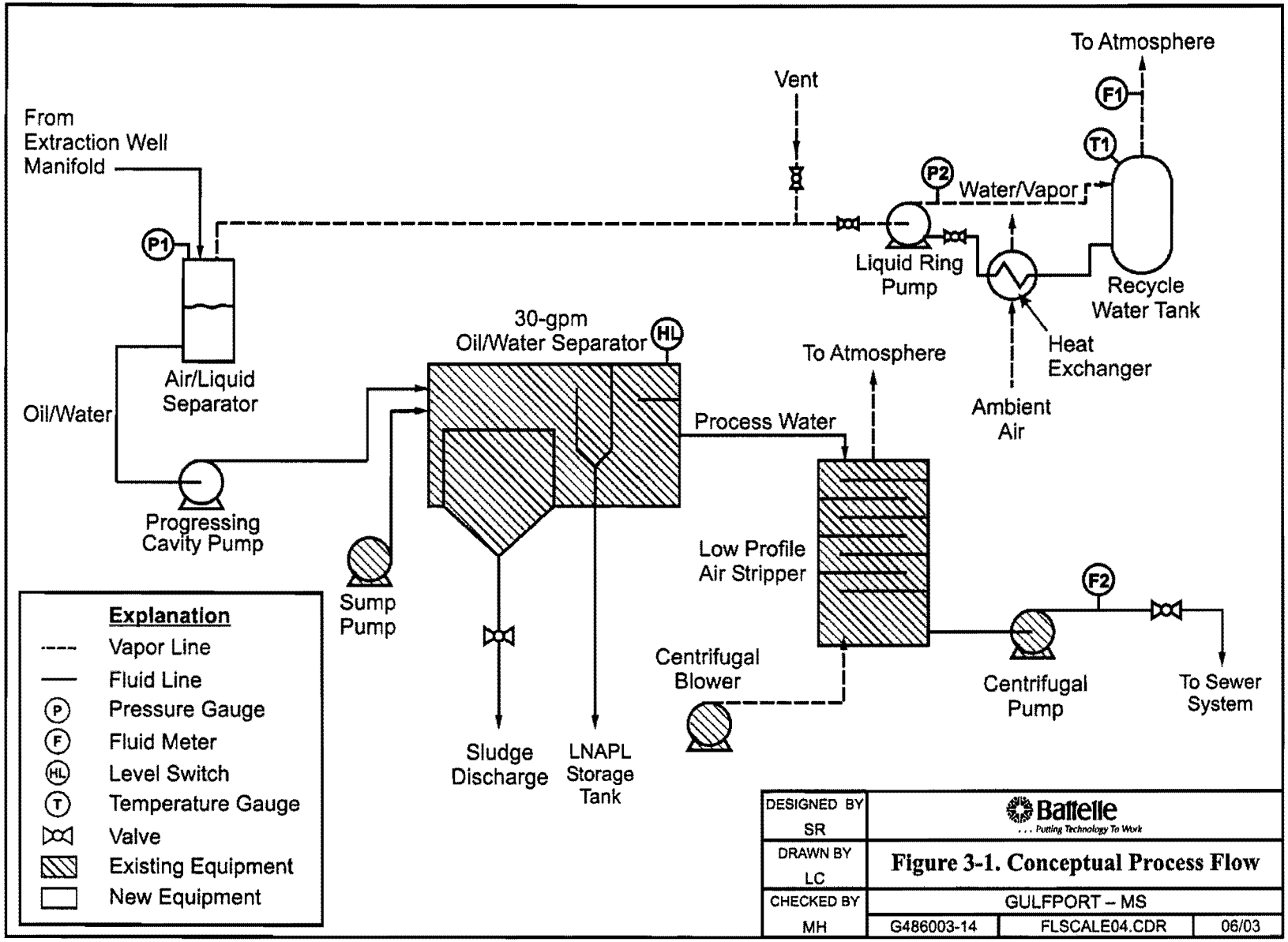


Figure 3-1. Bioslurper Conceptual Flow Diagram

The LRP requires a process liquid to form a seal to generate a vacuum. A nearby hydrant is used to supply water at a low flowrate (less than ¼ gpm) to maintain the fluid level inside the seal water tank and to provide additional cooling to the seal water. Excess water gravity flows through a hose into a sump located at the southeast corner of the equipment pad.

The OWS separates the LNAPL from the water stream. LNAPL gravity flows into a 500-gallon, double-walled, oil storage tank located at the rear of the trailer. Water from the OWS flows to a water treatment skid consisting of an OWS, an air stripping tower, and associated transfer pumps and controls. The aqueous effluent from the treatment skid is discharged to the Gulfport publicly owned treatment works (POTW). The discharge point is a sanitary sewer located 100 ft east of the equipment pad.

3.3 LNAPL Recovery

Hydrocarbon contamination is removed in the form of LNAPL, dissolved/emulsified oil in the aqueous discharge stream, and the off-gas in the vapor phase. The mass removed in each stream is summarized in Table 3-1. The cumulative total is presented graphically in Figure 3-2. An explanation of how the mass of hydrocarbons was determined in each stream can be found in the 6th Quarterly Status Report (Battelle, 2003a).

Table 3-1. Hydrocarbon Removal

Process Stream	Hydrocarbons Removed (lb)		
	Present (Mar 1–May 15)	**Previous Quarter[a]**	**Cumulative**
LNAPL[b]	2,303 (317 gallons)	500 (69 gallons)	13,841 (1,907 gallons)
Dissolved/Emulsified Hydrocarbons[c]	189	NA	2,639
Off-Gas[c]	22.6	NA	432
Total:	**2,515**	**>500**	**16,912**

(a) Only operated for about 2 weeks during the previous quarter. System was shut off until the water table level elevation decreased.
(b) A specific gravity of 0.87 was used to estimate the mass of LNAPL recovered.
(c) Estimated value based on analytical results received at the time the quarterly status report was prepared.

There is a strong correlation between water table elevation and LNAPL recovery. During periods of high water table elevation, LNAPL thickness has been observed to decrease significantly. This likely is because a large portion of the LNAPL becomes trapped in pockets beneath the water table. As the water table elevation subsides, the LNAPL is released and can be drawn more easily into the extraction wells by the bioslurper system. The groundwater table elevation was relatively high during the fall of 2002. The LNAPL recovery had decreased to only a few gallons per month; hence, the system

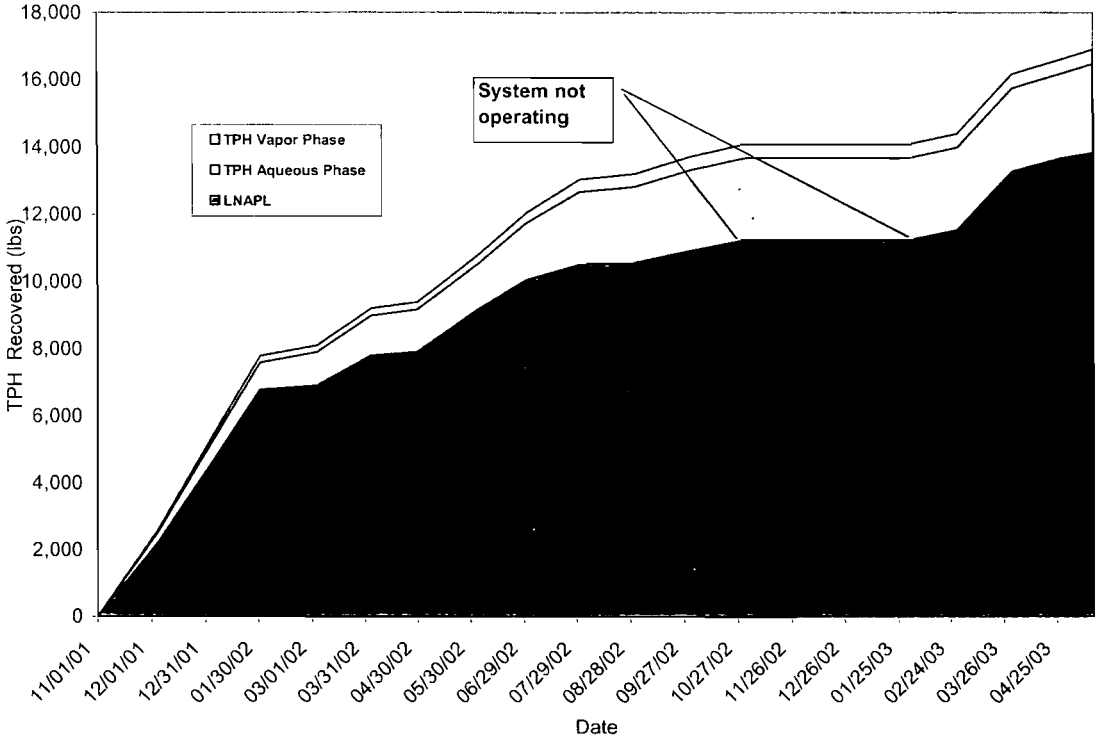


Figure 3-2. Cumulative Mass of Hydrocarbons Removed

was shut down until the groundwater table began to recede. The system was restarted on February 18, 2003. An increased rate of recovery was observed; however, recovery was observed to begin to taper off in March after the majority of the recoverable LNAPL had been removed.

3.4 LNAPL Remaining

The LNAPL remaining in the subsurface is tracked by measuring the thickness of LNAPL in the extraction wells. Each quarter, the bioslurper system is shut down for up to 10 days to allow the remaining LNAPL to equilibrate in the extraction wells. Depths to the LNAPL and the water are measured and plotted using Surfer™. A contour plot generated using data collected on October 31, 2001 prior to starting the bioslurper system is shown in Figure 3-3. The data collected during a recent monitoring event (May 16, 2003) is shown in Figure 3-4. Comparing this data with the baseline data (Figure 3-3) shows that very little LNAPL appears to be remaining. However, it should be noted that subsurface changes such as water table elevation can significantly impact the distribution and thickness of LNAPL. Additional LNAPL distribution plots are provided in the six quarterly reports prepared during the course of this remedial effort (Battelle, 2002a, 2002b, 2002c, 2002d, 2003a, and 2003b).

Average LNAPL thickness and groundwater table elevations also have been tracked during operation. Measurements are collected from all of the extraction wells every two weeks and are averaged and plotted (Figure 3-5). Results are used to identify various trends such as a correlation between LNAPL thickness and water table elevation, as well as an overall reduction of LNAPL thickness over time.

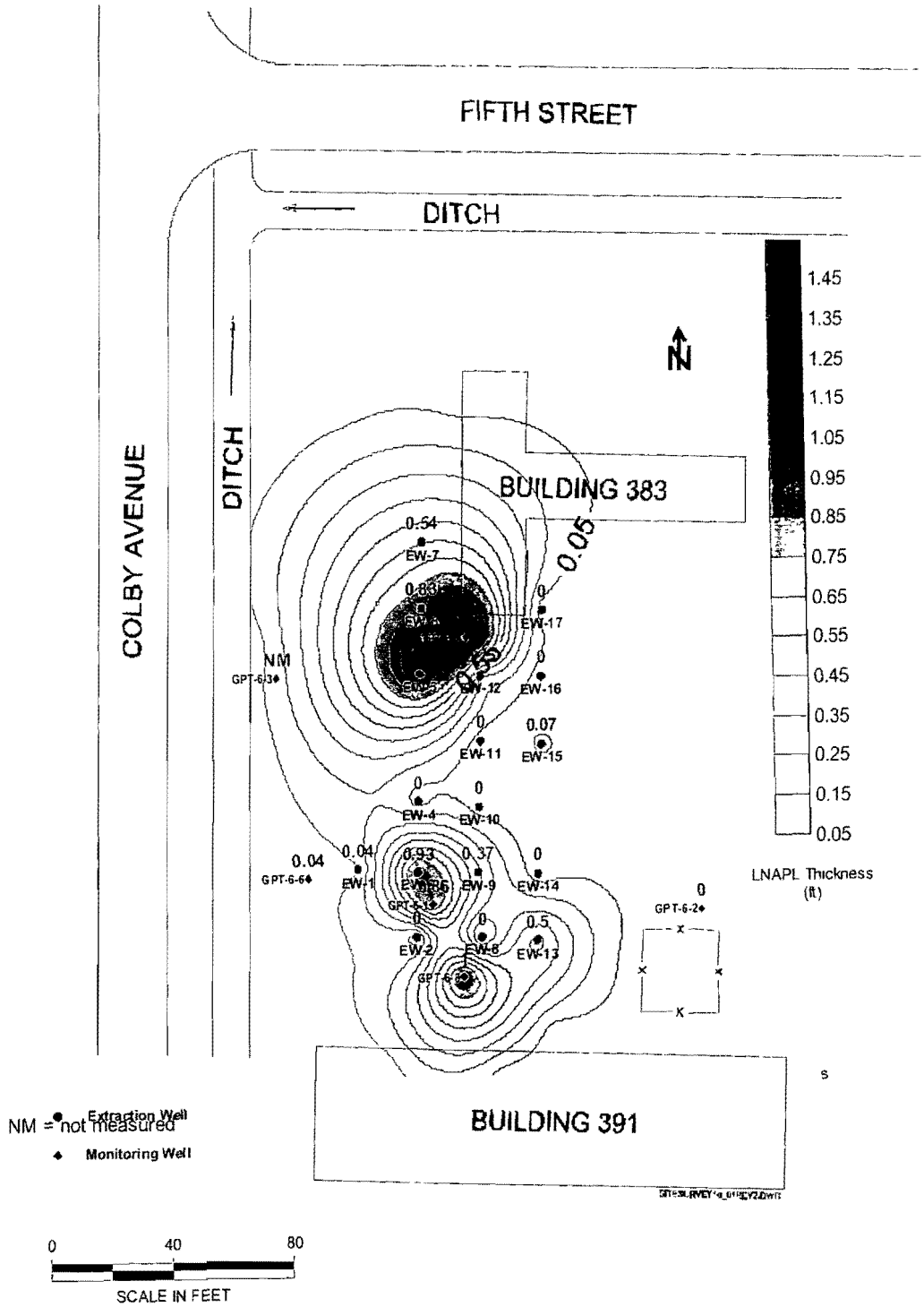


Figure 3-3. LNAPL Plume (October 31, 2001)

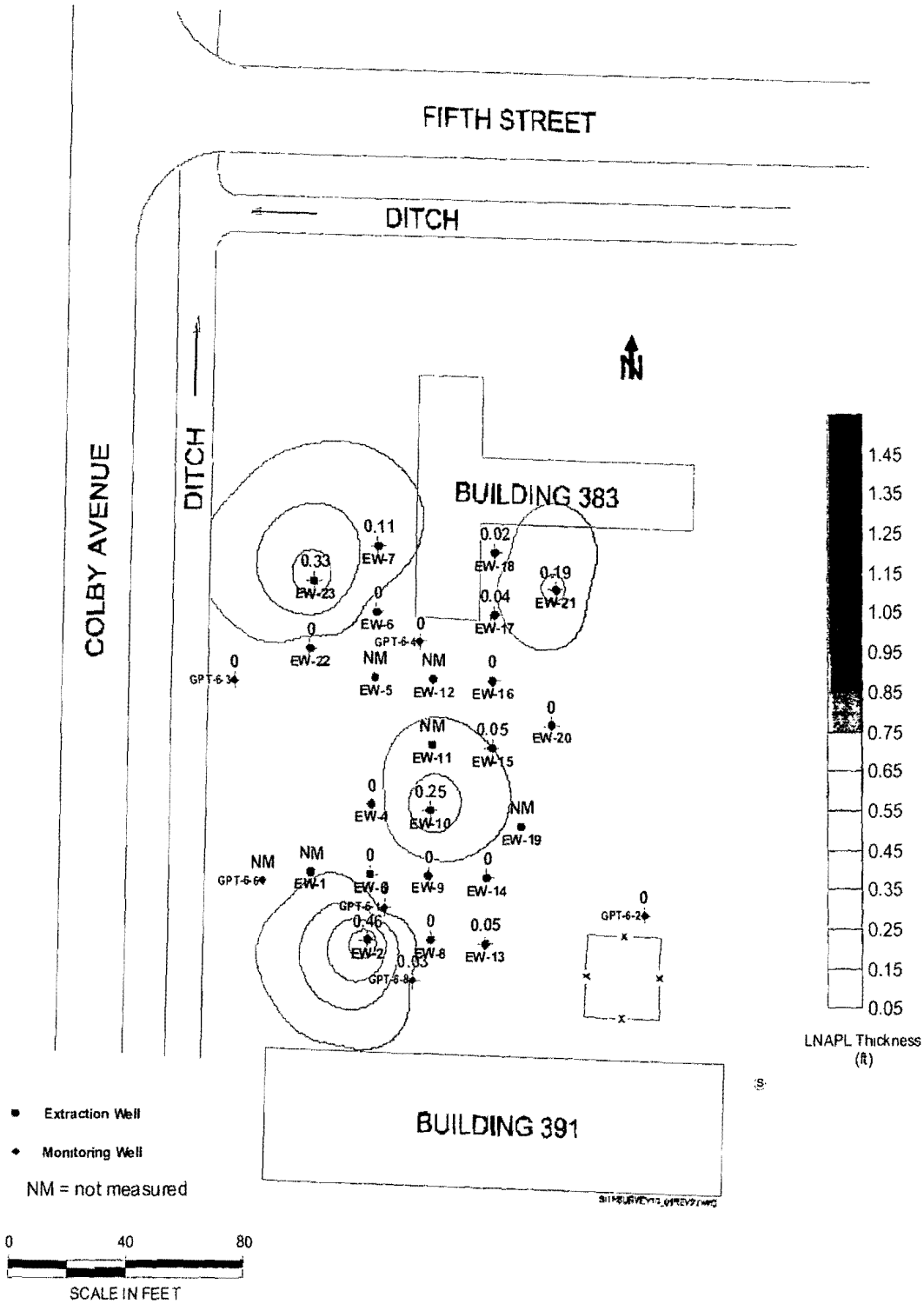


Figure 3-4. LNAPL Plume (May 16, 2003)

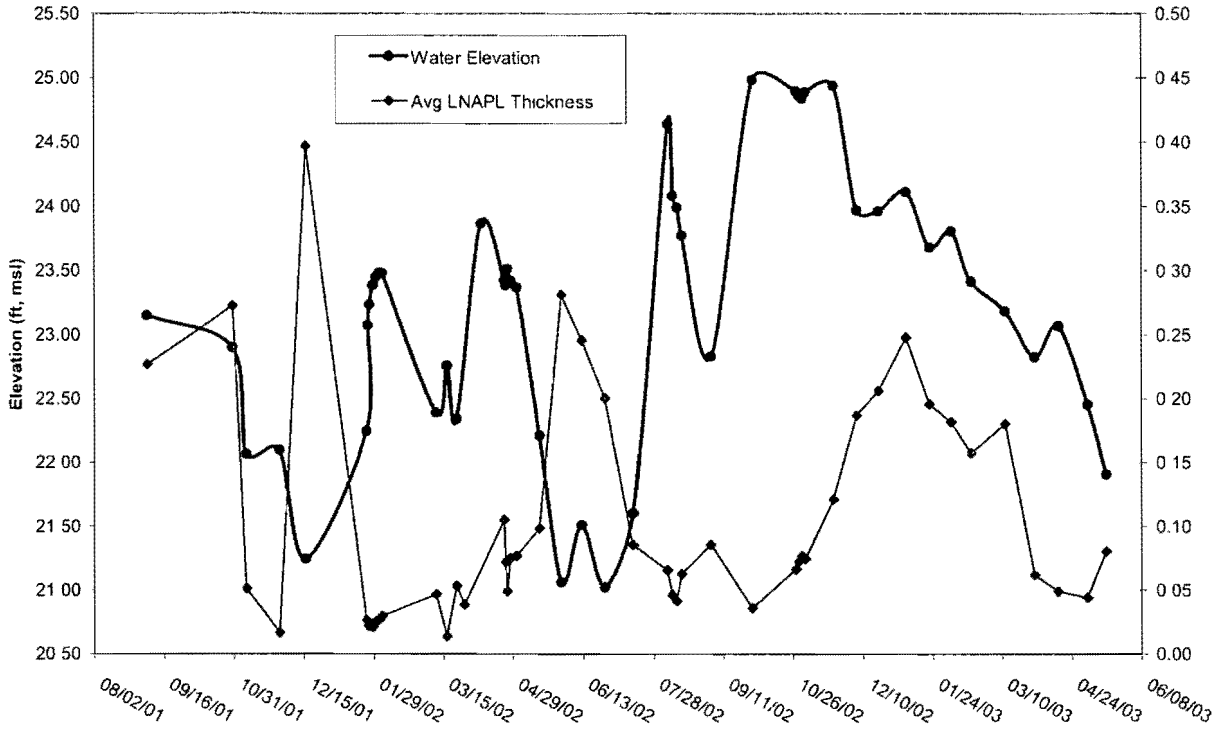


Figure 3-5. Average LNAPL Thickness and Water Elevation Measurements in Extraction Wells

3.5 Operating Cost

The cost to operate the bioslurper system is an important consideration in determining the point at which it is no longer practical to use the system for free-product recovery. The average monthly operation and maintenance (O&M) cost to recover LNAPL is shown in Figure 3-6. This cost includes on-site O&M labor, off-site technical support, analytical costs, document preparation, management, and travel and per diem. The capital cost to design and install the system is not included. In addition, electrical and waste disposal costs are not included. Several spikes in cost per gallon recovered have occurred resulting from a substantial decrease in LNAPL recovery. The cost per gallon of LNAPL recovered decreased during the last quarter of operation in comparison with the same cost during the summer of 2002. This primarily resulted from a substantial increase in the recovery of LNAPL.

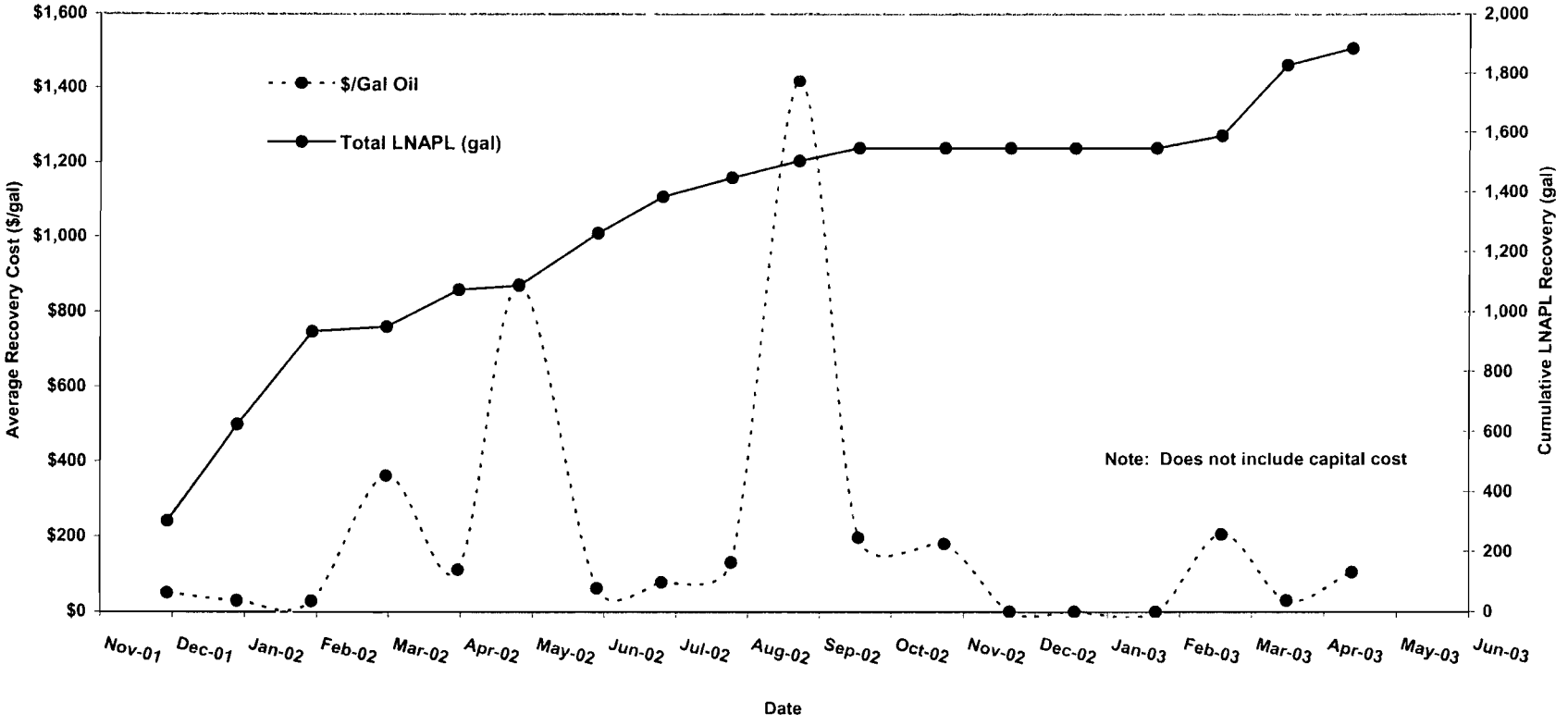


Figure 3-6. Average Recovery Cost ($/gal) and Cumulative LNAPL Recovery (gal)

Section 4.0: SAMPLING AND ANALYSIS PLAN

This section describes the work to be performed during the field investigation of the dissolved-phase plume at Site 6, NCBC Gulfport. One objective of this investigation is to identify the COCs in the source area by collecting groundwater samples from the site monitoring wells that are located within the free-phase product boundary. The investigation also is being conducted to determine whether the dissolved-phase plume extends beyond the present monitoring well network by performing a direct-push groundwater sampling study to delineate the horizontal and vertical extent of the dissolved-phase plume. A third objective of this investigation is to collect more information on the geology of the surficial aquifer and the underlying silty-clay unit. Finally, the data collected during the investigation will be used to select locations and to install long-term groundwater monitoring wells.

4.1 Technical Approach

Based on an evaluation of the historical data, TPH, VOCs, and SVOCs are the contaminant groups of concern. Contamination appears to be limited to the surficial aquifer, with trace quantities of VOCs detected in the deeper wells, GPT-6-5 and GPT-6-7 (ABB-ES, 1994). Contaminants, such as metals (filtered), herbicides, pesticides, and dioxins, will not be sampled because the 1993 CA showed that groundwater samples collected from within the free phase plume boundary (which presumably would be the area of highest concentrations) contained concentrations well below the Federal MCLs (ABB-ES, 1994). A systematic, iterative approach to will be used to delineate the horizontal and vertical extent of the dissolved-phase plume. Sampling and analysis of VOCs, which have greater potential for migration relative to SVOCs, will be conducted to define the extent of the dissolved-phase plume. The technical approach is summarized as follows:

- Groundwater samples will be collected from the following groundwater monitoring wells for VOC, SVOC, and TPH analyses: GPT-6-1, GPT-6-2, GPT-6-3, GPT-6-4, GPT-6-5, GPT-6-6, GPT-6-7, GPT-6-8, and GPT-6-PZ4 (Figure 4-1). As illustrated in Figure 4-1, wells GPT-6-1, GPT-6-4, GPT-6-5, GPT-6-6, GPT-6-7, and GPT-6-8 are located within the free-phase plume boundary. Monitoring wells GPT-6-5 and GPT-6-7 are deep monitoring wells and will be sampled to delineate the vertical extent of contamination. Monitoring well GPT-6-2 is located upgradient from the free-phase product plume. Monitoring well GPT-6-3 is located immediately downgradient from the leading edge of the free-phase product plume, while monitoring well GPT-6-PZ4 is located further downgradient from its leading edge.

- The free-phase plume will be the starting point of the direct-push groundwater sampling study. Battelle plans to sample approximately 30 locations both upgradient and downgradient of the presently known free-phase product contamination zone (see Figure 4-2). Initially, groundwater samples will be collected from direct push locations down-gradient of the free-phase product contamination (approximately 25-ft from the free-phase boundary). If contamination is detected in these samples, additional samples will be collected at downgradient and crossgradient locations until the dissolved-phase plume is defined.

- A mobile laboratory will be used to provide on-site rapid analysis of VOCs using EPA Method 8260B. This method uses a gas chromatography/mass spectrometry (GC/MS) and a purge-and-trap approach to identify the analytes and concentrations in liquid or solid matrices.

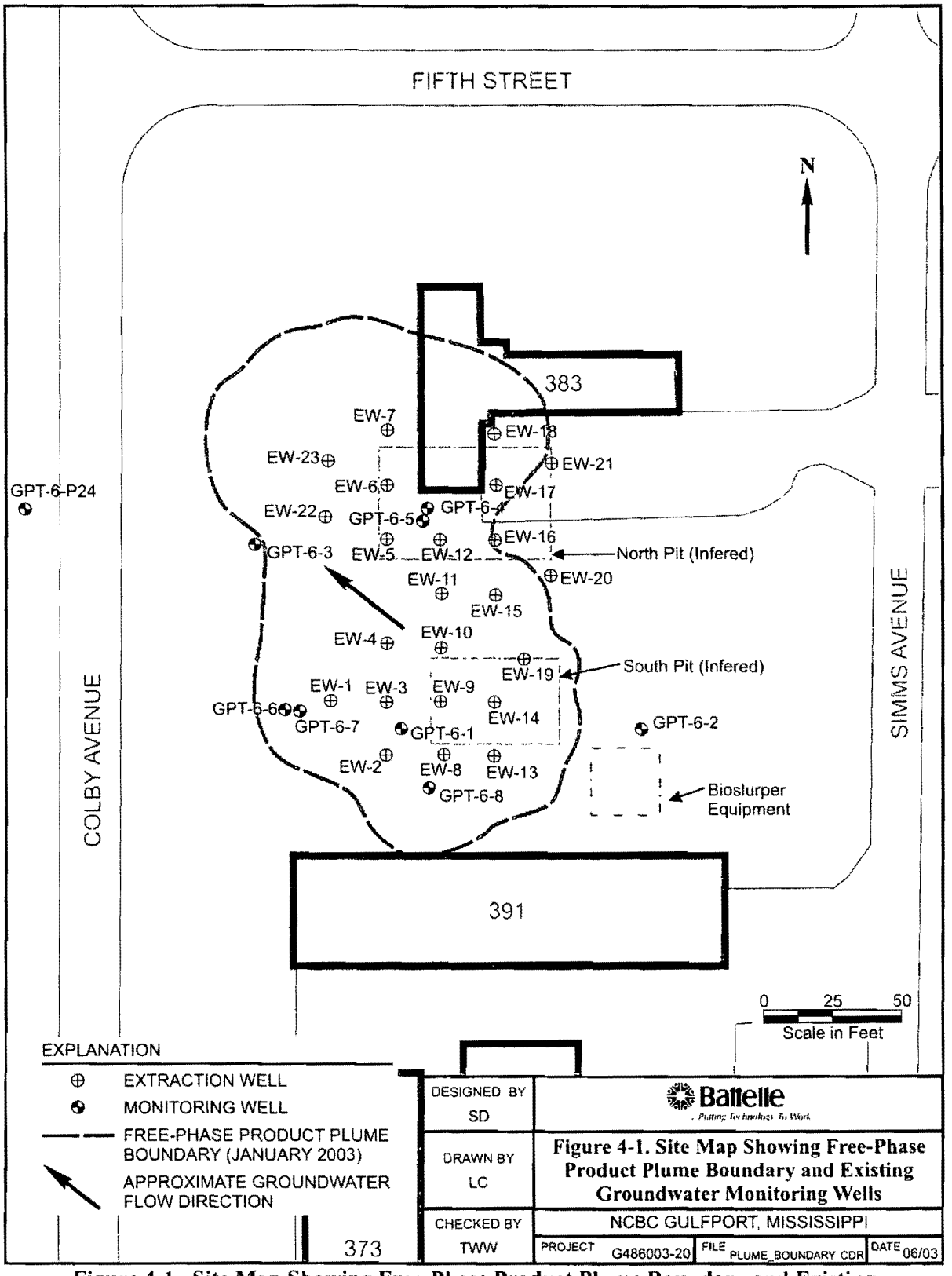


Figure 4-1. Site Map Showing Free-Phase Product Plume Boundary and Existing Groundwater Monitoring Wells

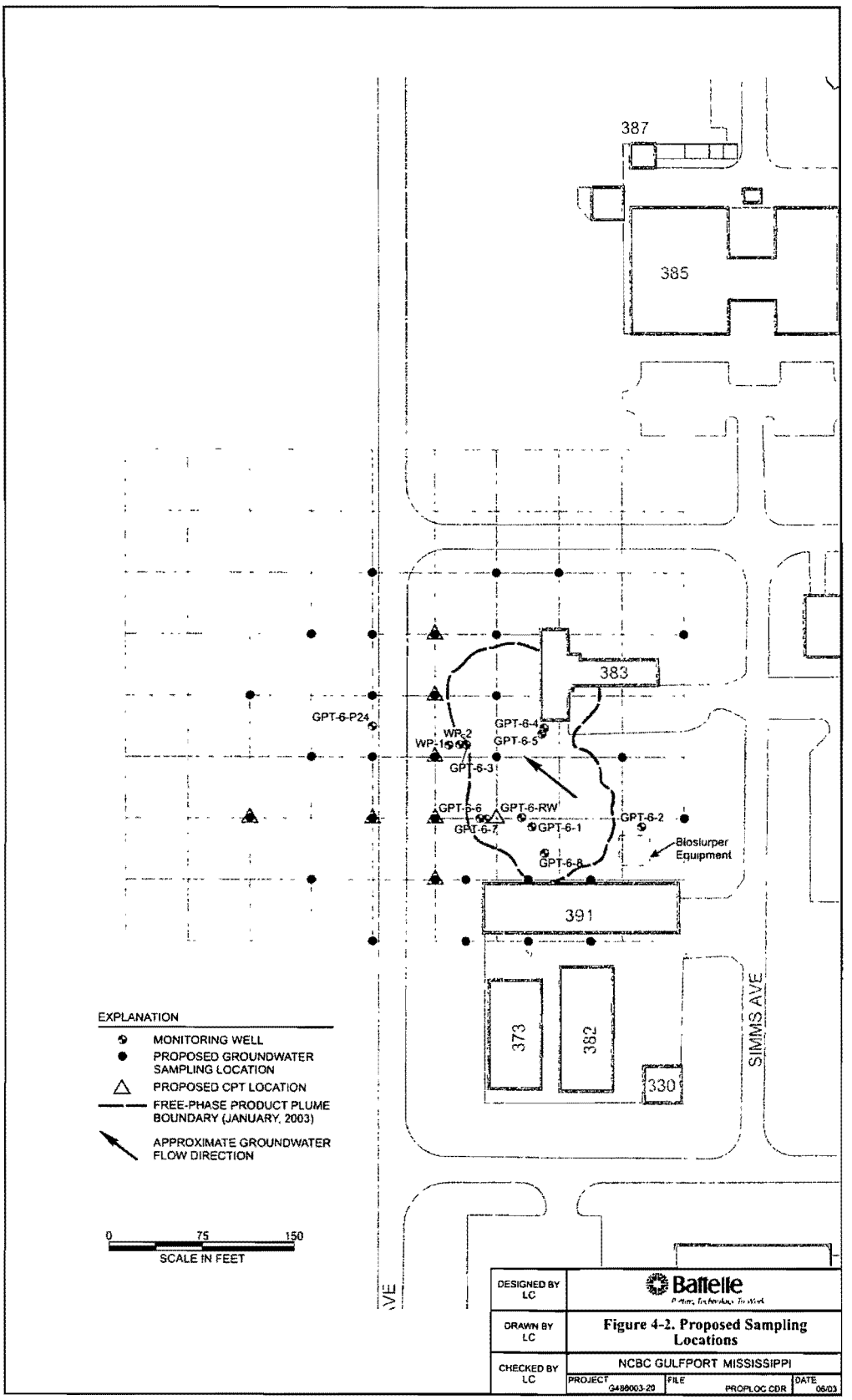


Figure 4-2. Site Map Showing Proposed Direct-Push Groundwater Sampling Locations

- At each location, a groundwater sample will be collected from a depth approximately 5 ft below the water table (sampling depth approximately 11 ft) and at the mid point between the water table and the base of the surficial aquifer (sampling depth approximately 21 to 26 ft bgs). In addition, a minimum of three locations within and downgradient of the source area will be sampled at the lower reaches of the surficial aquifer above the silty-clay unit (sampling depth approximately 35 to 45 ft bgs) to delineate the vertical extent of contamination. If the groundwater samples indicate significant contamination is present (i.e., concentrations approaching or above Federal MCLs–see Table 2-1), deeper samples will be collected every 5 ft until the vertical extent of the dissolved-phase contamination is defined.

- It is assumed that locations no more than 300 linear feet downgradient from the free-phase product boundary will need to be sampled. However, should sampling be needed farther downgradient from the grid locations shown in Figure 4-2, the locations will be determined in the field by the project field team leader.

- Cone penetrometer testing (CPT) will be conducted to collect in situ lithologic information at eight locations across the site to determine the depth to the silty-clay unit and verify its presence (Figure 4-2). Upon reaching the silty-clay unit, the CPT-cone will be advanced an additional ten ft to gauge the nature and extent of the silty-clay unit.

- The field investigation will be used as the basis for locating and installing permanent groundwater monitoring wells. Additional groundwater monitoring wells, if needed, will be installed following the direct-push groundwater study.

4.2 Groundwater Monitoring Well Sampling

Monitoring wells will be sampled following volume purging of a minimum of three wells or until water quality parameter stabilization. A peristaltic pump will be used to purge each well. Fresh polyethylene tubing will be used to purge and sample each well. The water will be pumped into a flowthrough cell to measure field parameters, which will be recorded on a purge log. The water level in the well will be measured with the water-level indicator and recorded on the purge log. The methods and results of each well purge will be recorded in a field logbook.

The following steps summarize the procedures for purging the well, determining when water-quality parameters have stabilized, and collecting samples:

- At each well, the well cap is removed and the wellhead is checked for organic vapors using a photoionization detector.

- The groundwater level is measured to the nearest 0.01 ft using a decontaminated oil/water interface probe from a marked survey point on top of the casing located within the protective wellhead. All readings are recorded in the groundwater sampling log.

- New polyethylene tubing is lowered into the well slowly to minimize disturbance of the well water. The tubing inlet or pump should be situated at approximately the midpoint of the well screen.

- The surficial end of the PET tubing is attached to a length of silicone tubing sufficient for placement within the peristaltic pump.

- The water-level indicator is lowered into the well to monitor drawdown induced by pumping. An attempt is made to avoid purging the well to dryness by pumping at a low flowrate to minimize drawdown.

- The flowrate is determined by measuring the time to fill a known volume (e.g., graduated cylinder).

- Temperature, oxygen-reduction potential, dissolved oxygen, turbidity, pH, and electrical conductivity are measured using calibrated field instruments at the outset of purging and then at regular intervals. Water-quality measurements are recorded in the groundwater sampling log and compared with the criteria in Table 4-1. If the last three sets of measurements meet the criteria, purging is considered adequate. If the measurements do not meet the criteria, additional increments of well water will be purged until the measurements for electrical conductivity, pH, turbidity, and temperature meet the criteria. No more than five well volumes will be purged.

- Wearing new, clean and chemical-resistant gloves, fills appropriate sample bottles for the requested analyses from the sample pump outlet line while an approximate flowrate of 0.5 liter/minute or less is maintained. One sample from each well will be provided to an on-site mobile laboratory for rapid VOC analysis. Samples collected for SVOC and TPH-diesel-range organics (DRO) analysis will be sent to an off-site laboratory for standard turnaround. The sampling containers, preservation methods, and holding times used during sample collection and analyses are presented in Section 4.5 of this report.

- To collect a sample for VOC analysis, the tubing first is filled with groundwater. Then, the tubing is quickly removed from the pump and a gloved thumb is placed on top of the tubing to stop the water from draining out and to capture the groundwater. Volatile organic analysis (VOA) containers then are filled by gravity, capped, and turned upside down to check for bubbles. If bubbles are present, the sample is discarded; and another vial is filled, preserved, and checked for bubbles. The process is repeated until a sample free of headspace is collected. Alternatively, a disposable Teflon™ bailer may be used to collect samples for VOC analysis.

- Samples are placed in ice chests or a refrigerator and maintained at approximately 4°C until shipment for analyses.

Table 4-1. Groundwater Quality Field Parameters and Stabilization Criteria for Sampling

Parameter	Criteria
Temperature (°C)	±0.1
Turbidity (NTU)	<10
pH	±0.1
Conductivity (mS/cm)	±10%

mS/cm - millisiemens per centimeter
NTU = nephelometric turbidity unit

4.3 Direct-Push Sampling

4.3.1 Soil Characterization. Prior to conducting the direct-push groundwater sampling, a CPT-rig or equivalent will be used to advance a CPT cone at selected locations to obtain lithologic information and to identify the depth to the silty-clay unit that underlies the surficial aquifer. The CPT-cone will be advanced to ten ft below the top of the silty-clay unit, which is approximately 35 to 45 ft bgs. The CPT-rig is a direct-push unit that uses hydraulic pressure and the weight of the rig to advance the probe rods through the subsurface. No soil cuttings are produced when the direct-push method is employed. CPT is a method for characterizing subsurface stratigraphy by testing the response of soil to the force of a penetrating cone. One of the eight CPT pushes will be advanced adjacent to GPT-6-7 to compare and verify the CPT lithological interpretation with the soil boring log for this deep well.

4.3.2 Groundwater Sampling. To collect groundwater samples, a Geoprobe (or equivalent) will advance a series of hollow stainless-steel rods to the desired sample depth. The rods will be retracted, exposing a 2- to 3-ft section of screen in the lead rod. Groundwater entering the rod chain through the screened interval will be collected for analysis using a decontaminated stainless-steel bailer. The bailer will be lowered into the rods slowly to minimize aeration. The VOA vials will be carefully filled until a meniscus is formed at the top of the vial. Each vial will be preserved with two drops of hydrochloric acid (HCl), provided by the analytical laboratory, to reduce the pH to less than 2. The vial will be capped and turned upside down to check for bubbles. If bubbles are present, the sample will be discarded and another vial will be filled, preserved, and checked for bubbles.

The samples will be provided to an on-site mobile laboratory for rapid VOC analysis following U.S. EPA Method 8260B. All push-holes created by the direct-push rig during the groundwater sampling effort will be grouted upon completion of sampling activities.

4.4 Groundwater Monitoring Well Installation

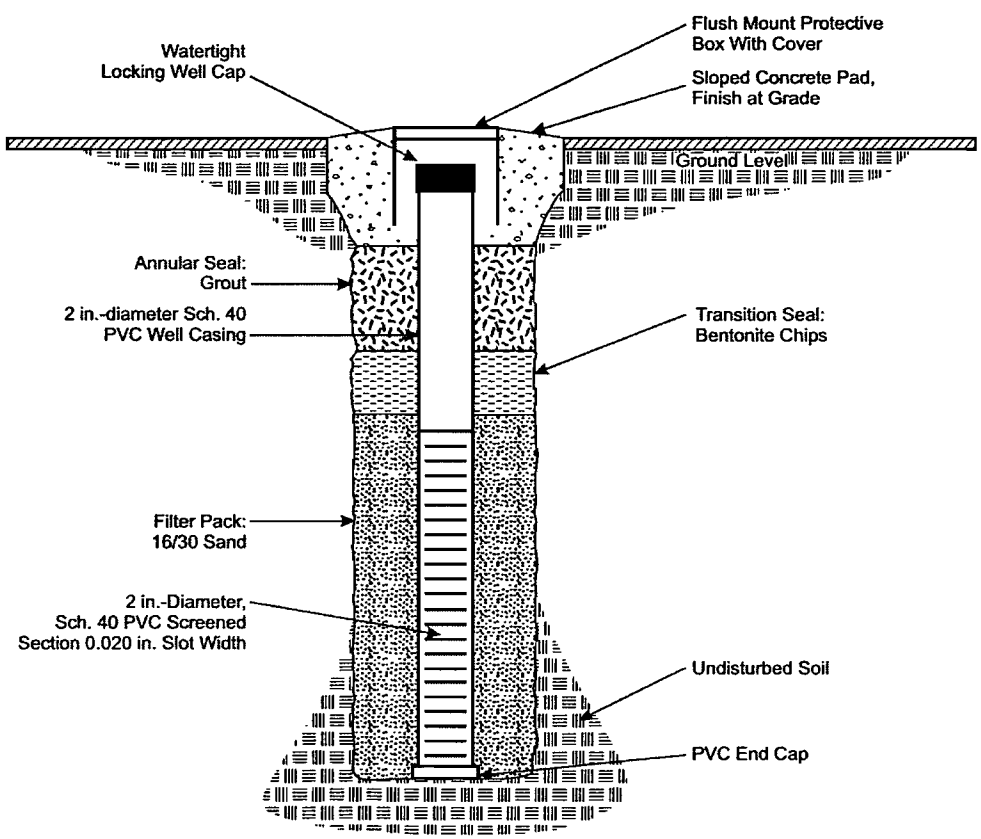
The results of the proposed investigation will be assessed to determine if additional groundwater monitoring wells will be necessary to evaluate trends in contaminant concentrations within the plume and to monitor any further migration of the plume. New wells will be installed only if existing wells cannot be used to adequately monitor the dissolved-phase plume. The completed monitoring well network, using existing wells where appropriate, shall include the following:

- One monitoring well located upgradient of the dissolved-phase plume to monitor background water quality
- Two to three wells within the dissolved-phase plume to monitor changes in contaminant concentration
- One to two wells located at the leading edge of the dissolved-phase plume
- One to two wells located immediately downgradient of the dissolved-phase plume
- Two wells located along the perimeter (crossgradient) of the dissolved-phase plume.

Prior to installation of the monitoring wells, Battelle will confer with the Navy regarding the proposed well locations. Groundwater samples will be collected from the newly installed wells

approximately two days following well development for TPH, VOCs and SVOC analyses to establish baseline water quality parameters.

Groundwater monitoring wells will be constructed of 2-inch ID schedule 40 PVC riser pipe and well screen and will be installed using a small-diameter hollow-stem auger. The screen depth will be determined based on analytical results and observations made during the plume delineation investigation. Well clusters may be installed to monitor different depths of the aquifer if needed. A schematic diagram of a typical groundwater monitoring well is presented in Figure 4-3.



NOT TO SCALE

DESIGNED BY SD	Battelle
DRAWN BY LC	Figure 4-3. Schematic Showing Example Monitoring Well Construction
CHECKED BY TWW	NCBC GULFPORT, MISSISSIPPI
	PROJECT G486003-20 | MONITORINGWELL CDR | DATE 06/03

Figure 4-3. Schematic Showing Example Monitoring Well Construction

4.5 Survey of Sampling and Monitoring Well Locations

Prior to beginning the groundwater investigation, a Mississippi-licensed surveyor will be used to delineate a 50-ft sampling grid, as shown in Figure 4-2. The sampling grid shall extend approximately 300 ft downgradient from the source area. Following the sampling event, the actual groundwater sampling locations and the groundwater monitoring wells will be surveyed. The horizontal coordinates will be reported in Mississippi State Plane Coordinates (based on North American Datum, 1983). The vertical datum will be referenced to the North American Vertical Datum, 1988. The new sampling locations will be integrated into existing Site 6 maps.

4.6 Sample Analysis

This section describes the analytical methods for collecting groundwater samples during the field investigation. Groundwater samples will be collected for analysis of VOCs, SVOCs, and TPH-DRO. Table 4-2 provides the list of laboratory analytical methods for chemical analyses.

Table 4-2. Laboratory Analytical Methods for Chemical Analyses

Parameter	Analytical Method	Technique
VOCs	U.S. EPA 8260B	GC/MS
SVOCs	U.S. EPA 8270C	GC/MS
TPH-DRO	U.S. EPA 8015B	GC

4.7 Sample Handling and Documentation

This section describes analytical methods and container and preservative requirements. Field and laboratory quality control (QC) samples are discussed in Section 3.

4.7.1 Sample Identification. All samples submitted to an analytical laboratory will be uniquely numbered labeled for sample identification as follows: YYY-ZZZZ-AAA. In this scheme, the first three entries (YYY) represent a well name or sampling location, the (ZZZZ) entries represents the date the sample was collected, and the (AAA) entries are modifiers that can be used to reflect a QC sample, for example.

The sample number will be recorded in the field logbook and on the chain-of-custody form at the time of sample collection. A complete description of the sample and sampling circumstances will be recorded in the field logbook and referenced to the unique sample identification number.

Sample labels will be filled out with indelible black ink and affixed to each sample container. Each sample container will be labeled with the following, at a minimum:

- Sample identification
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project identification
- Sampler's initials
- Analyses to be performed
- Preservation (if any).

4.7.2 Sample Containers, Preservation, Holding Times, and Requirements. Requirements for sample containers, preservation, and holding times are listed in Table 4-3. New, precleaned sample containers will be used for sample collection. Once collected, each containerized sample will be labeled and placed into a matrix-specific sample cooler. The sample cooler will serve as the shipping container and will be packed with ice to cool samples to the appropriate temperature for preservation.

Table 4-3. Sample Container, Holding Time, and Preservation Method

Analysis	Analytical Method	Container	Preservative	Holding Time
VOCs	U.S. EPA 8260B	Three 40-mL glass vials with Teflon-lined septum caps	Cool, 4°C, pH ≤ 2 w/ HCl (no headspace)	14 days
SVOCs	U.S. EPA 8270C	1-L amber glass container with Teflon-lined lid	Cool, 4°C	7 days for extraction and 40 days for analysis
TPH (DRO)	U.S. EPA 8015B	Two 1-L amber glass containers with Teflon-lined lid	Cool, 4°C	7 days for extraction and 40 days for analysis

4.7.3 Sample Documentation. At a minimum, sampling information will be recorded on a chain-of-custody form and in the field logbook. Both documents will be completed in the field at the time of sample collection. All entries will be legible and recorded in indelible black ink. Table 4-4 lists the information that will be recorded in the chain-of-custody form and the field logbook.

A bound field logbook with consecutively numbered pages will be assigned to each site in this project. All entries will be recorded in indelible black ink. Corrections will be made by crossing out erroneous data with a single line and dating and initialing the entry. At the end of each workday, the responsible sampler will sign the logbook pages and cross out, sign, and dated any unused portions of logbook pages.

Changes or corrections on any project documentation will be made by crossing out the item with a single line, initialing (by the person performing the correction), and dating the correction. The original item, although erroneous, must remain legible beneath the cross out. The new information should be written clearly above the crossed-out item.

4.7.4 Sample Packaging and Shipment. Immediately after sample collection, sample labels will be affixed to each sample container and the sample will be placed inside a cooler. Each sample will be placed in a resealable plastic bag to keep the sample container and label dry. All glass sample containers will be protected with bubble wrap.

Ice will be added to the cooler in sufficient quantity to keep the samples cooled to 4 ± 2 C for the duration of the shipment to the laboratory. Each cooler will be shipped with a temperature blank. A temperature blank is a sample container filled with tap water and stored in the cooler during sample collection and transportation. The temperature of the temperature blank will be recorded by the laboratory immediately upon receipt of the samples. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage.

Table 4-4. Sample Documentation

Chain-of-Custody Information	Field Logbook Information
Project name Project location Project number Sample numbers Date (of sample collection) Time (of sample collection to the nearest minute, military time) Sample type (composite or grab) Sample description (location, matrix, depth, etc.) Number of sample containers Analysis required Observations specific to sample Transfer signature (to relinquish samples) Courier/laboratory representative signature (for commercial carrier, record airbill number here) Date/time (of custody transfer) Additional comments, such as turnaround time requirement Sampler signature	Project name and location Date and time Personnel in attendance General weather information Work performed Field observations Sampling performed, including specifics such as location, type of sample, type of analyses, and sample identification Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments Descriptions of deviations from the Field Sampling Plan Problems encountered and corrective actions taken Identification of field QC samples QC activities Verbal or written instructions Any other events that may affect the samples

The chain-of-custody form will be completed and signed by the laboratory-assigned courier. The cooler will then be released to the courier for transportation to the laboratory. If a commercial carrier is used, the chain-of-custody form will include the airbill number in the "transfers accepted by" column and will be sealed in a resealable bag. The chain-of-custody form will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. Saturday deliveries must be coordinated with the laboratory, and the airbill and cooler must be marked appropriately. A copy of the courier airbill will be retained for documentation.

The laboratory will designate a sample custodian. This individual is responsible for inspecting and verifying the correctness of the chain-of-custody records upon sample receipt. The sample custodian will accept the samples by signing the chain-of-custody form and noting the condition of the samples in the space provided on the chain-of-custody form or other receipt form. The sample custodian will notify the Field Task Leader of any discrepancies. The chain-of-custody is generally considered to be a legal document and thus will be filled out legibly and as error-free as possible. Samples received by the laboratory will be entered into a sample management system, which must include the following:

- Laboratory sample number
- Field sample designation
- Analytical batch numbers
- List of analyses requested for each sample container.

Immediately after receipt, the samples will be stored in an appropriate secure storage area. The laboratory will maintain custody of the samples as required by the contract or until further notification by the Battelle Field Task Leader. The analytical laboratory will maintain written records showing the chronology of sample handling during the analysis process by various individuals at the laboratory.

4.8 Field Instrument Calibration

A portable water quality meter (Horiba U22 or equivalent) will be used to measure pH, temperature, conductivity, dissolved oxygen, and turbidity in monitoring wells. To obtain the most accurate measurements, a continuous flowthrough cell will be used to provide a sampling chamber for the meter. The meter will be cleaned and calibrated prior to use in accordance with the manufacturer's instructions.

4.9 Equipment Decontamination Procedures

All field equipment used in sampling will be decontaminated as described below before each use to avoid cross contamination between samples and to ensure the health and safety of the field crews. The first rinse will consist of commercially available distilled or deionized (DI) water. The sampling equipment and associated tubing are then washed with commercially available distilled or DI water mixed with Liquinox™ detergent. Next, the sampling equipment will be rinsed thoroughly with methanol. The final rinse will consist of commercially available distilled or DI water. Any liquid or solid waste generated during decontamination procedures will be disposed of in accordance with procedures outlined for the disposal of investigation-derived waste (IDW) (see Section 4.8).

4.10 Management of Investigation-Derived Waste

Used personal protective equipment (PPE), soil cuttings, decontamination wastewater, well development water, and purge water will be generated during investigative and well installation activities.

Wastewater will be stored in temporary containers and then transferred into the OWS, which is a component of the bioslurper process water treatment system located at Site 6. Water from the OWS flows to the air stripper, where it is treated prior to discharge to the Gulfport POTW. Used PPE (e.g., disposable gloves and earplugs) will be placed in trash bags for disposal at the local landfill. Soil material generated during field activities will be placed in separate U.S. Department of Transportation approved drums to await sampling for chemical characterization. Each drum will be labeled, on which the following information displayed: type of waste, date produced, source, and generator. NCBC Gulfport will be named as the waste generator.

A grab sample from each drum of soil IDW will be collected and analyzed for hazardous waste characteristics based on the total threshold limit concentration, soluble threshold limit concentration, and Toxicity Characteristic Leach Procedure. Soil IDW samples will be analyzed for VOCs and SVOCs.

IDW analyses will be performed by an off-site laboratory with normal turnaround time. Analytical results for IDW samples will not be subjected to data validation procedures. IDW results will be submitted to the waste hauler for determination of proper disposal methods for the IDW. Based on previous site investigations, it is expected the soil cuttings will be characterized nonhazardous and will be accepted for disposal at the sanitary landfill. However, if the soil is characterized as hazardous, the waste will be collected and removed by a licensed hauler for transport to a Resource Conservation and Recovery Act treatment, storage, and disposal facility.

Section 5.0: QUALITY ASSURANCE AND QUALITY CONTROL

This section describes the quality assurance (QA) and QC procedures for groundwater monitoring at Site 6.

5.1 Quality Assurance Procedures

Quality of the field data will be assessed through the collection and analysis of field QC samples on a regularly scheduled basis. Laboratory QC samples also will be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures and analyses are conducted properly. The following subsections discuss field QC samples and laboratory QC samples.

5.1.1 Field QC Samples. Field QC samples will be collected and analyzed during the project to assess the consistency and frequency (10% of the total number of field samples of the sampling program). Field QC samples for this project include field duplicates, trip blanks, field blanks, and confirmatory samples (Table 5-1).

Table 5-1. Field Quality Control Samples and Sample Frequency

Sample Type	Sample Frequency
Field Duplicate	10%
Trip Blank	1 per cooler shipment, only for VOC samples
Field Blank	10%
Confirmatory Sample	10% of samples analyzed by the mobile laboratory

Field Duplicates
Field duplicates consist of two samples (an original and a duplicate) of the same matrix collected at the same time and location to the extent possible and using the same sampling techniques. The purpose of field duplicate samples is to evaluate the precision of the overall sample collection and analysis process. Field duplicates will be collected at a frequency of one per 10 samples and analyzed for the same analytes as the original sample. Exact locations of duplicate samples and their identifications will be recorded in the field logbook.

Trip Blanks
Trip blank samples will accompany each cooler that contains samples being submitted for volatile parameter analysis. Trip blanks will be prepared at the laboratory by filling 40-mL VOA vials with high-performance liquid chromatography-grade water. Trip blanks are not to be opened in the field. Trip blanks will be analyzed for VOCs only if contamination of the samples during transport is suspected.

Field Blanks
Field blanks serve as a check on reagent and environmental contamination. One field blank will be collected from each source water (commercially available distilled or DI water) used to decontaminate sampling equipment. Field blanks will be prepared by transferring water from the source water container to the sample containers at the sampling site and preserving it with the appropriate reagents. This blank will be analyzed for the same constituents as the field samples.

Confirmatory Sample
Confirmatory samples will be collected in the same manner as the field duplicate samples for analysis of VOCs in groundwater at an off-site laboratory to verify the results of the mobile laboratory.

5.1.2 Laboratory Quality Control. The laboratory will perform QC procedures in accordance with its internal standard operating procedure. Laboratory QC samples will include initial and instrument check calibrations, instrument blanks, method blanks, laboratory control spikes, and laboratory duplicates. In addition, the laboratory will analyze a matrix spike/matrix spike duplicate (MS/MSD) for every 20 project samples. In order for the laboratory to prepare a project-specific MS/MSD, field personnel will collect triple the sample volume for aqueous samples at a minimum of one MS/MSD per 20 samples collected. Field personnel will designate one sample in 20 for MS/MSD analysis on the chain-of-custody form.

Calibration
Initial calibrations are performed when the method is first used and again whenever the continuing calibrations fail to meet their respective acceptance critera. In addition, if the instrument undergoes significant maintenance, the initial calibrations must be repeated. Continuing calibrations are used to verify that the instrument performance has remained within the limits set at the time of the initial calibration. The frequency of continuing calibrations is method-dependent.

Method Blanks and Instrument Blanks
Method blanks are designed to detect contamination of field samples that may occur in the laboratory. Method blanks verify that method interference caused by contaminants in solvents, reagents, glassware, and other sample-processing hardware are known and minimized. Method blanks are DI water for aqueous samples, a clean solid matrix for soil and sediment, and clean filters or puffs for vapor and air samples. Each day that field samples are analyzed, a minimum of one method blank will be analyzed at a rate of one per 20 field samples. A method blank must be analyzed daily. The concentratation of the target compounds in the method blank sample must be less than five times the method detection limit (MDL). If the blank is not under the specified limit, the source contamination is to be identified and corrective actions taken.

Laboratory Control Samples
Laboratory control samples include blank spikes and blank spike duplicates. Blank spike samples are designed to check the accuracy of the laboratory analytical procedures by measuring a known concentration of an analyte in the blank spike samples. Blank spike duplicate samples are designed to check laboratory accuracy and precision of the analytical procedures by measuring a known concentration of an analyte in the blank spike duplicate sample. Blank spike and blank spike duplicate samples are prepared by the laboratory using clean laboratory matrices spiked with the same spiking compounds used for matrix spikes at levels approximately 10 times greater than the MDL.

Laboratory Duplicates
Laboratory duplicates are two aliquots of a sample taken from the same sample container under laboratory conditions and analyzed independently. The analysis of laboratory duplicates allows the laboratory to measure the precision associated with laboratory procedures.

Matrix Spikes
MS and MSD samples are designed to check the precision and accuracy of the analytical methods by analyzing a field sample with a known amount of analyte added. Additional sample volume for MS and MSD samples is collected in the field in the same manner as field duplicate samples. In the laboratory, two portions of the sample are spiked with a standard solution of target analytes. MS and MSD samples

are analyzed for the same parameters as the field samples, and analytical results are evaluated for precision and accuracy of the laboratory process and effects of the sample matrix.

5.2 Performance Criteria for Laboratory Analytical Data

The project reporting limits for the analytical laboratory are provided in Table 5-2.

Table 5-2. Project Reporting Limits

Parameter/Method	Analyte	RL	Unit
TPH-DRO/SW8015M	TPH-DRO	0.3	mg/L
VOC Compounds EPA8260B	1,1,1-Trichloroethane	5	µg/L
	1,1,2-Trichloro-1,2,2-trifluoroethane	50	µg/L
	1,1,2,2-Tetrachloroethane	5	µg/L
	1,1,2-Trichloroethane	5	µg/L
	1,1-Dichloroethane	5	µg/L
	1,1-Dichloroethene	5	µg/L
	1,2-Dichloroethane	5	µg/L
	1,2-Dichloroethene (total)	5	µg/L
	1,2-Dichloropropane	5	µg/L
	2-Chloroethylvinylether	50	µg/L
	2-Hexanone	50	µg/L
	Acetone	50	µg/L
	Benzene	5	µg/L
	Bromodichloromethane	5	µg/L
	Bromoform	5	µg/L
	Bromomethane	5	µg/L
	Carbon tetrachloride	5	µg/L
	Chlorobenzene	5	µg/L
	Chloroethane	5	µg/L
	Chloroform	5	µg/L
	Chloromethane	5	µg/L
	cis-1,2-Dichloroethene	5	µg/L
	cis-1,3-Dichloropropene	5	µg/L
	Dibromochloromethane	5	µg/L
	Ethylbenzene	5	µg/L
	Methyl ethyl ketone (MEK)	50	µg/L
	Methyl tert-butyl ether (MTBE)	10	µg/L
	Methylene chloride	5	µg/L
	Methylisobutyl ketone (MIBK)	50	µg/L
	Styrene	5	µg/L
	Tetrachloroethene	5	µg/L
	Toluene	5	µg/L
	trans-1,2-Dichloroethene	5	µg/L
	trans-1,3-Dichloropropene	5	µg/L
	Trichloroethene	5	µg/L
	Vinyl acetate	50	µg/L
	Vinyl chloride	5	µg/L
	Xylene, Total	5	µg/L

Table 5-2. Project Reporting Limits (continued)

Parameter/Method	Analyte	RL	Unit
SVOC Compounds EPA8270C	1,2,4-Trichlorobenzene	10	µg/L
	1,2-Dichlorobenzene	10	µg/L
	1,3-Dichlorobenzene	10	µg/L
	1,4-Dichlorobenzene	10	µg/L
	2,4-Dinitrotoluene	10	µg/L
	2,6-Dinitrotoluene	10	µg/L
	2-Chloronaphthalene	10	µg/L
	2-Methylnaphthalene	10	µg/L
	2-Nitroaniline	50	µg/L
	3-Nitroaniline	50	µg/L
	3,3'-Dichlorobenzidine	10	µg/L
	4-Bromophenyl phenyl ether	10	µg/L
	4-Chloroaniline	10	µg/L
	4-Chlorophenyl phenyl ether	10	µg/L
	4-Nitroaniline	50	µg/L
	Acenaphthylene	10	µg/L
	Acenapthene	10	µg/L
	Anthracene	10	µg/L
	Benzo (a) anthracene	10	µg/L
	Benzo (a) pyrene	10	µg/L
	Benzo (b) fluoranthene	10	µg/L
	Benzo (k) fluoranthene	10	µg/L
	Benzo (g,h,i) perylene	10	µg/L
	Benzoic Acid	50	µg/L
	Bis (2-chloroethoxy) methane	10	µg/L
	Bis (2-chloroethyl) ether	10	µg/L
	Bis (2-chloroisopropyl) ether	10	µg/L
	Bis (2-ethylhexyl) phthalate	10	µg/L
	Butyl benzylphthalate	10	µg/L
	Chrysene	10	µg/L
	Di-n-butylphthalate	10	µg/L
	Di-n-octylphthalate	10	µg/L
	Dibenz (a,h) anthracene	10	µg/L
	Dibenzofuran	10	µg/L
	Diethyl phthalate	10	µg/L
	Dimethyl phthalate	10	µg/L
	Fluoranthene	10	µg/L
	Fluorene	10	µg/L
	Hexachlorobenzene	10	µg/L
	Hexachlorobutadiene	10	µg/L
	Hexachlorocyclopentadiene	10	µg/L
	Hexachloroethane	10	µg/L
	Indeno (1,2,3-cd) pyrene	10	µg/L
	N-Nitrosodiphenylamine	10	µg/L
	N-Nitrosodi-n-propylamine	10	µg/L
	Naphthalene	10	µg/L
	Nitrobenzene	10	µg/L
	Phenanthrene	10	µg/L

Table 5-2. Project Reporting Limits (continued)

Parameter/Method	Analyte	RL	Unit
SVOC Compounds EPA 8270C	Pyrene	10	µg/L
	2,4,5-Trichlorophenol	50	µg/L
	2,4,6-Trichlorophenol	10	µg/L
	2,4-Dichlorophenol	10	µg/L
	2,4-Dimethylphenol	10	µg/L
	2,4-Dinitrophenol	50	µg/L
	2-Chlorophenol	10	µg/L
	2-Methylphenol	10	µg/L
	2-Nitrophenol	10	µg/L
	4,6-Dinitro-2-methylphenol	50	µg/L
	4-Chloro-3-methylphenol	10	µg/L
	4-Methylphenol	10	µg/L
	4-Nitrophenol	50	µg/L
	Pentachlorophenol	10	µg/L

5.2.1 Quantitative Objectives: Precision, Accuracy, and Completeness. The analytical data being generated will be assessed in terms of precision, accuracy, and completeness (Table 5-3). Precision measures the reproducibility of repetitive measurements under specified laboratory conditions. The analytical precision acceptability limits for this project are 30% for all water analyses. Precision is estimated by calculating the relative percent difference (RPD) of laboratory and field duplicates, as shown in the following equation:

$$\text{RPD} = \left[\frac{2 \times (\text{Result - Duplicate Result})}{(\text{Result + Duplicate Result})} \right] \times 100\%$$

Accuracy refers to the percentage of a known amount of analyte recovered from a given matrix. It indicates any bias in the performance of the analytical method and the ability of the instrumentation to provide valid measurements. The recovery of most spiked organic compounds is expected to fall within a range of 70 to 130%. Accuracy is expressed as the percent recovery of the surrogate from the spiked sample and is calculated using the following equation:

$$\text{Recovery (\%)} = \left[\frac{(\text{Spiked Sample Results - Original Sample Results})}{\text{Amount of Spiked Sample}} \right] \times 100\%$$

Completeness refers to the percentage of valid data received from actual testing done in the laboratory. The target completeness goal for all compounds is 90%. Completeness is calculated using the following equation:

$$\text{Completeness} = \left[\frac{\text{Valid Results}}{\text{Total Analyses}} \right] \times 100\%$$

5.2.2 Qualitative Objectives: Comparability and Representativeness. Comparability is the degree to which one data set can be compared with another. To ensure comparability, samples will be collected at specified intervals and in a similar manner and analyzed within the required holding times by accepted and comparable methods. All data and units used in reporting for this project will be consistent with accepted conventions for environmental matrix analyses. This approach will ensure direct

comparability between the results from this project and the results from other projects using the methods presented in this Sampling and Analysis Plan.

Representativeness is the degree to which a sample or group of samples is indicative of the population being studied. Over the course of a project, samples will be collected in a manner such that they are representative of both the chemical composition and the physical state of the sample at the time of sampling.

Table 5-3. Precision and Accuracy Requirements for Groundwater Samples

Method	Analyte	Accuracy LCS Analyte Limit	Precision RPD	Accuracy Sample/ MS/MSD Analyte Limit	Precision RPD
SW 8260B	Benzene	63-133	25	64-136	25
	Toluene	76-114	25	75-115	25
	Ethylbenzene	77-114	25	78-114	25
	Xylenes (total)	59-142	25	47-159	25
	Naphthalene	70-130	25	70-130	25
	Methyl tert-butyl ether	65-120	25	51-137	25
SW 8270C	Acenaphthene	55-103	20	29-111	20
	Pyrene	45-124	20	37-117	20
SW8015	TPH	57-131	20	17-109	20

Method	Analyte	Accuracy LCS Surrogate Limit	Accuracy Sample/MS/MSD Surrogate Limit
SW 8260B	4-Bromofluorobenzene	66-118	50-144
	1,2-Dichloroethane-d4	69-120	60-124
	Toluene-D8	82-111	80-109
SW 8270C	Nitrobenzene-d5	37-112	20-111
	p-Terphenyl	30-145	16-138
	2-Fluorobiphenyl	43-105	35-107
	o-Terphenyl	61-117	48-115
SW8015	o-Terphenyl	51-150	41-145

LCS = laboratory control sample

5.3 Corrective Action

An effective QA program requires prompt and thorough correction of nonconformances that affect quality. Rapid and effective correction action minimizes the possibility of questionable data or documentation. QA problems and corrective actions will be documented to provide a complete record of QA activities in the field and at the laboratory.

5.3.1 Field Corrective Action Procedures. The level of corrective action procedures performed in the field will depend of the severity of the nonconformance. In cases where immediate and complete corrective action may be implemented by field personnel, the corrective action taken will be recorded in the field record book. If the nonconformance cannot be corrected immediately or completely, the field personnel will evaluate the potential negative effects of the problem. If the nonconformance could cause

data to fail to meet chemical data quality objectives, data collection will stop until a conforming workaround is identified. If adequate data quality can be maintained after implementing the workaround, data collection may continue after the workaround is implemented. The field personnel will record the action taken and rationale in the field record book.

5.3.2 Laboratory Corrective Action Procedures. The internal laboratory corrective action procedures and description of out-of-control situations requiring corrective action are contained in the laboratory QA plan. At a minimum, corrective action will be implemented when control chart warning or control limits are exceeded, method QC requirements are not met, or sample hold times are exceeded. Out-of-control situations will be reported to field personnel when identified. In addition, a corrective action report, signed by the laboratory director or project managers and the laboratory QC coordinator, will be provided to the field personnel. The corrective action report will include a description of the problem, identification of the affected samples, and the required corrective action.

The corrective action procedures require that the laboratory identify out-of-control situations that would affect significant amounts of data and perform corrective action designed to reduce the amount of data affected. This corrective action is often reanalysis of samples once the cause of the out-of-control situation has been identified and corrected.

5.4 Data Reduction, Validation, and Reporting

The analytical laboratory will prepare a sampling report, which will present results in a tabular format. The laboratory data package will include a case narrative; chain-of-custody and sample receipt documentation; a summary of results for environmental samples (including quantitation limits); and a summary of QA/QC results, surrogate recoveries, and RPDs for all duplicate samples. All contractor laboratory data will be included in the project report.

Chemical data will be subject to data validation by an independent contractor following Contract Laboratory Program National Function Guidelines for Validation of Organic Analysis (U.S. EPA, 1994). At a minimum, full data validation (Level 4) will be performed on 10 percent of the laboratory-generated chemical data as recommended in the Department of the Navy Installation Restoration Manual (Department of Navy, 1997). Level 3 data validation will be performed on the remaining 90 percent of the data. Data validation is the process of evaluating data and accepting or rejecting it on the basis of the chemical data quality objectives. Data validation will include evaluation of blanks, QC results, and verification of results. A daily QC report including a description of all activities and problems will be prepared by the field project manager during field activities. The daily QC report will list sample numbers taken within the time period covered by the daily report. Information on the conduct of sampling operations, field instrument calibration data, water sampling forms, and chain-of-custody forms, coupled with laboratory analytical data and validation data, will be used to assess the quality of the sampling data. The completeness and validity of the data with respect to the quantitative QA objectives will be discussed. Invalid data or data reported below the reporting limit will be flagged, and the implications discussed in the accompanying text.

Following the field investigation, a summary report will be prepared and submitted to the Navy and to the NCBC. The monitoring report will compare the analytical results from the field investigation event with historical groundwater monitoring data and describe the rationale for the additional monitoring well locations. The report also will include recommendations for monitoring strategy that will identify the COCs, the selected monitoring wells, sample analyses (including COCs and other water quality parameters), and monitoring frequencies. The results of the monitoring will be used to determine the endpoint for remedial action.

Section 6.0: PROJECT ORGANIZATION AND SCHEDULE

Contact information for key personnel and specific responsibilities for Battelle's groundwater monitoring project staff members are described in Table 6-1.

Table 6-1. Contact Information for Key Project Personnel

Title	Name and Contact Information
U.S. Navy Remedial Project Manager	Art Conrad Naval Facilities Engineering Command Southern Division 2155 Eagle Drive North Charleston, SC 29419-9010 (843) 820-5520 ConradAL@edfsouth.navfac.navy.mil
NCBC Gulfport Point of Contact	Gordon Crane NCBC 5200 CBC 2nd Street Gulfport, MS 39501 (228) 871-2485 gwcrane@cbcgulf.navfac.navy.mil
Battelle Project Manager: Responsible for all aspects of work performed	Steve Rosansky, P.E. Battelle 505 King Ave Columbus, OH 43201 (614) 424-7289 rosansky@battelle.org
Battelle Hydrogeologist: Responsible for planning and implementing fieldwork, and for evaluating chemical and hydrogeological data.	Mark Kelley, CGWP, P.G. Battelle 505 King Ave Columbus, OH 43201 (614) 424-3704 kelleym@battelle.org
Battelle Field Geologist: Responsible for planning and implementing fieldwork, maintaining project records, and managing subcontractors.	Lydia Cumming Battelle 505 King Ave Columbus, OH 43201 (614) 424-7778 cummingl@battelle.org
Battelle QC Manager: Responsible for reviewing laboratory data package for compliance with the program chemical data quality objectives.	Terri Pollock Battelle 505 King Ave Columbus, OH 43201 (614) 424-5883 pollockt@battelle.org

It is anticipated that the field investigation will be conducted in August 2003. Subsequent activities, such as well installation and monitoring, will be determined upon evaluation of the data generated during the field investigation and discussions with the Navy and the NCBC. A schedule of proposed tasks is shown in Table 6-2.

Table 6-2. Tentative Schedule of Activities at Day Tanks and Fueling Pier

Activity	Start Date	End Date
Submit Groundwater Monitoring Work Plan		July 1, 2003
Government Review	July 2	August 1
Field Investigation	August 4	August 9
Install additional Groundwater Monitoring Wells and Sample (If Necessary)	August 18	August 22
Prepare Draft Plume Delineation Report	August 11	September 12
Government Review	September 15	September 19
Prepare Final Plume Delineation Report	September 22	September 30

Section 7.0: REFERENCES

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