FINAL

SAMPLE STRATEGY PLAN

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

OPERABLE UNIT NO. 17
SITES 90, 91, AND 92

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0344

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Prepared for:

DEPARTMENT OF THE NAVY
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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	Microgram per Kilogram
µg/L	Microgram per Liter
AST	Above Ground Storage Tank
Baker	Baker Environmental, Inc.
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Total Xylene
DoN	Department of the Navy
GRO	Gasoline Range Organics
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LUST	Leaking Underground Storage Tank
MCB	Marine Corps Base
NC DEHNR	North Carolina Department of the Environment, Health, and Natural Resources
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SSP	Sample Strategy Plan
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS/TSS	Total Dissolved Solids/Total Suspended Solids
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This Sample Strategy Plan (SSP) presents an overview of the Remedial Investigation (RI) scope of work for Operable Unit (OU) No. 17. OU No. 17 includes Site 90 (BB-9), Site 91 (BB-51), and Site 92 (BB-46)at Marine Corps Base (MCB), Camp Lejeune, North Carolina (Figure 1-1).

The purpose of the SSP is to provide the United States Environmental Protection Agency (USEPA) Region IV, and the North Carolina Department of the Environment, Health, and Natural Resources (NC DEHNR) with a summary of the proposed field investigations that will be presented by the Department of the Navy (DoN), Atlantic Division, Naval Facilities Engineering Command (LANTDIV) at an upcoming project scoping meeting. This document is meant to be used as a supplement to the scoping meeting, and is not intended for formal comment. Questions or comments on the proposed RI field investigations will be addressed during a future meeting.

Each site is addressed separately in this document. A brief description of the site history, and summaries of previous investigations and the site visit are provided. The proposed field investigations are described, including the objectives and sampling rationale. The investigation areas for Sites 90, 91, and 92 are presented on Figure 1-2.

FIGURES

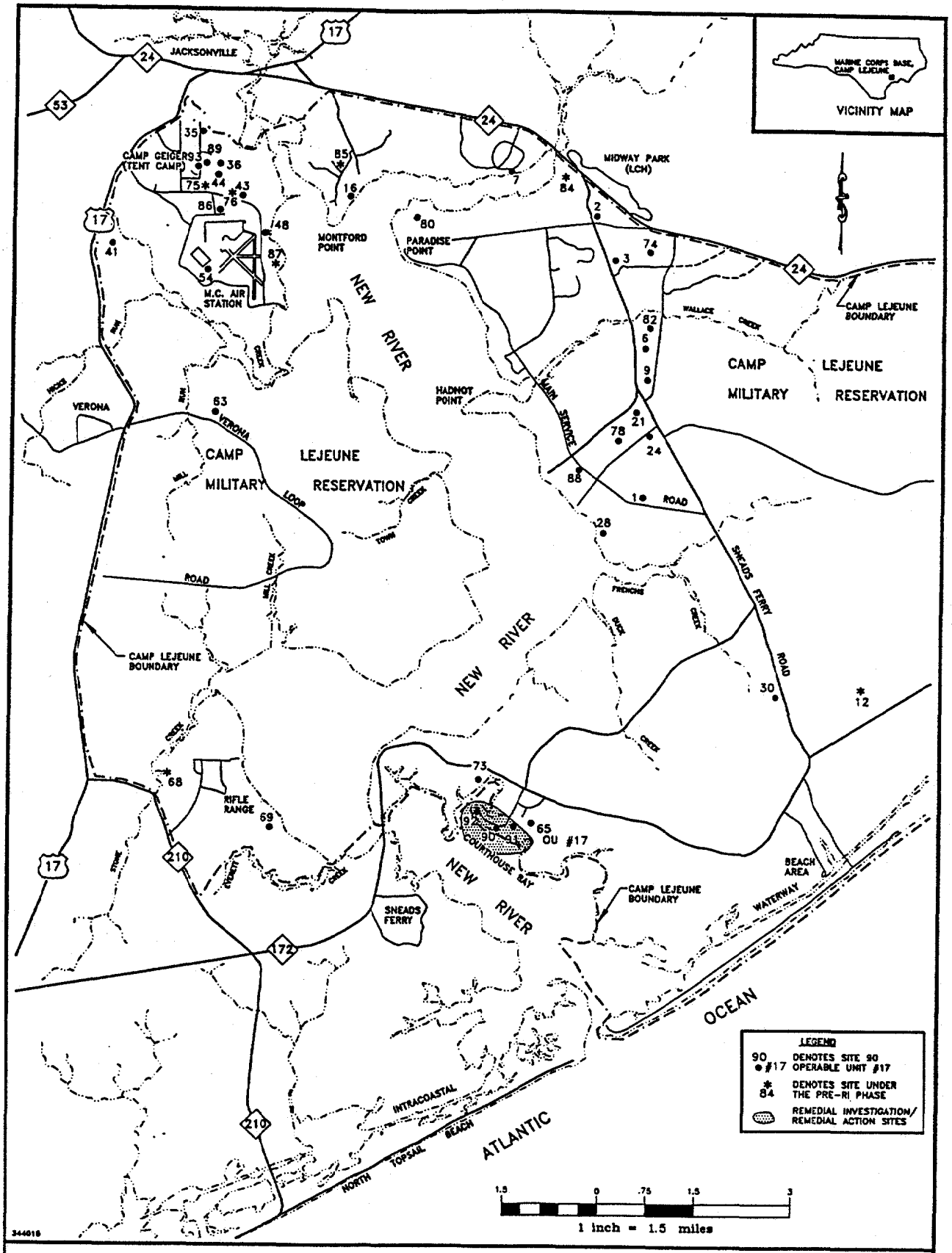

FIGURE 1-1
OPERABLE UNITS AND SITE LOCATIONS AT
MARINE CORPS BASE CAMP LEJEUNE
SAMPLE STRATEGY PLAN CTO-0344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker

Baker Environmental, Inc.

FIGURE 1-2
SITES 90, 91 AND 92 LOCATION MAP
SAMPLE STRATEGY PLAN CTO-344
MCB CAMP LEJEUNE
NORTH CAROLINA

SOURCE: U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE:
AERIAL PHOTOGRAPH FIELD OFFICE

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2.0 SITE 90 (BB-9)

Site 90, the former underground storage tanks (USTs) for Building BB-9, is located near the intersection of Middle Road and Peach Street between Buildings BB-9 and BB-16 in the Courthouse Bay area of MCB Camp Lejeune (Figure 2-1). Building BB-9 currently operates as a steam generation and heating plant. Three steel 1,000-gallon USTs, used to store heating oil, were located adjacent to Building BB-9. A dry cleaning facility (Building BB-16) is located northeast of the site (no dry cleaning on the premises, drop-off and pick-up point only). Located to the north and northwest of Building BB-9 are several buildings and paved parking areas. The New River is the nearest surface water body, located approximately 800 feet downgradient (south) of the former UST basin. The nearest known water supply well (BB-45) is located approximately 1,275 feet west of the site.

2.1 Site History

Building BB-9 is currently operating as a steam generation and heat plant. Adjacent to the building were three 1,000-gallon steel USTs used to store heating oil for the steam plant. All three tanks were excavated and permanently closed in March 1993. Soil contamination was noted during the tank removal activities; however, there was no information documenting the collection of soil or groundwater to confirm or estimate the extent of the impact. The former tank basin currently remains unpaved. There are three active above ground storage tanks (ASTs) of unknown capacity reported to store diesel fuel #2 east of Building BB-9. There is an active concrete oil/water separator for storm water runoff from the active AST pad southeast of the former UST basin. There also were two active 250-gallon ASTs which were used for solvent storage located west of the former UST basin. The dry cleaning process in Building BB-16 is no longer conducted in the building, but previously there was a 250-gallon AST in the building which contained dry cleaning fluid.

2.2 Previous Investigations

As a follow-up to the tank removals, a three well site check was conducted in April 1993 by Groundwater Technology Government Services, Inc., to identify and/or verify the suspected hydrocarbon impact in the subsurface soil and groundwater. The activities included:

- Installing three monitoring wells (BB9-1 through BB9-3) around the former UST basin in April 1993. The wells were approximately 20 feet below ground surface (bgs). Groundwater was approximately 5 feet bgs. Figure 2-2 presents the monitoring well locations.

- TPH analysis of the three soil samples, one from each soil boring, revealed total petroleum hydrocarbon (TPH) concentrations ranging from 142,000 to 690,000microgram per kilogram (µg/kg) of TPH-diesel, 120,000 to 1,700,000 µg/kg TPH-lubrication oil, and 870,000 to 3,800,000 total oil and grease.

- Analyzing groundwater samples for benzene, toluene, ethylbenzene, and total xylenes (BTEX) revealed maximum concentrations of 2.7 micrograms per liter (µg/L) benzene, 5.1 µg/L toluene, 11.0 µg/L ethylbenzene, and 48.0 µg/L total xylenes. No free phase product was noted in any of the wells.

A leaking underground storage tank (LUST) comprehensive site assessment for Site 90 was conducted in December 1994 by Richard Catlin & Associates, Inc. to determine site subsurface characteristics and the extent of impact to subsurface soil and groundwater. The work performed included:

- Utilizing 12 HydroPunch™ penetrometers (HP-1 through HP-12) to provide preliminary data to assist with the location of the permanent monitoring wells. The HydroPunch™ samples were analyzed for polynuclear aromatic hydrocarbons (PAHs). Figure 2-2 presents the HydroPunch™ locations.

- Advancing fifteen soil borings to install 12 Type II (BB9-4 through BB9-15) and three Type III (BB9-16 through BB9-18) monitoring wells to determine the horizontal and vertical extent of petrochemical contamination in the former UST area. Figure 2-2 presents the monitoring well locations. Designated soil boring samples were analyzed for TPH, Toxicity Characteristic Leaching Procedure (TCLP) organics and metals, flashpoint, purgeable aromatics, and soil pH.

- Collecting 15 groundwater samples from the newly installed monitoring wells. Select samples were analyzed for PAHs, purgeable organics, TCLP metals, and drinking water volatiles.

The results of the analyses requested above are provided below:

- HydroPunch™ Groundwater: The highest total PAH concentrations detected were in HydroPunch™ samples HP-8 (21.4 µg/L) and HP-7 (17.3 µg/L), located upgradient of the former UST basin. Trace levels were detected in samples HP-1 (4.1 µg/L), HP-2 (2.1 µg/L), HP-4 (1.5 µg/L), HP-5 (2.7 µg/L), HP-9 (0.6 µg/L), and HP-10 (0.9 µg/L). HydroPunch™ results are presented in Table 2-1.

- Soil Borings: TPH, identified as gasoline, was detected in BB9-18 at two depths (7.5 to 10.0 feet and 22.5 to 25.0 feet) at concentrations of 16,000 and 26,000 µg/kg, respectively. No TPH-gasoline or TPH-diesel was identified in any other soil samples.

- Soil Borings: Maximum contaminant levels of purgeable aromatics were detected in soil borings BB9-7 (36.5 µg/kg) and BB9-11 (8.6 µg/kg), located north and upgradient of the former UST basin. Trace levels also were detected in BB9-4 and BB9-15 (4.5 µg/kg), BB9-12 (4.0 µg/kg), and BB9-14 (5.8 µg/kg). Soil boring locations BB9-4, BB9-12, and BB9-15 were all within the immediate vicinity of the former UST basin. Soil boring BB9-14 is located topographically downgradient from the AST pad. Soil boring results for purgeable aromatics are presented in Table 2-2.

- Monitoring Wells: Trace levels of PAH compounds were detected in monitoring wells BB9-4, BB9-5, BB9-7, and BB9-13 through BB9-18. The highest detections were interpreted to be immediately south and downgradient of the former UST basin and the active oil/water separator and in the northern portion of the area adjacent to Building BB-210. Groundwater results for PAHs are presented in Table 2-3.

- Monitoring Wells: Purgeable organics were detected below regulatory limits in monitoring well BB9-4 and BB9-5. Drinking water volatiles (purgeable organics and chlorinated organic compounds) were detected in excess of State standards in monitoring wells BB9-4, BB9-5, BB9-7, BB9-9, and BB9-12. The highest detections were immediately adjacent to and downgradient of the former UST basin and west of Building BB-210, located north and upgradient of the former UST basin. Groundwater results for purgeable organics are presented in Table 2-4. Groundwater results for drinking water volatiles are presented in Table 2-5.

- Monitoring Wells: TCLP metals which exceeded established standards were cadmium, lead, and silver in monitoring wells BB9-4, BB9-5, BB9-6, BB9-15, and BB9-16. In addition, monitoring wells BB9-5 and BB9-6 reported elevated chromium levels. Groundwater results for TCLP metals are presented in Table 2-6.

- Monitoring Wells: Trace levels of PAH compounds were detected in the Type III wells BB9-16, BB9-17, and BB9-18. Groundwater results for PAHs are presented in Table 2-3.

- No evidence or measurable thickness of free product was identified during the course of this investigation.

2.3 Site Visit

The following provides a brief description of Site 90 field observations which were noted during the site visit conducted by Baker Environmental, Inc. (Baker) from September 13 through 15, 1995. Figure 2-2 depicts the locations of the features noted during the site visit. Photographs 2-1 and 2-2 were taken during the site visit and depict the UST and surrounding area.

- The oil/water separator and the wells, installed under the previous investigations, around the UST excavation area were located. Locking caps installed on many of the wells prevented them from being opened to conduct water level measurements.

- Water levels in existing monitoring wells were measured from the top of the casing:

BB9-1	9.5 feet bgs
BB9-2	Dry (total depth of well - 8.3 feet bgs)
BB9-3	9.6 feet bgs

- The AST in Building BB-16 is no longer there. The dry cleaning facility now performs the dry cleaning process elsewhere.

- The two solvent storage ASTs north of Building BB-9 were located.

2.4 Proposed Sample Strategy

The following sampling strategy is proposed for additional sampling activities at Site 90. Soil and groundwater sampling are proposed. An investigation of the oil/water separator is recommended as a "Good Housekeeping" measure; however, the oil/water separator will not be investigated during this sampling effort. Figure 2-2 identifies the proposed sampling locations. The soil boring locations will be finalized during the field investigation based on field observations.

2.4.1 Soil Investigation

The proposed soil investigation was developed with consideration to the potential soil contaminant migration and exposure routes at Site 90. The potential soil contaminant migration route is contaminant transport to shallow groundwater via soil leaching. Potential exposed populations include current military and civilian personnel involved in the day-to-day operations and military training.

- To determine if soil is a possible source of groundwater contamination, one surface and one subsurface soil sample will be collected from three soil boring locations around the former UST.

- Surface soil samples will be collected from just below ground surface to six inches and subsurface samples will be collected just above the water table. A third sample from each soil boring also may be submitted for analysis if evidence of

contamination (i.e., visible or by monitoring instrument) is noted. Additionally, a mid-depth sample will be collected if depth to groundwater is greater than 10-feet bgs.

- Three surface soil and three subsurface soil samples will be analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and Target Analyte List (TAL) metals (Level D data quality). Ten percent (or one surface and one subsurface soil sample) will be analyzed for pesticides and polychlorinated biphenyls (PCBs). There is no reported historical use of pesticides or PCBs at this site.

- If there is visible contamination or elevated instrument readings, a single composite sample of drill cuttings will be obtained and analyzed in accordance with TCLP (including TCL PCBs) and for Resource Conservation and Recovery Act (RCRA) hazardous waste characteristics in order to assess disposal options, if necessary. Otherwise, the soil cuttings will be placed back in the borehole.

2.4.2 Groundwater Investigation

The proposed groundwater investigation was developed with consideration to the potential groundwater contaminant migration and exposure routes at Site 90. The potential groundwater migration routes include: horizontal migration of contaminants confined within the shallow groundwater zone and vertical contaminant migration from shallow groundwater to deeper groundwater zones.

- Redevelop select existing shallow and intermediate monitoring wells which are to be resampled.

- Resample nine existing shallow (Type II) monitoring wells (BB9-4, BB9-5, BB9-7, BB9-9, BB9-10, BB9-12, BB9-13, BB9-14, and BB9-15) upgradient, sidegradient, and downgradient of the UST basin to confirm groundwater flow direction and to determine the extent of horizontal contaminant migration. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Resample three existing intermediate monitoring wells (BB9-16, BB9-17, and BB9-18) to determine the extent of vertical contaminant migration. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Two rounds of groundwater samples will be collected from the 12 existing Site 90 monitoring wells under the Remedial Investigation/Feasibility Study (RI/FS). The first round of groundwater samples will be collected during the initial investigation. The second round of groundwater samples will be collected four months after the initial samples were collected.

- All groundwater samples will be analyzed for TCL VOCs, SVOCs, TAL total metals (Level D data quality), and total dissolved solids/total suspended solids (TDS/TSS). Ten percent (or two groundwater samples) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- Groundwater measurements will be taken to confirm groundwater flow direction.

- A single composite sample of purge/development water will be obtained and analyzed for full TCL (VOCs, SVOCs, Pesticides/PCBs), TAL metals, and TSS/TDS in order to assess disposal options.

2.4.3 Oil/Water Separator Investigation

The proposed oil/water separator investigation was developed with consideration to the potential contaminants which may be impacting the soil or groundwater due to the lack of maintenance of the separator.

- Oil/water separator: Determine drainage paths into and out of the oil/water separator, flow rates (how often water is discharged into the oil/water separators and flow through separators), and review as-builts of oil/water separator.

This investigation is recommended as a "Good Housekeeping" measure. The oil/water separator will not be investigated during this sampling effort.

TABLES

TABLE 2-1

HYDROPUNCH GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR POLYNUCLEAR AROMATIC HYDROCARBONS
OPERABLE UNIT NO. 16 (SITE 90)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	HP-1	HP-2	HP-2 DUP	HP-3	HP-4	HP-5	HP-6	HP-7	HP-8	HP-9	HP-10	HP-11	HP-12
Napthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**10.0**	BQL	BDL	BDL	BDL	BDL
Acenaphthylene	BDL	**1.0**	BDL	BDL	BDL	BDL	BDL	BQL	BDL	BDL	BDL	BDL	BDL
Acenaphthene	**3.0**	BDL	BDL	BDL	**1.5**	**2.7**	BDL	**4.2**	**3.2**	**0.6**	**0.9**	BDL	BDL
Phenanthrene	**1.1**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BQL	**1.5**	BDL	BDL	BDL	BDL
Fluoranthene	BDL	**1.1**	**2.0**	BDL	BDL	BDL	BDL	**0.6**	**1.3**	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BQL	**2.3**	BDL	BDL	BDL	BDL
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**2.5**	**10.0**	BDL	BDL	BDL	BDL
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**4.1**	BDL	BDL	BDL	BDL
All Others	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Totals	**4.1**	**2.1**	**2.0**	BDL	**1.5**	**2.7**	BDL	**17.3**	**21.4**	**0.6**	**0.9**	BDL	BDL

BDL - Below Detection Limit
BQL - Below Quantitation Limit
Concentrations expressed in µg/L (ppb)
Shaded areas indicate non compliant concentrations

TABLE 2-2

SOIL SAMPLE ANALYTICAL RESULTS
FOR PURGEABLE AROMATICS
OPERABLE UNIT NO. 16 (SITE 90)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	BB9-4	BB9-5	BB9-7	BB9-8	BB9-9	BB9-10	BB9-11	BB9-12	BB9-13	BB9-14	BB9-15
1,1,1-Trichloroethane	BQL	BQL	BQL	BQL	BQL	BQL	**4.5**	**4.0**	BQL	**5.8**	**4.5**
Toluene	BQL	BQL	**3.5**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Tetrachloroethene	BQL	BQL	BQL	BQL	BQL	BQL	**4.1**	BQL	BQL	BQL	BQL
Ethylbenzene	BQL	BQL	**4.2**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
m,p-Xylene	BQL	BQL	**9.8**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
o-Xylene/Stryene	BQL	BQL	**7.0**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
n-Propylbenzene	BQL	BQL	**1.9**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,3,5-Trimethylbenzene	BQL	BQL	**3.0**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
1,2,4-Trimethylbenzene	BQL	BQL	**7.1**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Napthalene	**4.5**	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
All Others	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
Total	**4.5**	BQL	**36.5**	BQL	BQL	BQL	**8.6**	**4.0**	BQL	**5.8**	**4.5**

BQL - Below Quantitation Limit
Concentrations expressed in µg/kg (ppb)

TABLE 2-3

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS FOR POLYNUCLEAR AROMATIC HYDROCARBONS OPERABLE UNIT NO. 16 (SITE 90) CTO 0344 MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB9-4	BB9-5	BB9-6	BB9-7	BB9-8	BB9-9	BB9-10	BB9-11	BB9-12	BB9-13	BB9-14	BB9-15	BB9-16	BB9-17	BB9-18
Napthalene	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**2.3**	**1.1**	0.8
Acenaphthene	--	80	**1.9**	**2.1**	BDL	**7.9**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	--	--	0.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	--	2,100	BQL	**1.7**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluorathene	--	--	**2.2**	BQL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	--	--	**0.9**	BQL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**3.0**	**3.3**	**4.0**	BDL	BDL	**15.0**
Benzo(a)anthracene	--	0.05	**2.6**	**1.6**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	--	5	**1.1**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
All Others	--	--	BDL/BQL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total			**9.5**	**5.4**	BDL	**7.9**	BDL	BDL	BDL	BDL	BDL	**3.0**	**3.3**	**4.0**	**2.3**	**1.1**	**15.8**

-- - No Published Standard
BDL - Below Detection Limit
BQL - Below Quantitation Limit
Concentrations expressed in µg/L (ppb)
Shaded areas indicate non compliant concentrations

TABLE 2-4

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR PURGEABLE ORGANICS
OPERABLE UNIT NO. 16 (SITE 90)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB9-4	BB9-5	BB9-7	BB9-9	BB9-13	BB9-14
Benzene	5	1	**0.6**	**0.6**	BDL	BDL	BDL	BDL
Toluene	1,000	1,000	**0.6**	BQL	BDL	BDL	BDL	BDL
All others	--	--	BDL	BDL	BDL	BDL	BDL	BDL
Total			**1.2**	**0.6**	BDL	BDL	BDL	BDL

-- - No Published Standard
BDL - Below Detection Limit
BQL - Below Quantitation Limit
Wells BB9-6, BB9-8, BB9-10, BB9-11, BB9-12, BB9-15, BB9-16, BB9-17, and BB9-18 not sampled.
Concentrations are expressed in µg/L (ppb)

TABLE 2-5

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR DRINKING WATER VOLATILES
OPERABLE UNIT NO. 16 (SITE 90)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB9-4	BB9-5	BB9-6	BB9-7	BB9-8	BB9-9	BB9-10	BB9-11	BB9-12	BB9-13	BB9-14	BB9-15
Chromomethane	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**16.0**
Bromomethane	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**1.6**
Chloroform	80	0.19	**5.9**	**7.0**	BDL	BDL	BDL	**1.9**	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	200	200	**2.2**	BDL	**1.5**	BDL	BDL	BDL	**2.0**	BDL	BDL	BDL	BDL	BDL
Bromodichloromethane	80	--	**2.8**	**4.4**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibromochloromethane	80	--	BDL	**2.3**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzene	5	1	**2.2**	**2.2**	BDL	**1.7**	BDL	**2.5**	BDL	BDL	**2.1**	BDL	BDL	BDL
m,p-Xylenes	10,000	530	BDL	BDL	BDL	BDL	BDL	BDL	**1.8**	BDL	BDL	BDL	BDL	BDL
1,2,3-Trichloropropane	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**3.6**	BDL
n-Propylbenzene	--	--	**3.0**	**4.5**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
sec-Butylbenzene	--	--	**2.8**	**2.6**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	--	21	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**13.0**
All others	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total			**18.9**	**23.0**	**1.5**	**1.7**	BDL	**4.4**	**3.8**	BDL	**2.1**	BDL	**3.6**	**30.6**

-- - No Published Standard
BDL - Below Detection Limits
BQL - Below Quantitation Limits
Concentrations are expressed in µg/L (ppb)
Shaded areas indicate non compliant concentrations

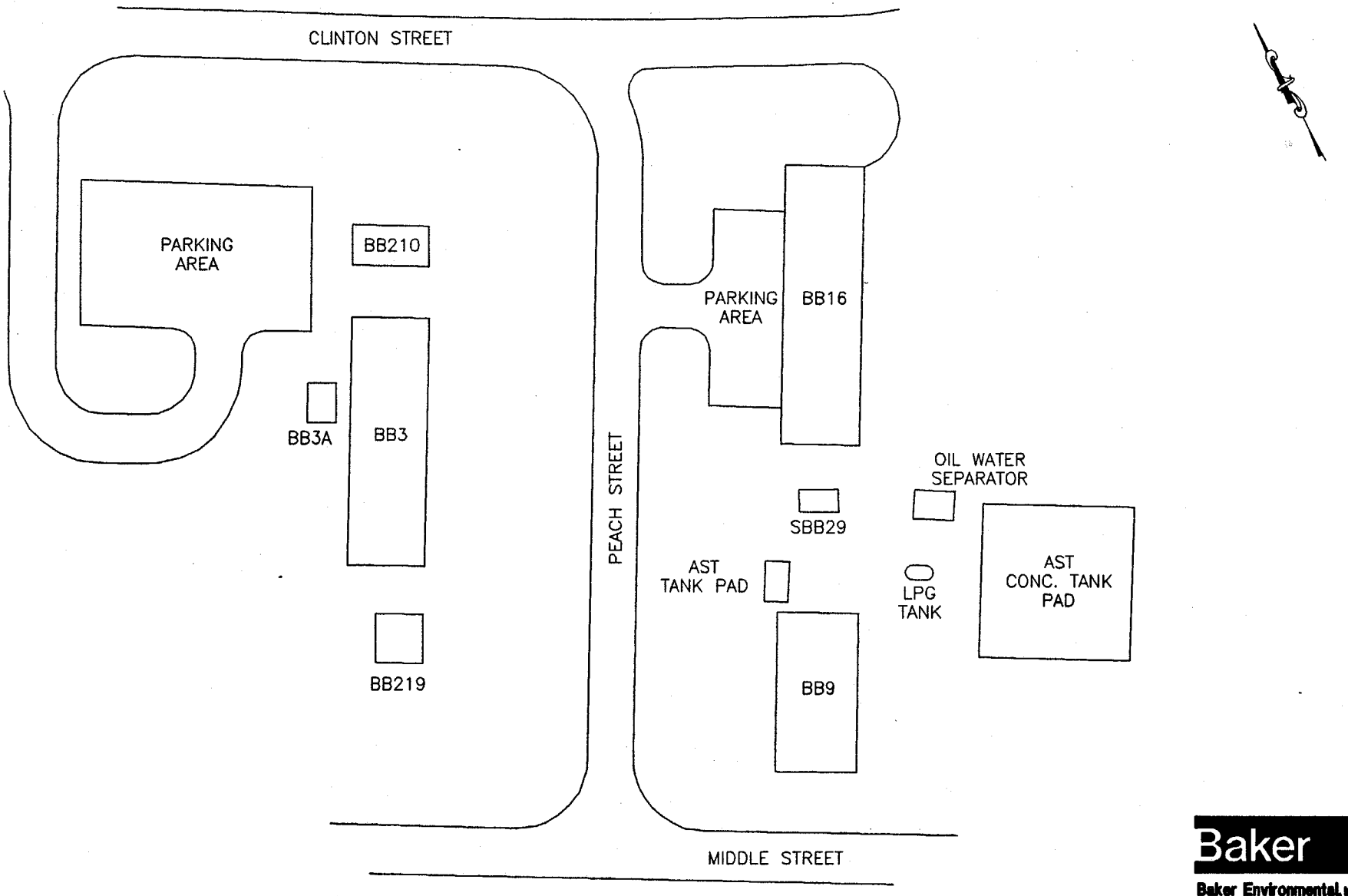
TABLE 2-6

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR TCLP METALS
OPERABLE UNIT NO. 16 (SITE 90)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB9-4	BB9-5	BB9-6	BB9-15	BB9-16
Arsenic	50	50	BQL	BQL	BQL	BQL	BQL
Barium	2,000	2,000	**98**	**281**	**147**	BQL	95
Cadmium	5	5	**45**	**69**	**59**	**36**	**104**
Chromium	100	50	BQL	**97**	**55**	BQL	**42**
Lead	15*	15	**133**	**169**	**121**	**69**	**221**
Mercury	2	1.1	**1**	BQL	BQL	**1**	BQL
Selenium	50	50	BQL	BDL	BDL	BQL	BDL
Silver	--	18	**132**	**237**	**143**	**191**	**204**

BDL - Below Detection Limit
BQL - Below Quantitation Limit
Concentrations are expressed in µg/L (ppm)
Shaded areas indicate non compliant concentrations
* Action level

FIGURES



Baker

Baker Environmental, Inc.

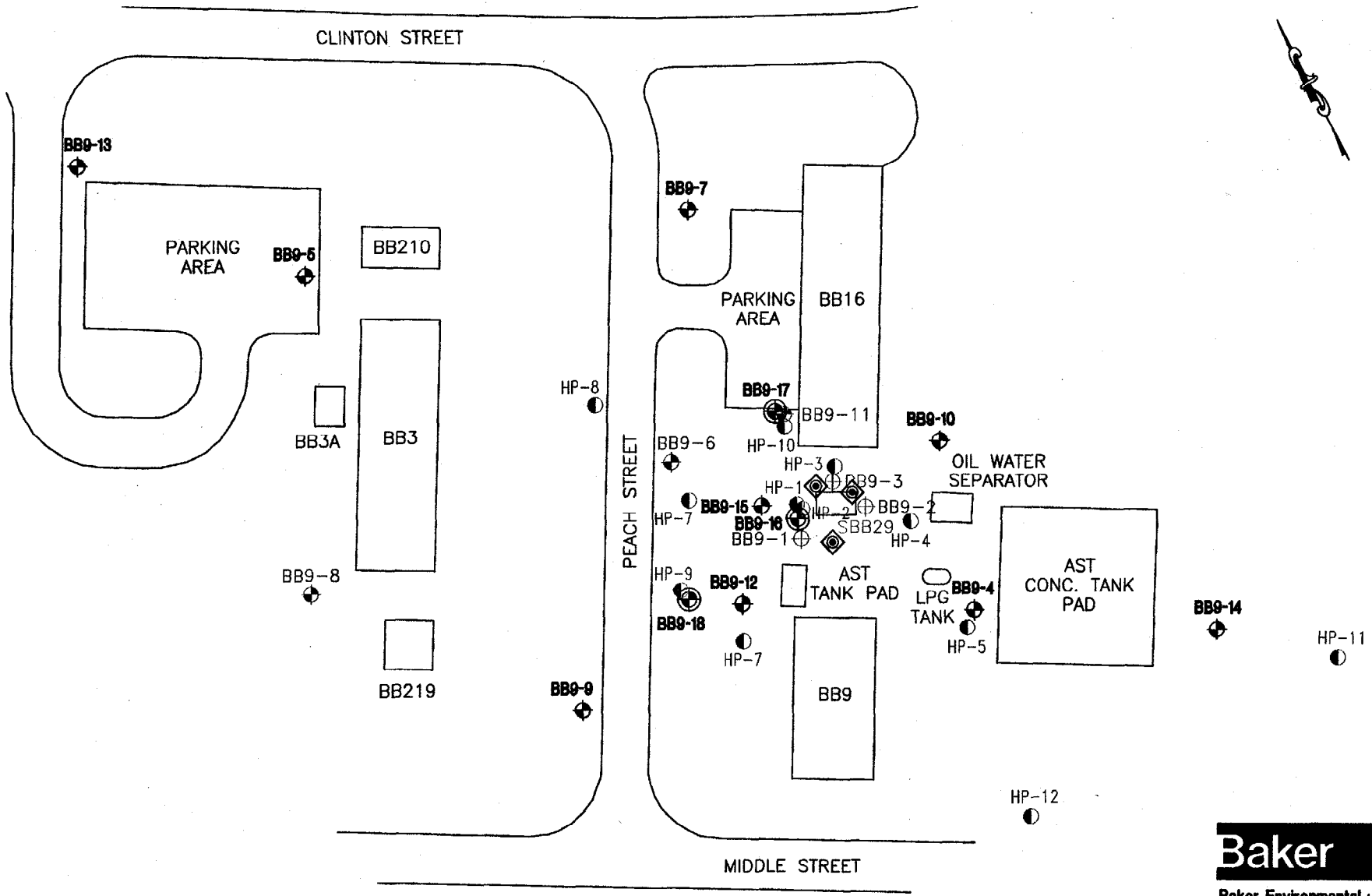
LEGEND

- BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

FIGURE 2-1
SITE 90 (BB9)
LOCATION MAP
SAMPLE STRATEGY PLAN CTO-344
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

344003



Baker

Baker Environmental, Inc.

LEGEND

- ◆ – EXISTING TYPE II WELL
- ⊕ – PRE-EXISTING TYPE II WELL
- ◉ – EXISTING TYPE III WELL
- ◐ – EXISTING HYDROPUNCH
- ◈ – PROPOSED SOIL BORING
- BB9-9 – EXISTING WELLS TO BE RESAMPLED
- ▭ – BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

FIGURE 2-2
SITE 90 (BB9)
EXISTING AND PROPOSED SAMPLING LOCATIONS
SAMPLE STRATEGY PLAN CTO-344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

344004

PHOTOGRAPHS

Photograph 2-1. Site 90, Building BB-16 (foreground), UST excavation area, and Building BB-9 (background), looking south.

Photograph 2-2. Site 90, Oil/water separator (foreground), UST excavation area, and Building BB-9 (background), looking southwest.

01707P02Y

3.0 SITE 91 (BB-51)

Site 91, the two former USTs associated with Building BB-51, is located at the northern dead end of Clinton Street northeast of Building BB-51 in the Courthouse Bay area of MCB Camp Lejeune (Figure 3-1). Building BB-51 is an instruction building for the Marine Corps Engineering School. Two USTs, both constructed of steel with a 300-gallon capacity, were reportedly used to store waste oil at the facility. The tanks were located in an unpaved area on the edge of the treeline, approximately 200 feet east of Building BB-51. Much of the area around Building BB-51 is unpaved and wooded. The New River is the nearest surface water body, located approximately 2,975 feet south-southwest of Building BB-51. The nearest known water supply well (BB-44) is located approximately 1,275 feet northwest of the site.

3.1 Site History

Building BB-51 was constructed, and is currently used, as an instruction building for the Marine Corps Engineering School. Northeast of the building were two 300-gallon steel USTs, used to store waste oil at the facility. The tanks were excavated and removed in August 1992. No information was available about the age or condition of the tanks at removal. Soil samples collected during the UST closure were analyzed and revealed concentrations of TPH-oil and grease. The former tank basin is now grass covered. There is a vehicle storage area west of the former UST basin and directly north of Building BB-51. A bermed petroleum, oil, and lubricants area is located 300 feet north of Building BB-51 and northwest of the former UST basin. An active lube-oil drum storage pad is located approximately 250 feet north of Building BB-51 and west of the former UST basin. An active vehicle/equipment wash pad is located approximately 170 feet north-northwest of Building BB-51 and west of the former UST basin. An active temporary storage area of hazardous/potentially hazardous materials is located west of the former UST basin and north-east of Building BB-51.

3.2 Previous Investigations

As a follow-up to the tank removals, a three well site check was conducted in April 1993 by Groundwater Technology Government Services, Inc., to identify and/or verify the suspected hydrocarbon impact in the subsurface soil and groundwater. The activities included:

- Installing three shallow monitoring wells (BB51-1 through BB51-3) around the former UST basin in April 1993. The wells were approximately 20 feet bgs. Groundwater was approximately 9 to 11 feet bgs. Figure 3-2 presents the monitoring well locations.

- TPH analysis of the three soil samples, one from each soil boring, revealed TPH concentrations ranging from 45,000 to 2,500,000 µg/kg of total oil and grease. There were no detectable concentrations of TPH-gasoline, diesel, lubricating oil, mineral spirits, kerosene, or fuel oil #6 reported.

- Analyzing groundwater samples for BTEX revealed a maximum concentration of 0.5 µg/L toluene. No free phase product was noted in any of the wells.

A leaking underground storage tank comprehensive site assessment for Site 91 was conducted in September 1994 by Richard Catlin & Associates, Inc. to determine site subsurface characteristics and the extent of impact to subsurface soil and groundwater. The work performed included:

- Utilizing 10 HydroPunch™ penetrometers (HP-1 through HP-10) to provide preliminary data to assist with the location of the permanent monitoring wells. The HydroPunch™ samples were analyzed for PAHs. Figure 3-2 presents the HydroPunch™ locations.

- Advancing fifteen soil borings to install 12 Type II (BB51-4 through BB51-15) and three Type III (BB51-16 through BB51-18) monitoring wells to determine the horizontal and vertical extent of petrochemical contamination in the former UST area. Figure 3-2 presents the monitoring well locations. Designated soil boring samples were analyzed for oil and grease, TCLP organics and metals, flashpoint, purgeable aromatics, and soil pH.

- Collecting 15 groundwater samples from the newly installed monitoring wells. Select samples were analyzed for PAHs, purgeable organics, TCLP metals, and drinking water volatiles.

The results of the analyses requested above are provided below:

- HydroPunch™ Groundwater: The only PAH concentration detected was chrysene in HydroPunch™ sample HP-5 (1.2 µg/L). Sample HP-5 is located approximately 50 feet southwest of the UST basin.

- Soil Borings: Oil and grease was identified in all but three of the soil boring samples analyzed (BB51-12, BB51-14, and BB51-15); however, only two of the concentrations reported were above regulatory levels. Sample BB51-12 (10 to 12 feet bgs) and BB51-16 (2.5 to 5 feet bgs) had detections of 460,000 µg/kg and 430,000 µg/kg, respectively. Two areas of oil and grease contaminated soil were identified in the subsurface within the area of investigation. The first area appears to be the vadose zone in and immediately surrounding the former UST basin. The second area was identified south of the former UST basin. Soil boring results for oil and grease are presented in Table 3-1.

- Soil Borings: Total purgeable aromatics were detected in all the soil borings. The majority of the compounds were detected in the 2 to 4 feet bgs and 10 to 12 foot bgs intervals, indicating a surface release. Soil boring results for purgeable aromatic results are presented in Table 3-2.

- Monitoring Wells: Trace levels of drinking water volatiles, cadmium, silver, and arsenic were detected in concentrations above the established State standards. However, no definite petrochemical plume within the vicinity of the former UST basin was identified. PAHs did not exceed established State standards. Groundwater results for: drinking water volatiles are presented in Table 3-3; PAHs are presented in Table 3-4; and TCLP metals are presented in Table 3-5.

- No evidence or measurable thickness of free product was identified during the course of this investigation.

3.3 Site Visit

The following provides a brief description of Site 91 field observations which were noted during the site visit conducted by Baker from September 13 through 15, 1995. Figure 3-2 depicts the locations of the features noted during the site visit. Photographs 3-1, 3-2, and 3-3 were taken during the site visit and depict the UST location, downgradient of the UST location, and Buildings BB-51 and BB-150.

- The wells, installed under the previous investigations ,around the UST excavation area were located. Locking caps installed on many of the wells prevented them from being opened to conduct water level measurements.

- Water levels in select existing monitoring wells were measured from the top of the casing:

BB51-3	9.0 feet bgs
BB51-11	14.7 feet bgs
BB51-12	11.9 feet bgs
BB51-18	30.3 feet bgs

- When the concrete pad under and east of Building BB-150 was replaced, it was reported that the soil was discolored and had a oily odor.

3.4 Proposed Sample Strategy

The following sampling strategy is proposed for additional sampling activities at Site 91. Figure 3-2 identifies the proposed sampling locations. The soil borings and shallow monitoring well locations will be finalized during the field investigation based on field observations.

3.4.1 Soil Investigation

The proposed soil investigation was developed with consideration to the potential soil contaminant migration and exposure routes at Site 91. The potential soil contaminant migration routes include: wind blown contaminated dust particles and contaminant transport to shallow groundwater via soil

leaching. Potential exposed populations include current military and civilian personnel involved in the day-to-day operations and military training.

- To determine if soil is a possible source of groundwater contamination, one surface and one subsurface soil sample will be collected from three soil boring locations around the former UST.

- To determine if another possible source of the groundwater contamination exists and to determine if there is overland surface contamination such as surface release, one surface and one subsurface soil sample will be collected from 17 soil boring locations in the site area. Two of these soil borings will be converted to shallow monitoring wells to determine if these areas are possibly source areas.

- Surface soil samples will be collected from just below ground surface to six inches and subsurface samples will be collected just above the water table. A third sample from each soil boring also may be submitted for analysis if evidence of contamination (i.e., visible or by monitoring instrument) is noted. Additionally, a mid-depth sample will be collected if depth to groundwater is greater than 10-feet bgs.

- Twenty surface soil and 20 subsurface soil samples will be analyzed for TCL VOCs, SVOCs, and TAL metals (Level D data quality). Ten percent (or two surface and two subsurface soil samples) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- If there is visible contamination or elevated instrument readings, a single composite sample of drill cuttings will be obtained and analyzed in accordance with TCLP (including TCL PCBs) and for RCRA hazardous waste characteristics in order to assess disposal options, if necessary. Otherwise, the soil cuttings will be placed back in the borehole.

3.4.2 Groundwater Investigation

The proposed groundwater investigation was developed with consideration to the potential groundwater contaminant migration and exposure routes at Site 91. The potential groundwater migration routes include: horizontal migration of contaminants confined within the shallow groundwater zone and vertical contaminant migration from shallow groundwater to deeper groundwater zones.

- Redevelop 6 existing shallow and 3 existing intermediate monitoring wells which are to be resampled.

- Install two shallow (Type II) monitoring wells (BB51-19 and BB51-20) upgradient and sidegradient of the former UST basin to confirm groundwater flow direction and to determine the extent of horizontal contaminant migration. The two shallow monitoring wells will be a flush-mount construction. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Resample six shallow (Type II) monitoring wells (BB51-6, BB51-8, BB51-9, BB51-10, BB51-11, BB51-12) upgradient, sidegradient, and downgradient of the UST basin area to determine the extent of horizontal contaminant migration. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Resample three intermediate monitoring wells (BB51-16, BB51-17, and BB51-18) to determine the extent of vertical contaminant migration. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Two rounds of groundwater samples will be collected from the nine existing and two newly installed Site 91 monitoring wells under the RI/FS. The first round of groundwater samples will be collected during the initial investigation. The second round of groundwater samples will be collected four months after the initial samples were collected.

- All groundwater samples will be analyzed for TCL VOCs, SVOCs, TAL total metals (Level D data quality), and TDS/TSS. Ten percent (or two groundwater samples) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- Groundwater measurements will be taken to confirm groundwater flow direction.

- A single composite sample of purge/development water will be obtained and analyzed for full TCL (VOCs, SVOCs, Pesticides/PCBs), TAL metals, and TSS/TDS in order to assess disposal options.

Type II shallow monitoring wells will be installed within the surficial aquifer at an estimated depth of 5 to 25 feet bgs. The Type II intermediate monitoring well will be installed at a depth of approximately 40 feet bgs. The bottom of the intermediate monitoring well will be placed at the top of the semi-confining layer.

TABLES

TABLE 3-1

**SOIL SAMPLE ANALYTICAL RESULTS
FOR OIL AND GREASE, FLASHPOINT, AND pH
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA**

Sample ID	Sample Depth (ft)	Laboratory Results		
		Oil and Grease 9071 (µg/kg)	Flashpoint (Degree C)	pH
BB51-4	2-4	120,000	NA	NA
	2-4 DUP	7,000	NA	NA
	10-12	110,000	NA	NA
BB51-5	2-4	130,000	NA	NA
	10-12	240,000	NA	NA
BB51-6	2-4	7,000	NA	NA
	10-12	29,000	NA	NA
BB51-7	2-4	54,000	NA	NA
	10-12	29,000	NA	NA
BB51-8	2-4	32,000	NA	NA
	10-12	54,000	>97	8.68
BB51-9	2-4	94,000	NA	NA
	10-12	7,000	>97	8.40
BB51-10	2-4	46,000	NA	NA
	10-12	46,000	>97	8.48
BB51-11	2-4	33,000	NA	NA
	10-12	7,000	>97	8.11
BB51-12	2-4	BDL	NA	NA
	2-4 DUP	110,000	NA	NA
	10-12	**460,000**	>97	7.03
BB51-13	2-4	47,000	NA	NA
	10-12	110,000	>97	6.76

TABLE 3-1 (Continued)

**SOIL SAMPLE ANALYTICAL RESULTS
FOR OIL AND GREASE, FLASHPOINT, AND pH
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA**

Sample ID	Sample Depth (ft)	Laboratory Results		
		Oil and Grease 9071 (µg/kg)	Flashpoint (Degree C)	pH
BB51-14	2-4	BDL	NA	NA
	10-12	140,000	>97	8.30
BB51-15	2-4	8,000	NA	NA
	10-12	BDL	>97	8.66
BB51-16	2.5-5.0	430,000	NA	NA
	10-12.5	NA	>97	7.04
	37.5-40	10,000	NA	NA
BB51-17	2.5-5.0	86,000	NA	NA
	10-12.5	NA	>97	7.06
	37.5-40	44,000	NA	NA
BB51-18	2.5-5.0	57,000	NA	NA
	37.5-40	95,000	NA	NA

NA - Not Analyzed
BDL - Below Detection Limits
BQL - Below Quantitation Limits
Concentrations are expressed in µg/kg (ppm), except as noted
Shaded areas indicate non compliant concentrations

TABLE 3-2

SOIL SAMPLE ANALYTICAL RESULTS
FOR PURGEABLE AROMATICS
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	BB51-11 (2-4)	BB51-11 (10-12)	BB51-12 (2-4)	BB51-12 (2-4 DUP)	BB51-12 (10-12)	BB51-13 (2-4)	BB51-13 (10-12)	BB51-14 (2-4)	BB51-14 (10-12)	BB51-15 (2-4)	BB51-15 (10-12)	BB51-17 (2.5-5.0)
1,1-Dichloroethene	BDL	BDL	**1.8**	**2.1**	**5.7**	**2.7**	**3.1**	**2.1**	**4.8**	BDL	BDL	**4.1**
1,1,2-Dichloroethene	**0.6**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,1-Dichloroethane	**1.5**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2,2-Dichloropropane	**3.0**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	**1.8**	**1.0**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzene	**0.8**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Trichloroethene	**1.7**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2-Dichloropropane	**1.4**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibromomethane	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**2.1**	BDL	BDL	BDL
Toluene	**3.2**	**1.0**	BDL	**0.8**	BDL	BDL	BDL	**0.9**	**2.4**	**1.0**	**0.7**	BDL
1,1,2-Trichloroethane	**0.9**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	**1.3**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.8**	BDL	BDL	BDL
1,1,1,2-Tetrachloroethane	**1.2**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
m,p-Xylene	**4.3**	**1.2**	BDL	BDL	BDL	BDL	BDL	**0.9**	**4.4**	**1.9**	**0.7**	BDL
o-Xylene	**2.8**	**1.4**	BDL	BDL	BDL	**0.8**	BDL	**1.3**	**2.2**	**1.4**	**1.2**	BDL
Isopropylbenzene	**0.6**	BDL	**4.4**	**5.2**	BDL	**0.7**	BDL	**10**	BDL	BDL	BDL	BDL
1,1,2,2-Tetrachloroethane	**2.8**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
n-Propylbenzene	**0.8**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,3,5-Trimethylbenzene	**1.3**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Chlorotoluene	**1.0**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,2,4-Trimethylbenzene	**5.4**	**2.1**	**0.8**	**1.2**	BDL	BDL	BDL	**1.1**	**8.2**	**5.7**	**1.8**	**2.1**
sec-Butylbenzene	**0.7**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,4-dichlorobenzene	**0.8**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
n-Butylbenzene	**0.9**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

TABLE 3-2 (Continued)

SOIL SAMPLE ANALYTICAL RESULTS
FOR PURGEABLE AROMATICS
OPERABLE UNIT NO. 16 (SITE 91)
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	BB51-11 (2-4)	BB51-11 (10-12)	BB51-12 (2-4)	BB51-12 (2-4 DUP)	BB51-12 (10-12)	BB51-13 (2-4)	BB51-13 (10-12)	BB51-14 (2-4)	BB51-14 (10-12)	BB51-15 (2-4)	BB51-15 (10-12)	BB51-17 (2.5-5.0)
Naphthalene	**1.3**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chloroform	**1.0**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
p-Isopropyltoluene	BDL	BDL	**18**	**1.6**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Hexachlorobutadiene	BDL	BDL	BDL	BDL	**0.6**	BDL	BDL	BDL	BDL	BDL	BDL	BDL
All others	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total	**41.1**	**6.7**	**25**	**10.9**	**6.3**	**4.2**	**3.1**	**16.3**	**24.9**	**10.0**	**4.4**	**6.2**

BDL - Below Detection Limits
Concentrations are expressed in µg/kg (ppb)

TABLE 3-3

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR DRINKING WATER VOLATILES
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB51-3	BB51-4	BB51-5	BB51-6	BB51-7	BB51-8	BB51-9	BB51-10	BB51-11	BB51-12	BB51-13	BB51-14	BB51-15
Chloroform	80	0.19	0.7	2.9	0.8	1.2	1.5	4.6	3.0	BDL	0.9	7.5	BDL	0.5	0.9
1,1,1-Trichloroethane	200	200	BDL	BDL	BDL	1.2	BDL	1.6	2.0	BDL	1.2	2.1	BDL	1.2	1.6
1,1-Dichloroethane	--	--	BDL	BDL	BDL	BDL	1.1	BDL	1.9	BDL	4.6	1.9	BDL	BDL	BDL
Bromochloromethane	--	--	BDL	BDL	BDL	BDL	BDL	1.5	0.8	BDL	BDL	BDL	BDL	BDL	BDL
Benzene	5	1	BDL	BDL	BDL	BDL	BDL	1.1	0.6	BDL	BDL	BDL	BDL	BDL	BDL
Dibromomethane	--	--	BDL	BDL	BDL	BDL	2.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Toluene	1,000	1,000	BDL	BDL	BDL	0.8	0.5	5.7	2.7	1.3	3.6	3.9	BDL	2.3	2.9
Ethylbenzene	700	29	BDL	BDL	BDL	BDL	BDL	1.4	1.1	BDL	BDL	BDL	BDL	BDL	BDL
m,p-Xylene	10,000	530	BDL	BDL	BDL	BDL	BDL	7.8	7.9	BDL	3.2	4.7	BDL	3.1	12
o-Xylene	10,000	--	BDL	BDL	BDL	BDL	BDL	3.6	3.4	BDL	1.2	2.7	BDL	1.0	4.5
Isopropylbenzene	--	--	BDL	BDL	BDL	1.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,3,5-Trimethylbenzene	--	--	BDL	BDL	BDL	BDL	BDL	1.6	1.3	BDL	BDL	BDL	BDL	BDL	0.8
1,2,4-Trimethylbenzene	--	--	0.8	BDL	BDL	3.0	1.8	21	20	1.8	5.8	2.8	0.9	11	19
1,2,4-Trichlorobenzene	70	--	BDL	0.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	--	--	BDL	BDL	BDL	1.3	BDL	3.4	6.3	1.3	BDL	BDL	BDL	17	36
tert-Butylbenzene	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.8	BDL	BDL	BDL	BDL	BDL
p,Isopropyltoluene	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.6	BDL	BDL	BDL
All others	--	--	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total			1.50	3.40	0.80	9.00	7.00	53.30	50.80	5.20	20.50	26.20	0.90	20.80	45.30

-- - No Published Standard
BDL - Below Detection Limits
BQL - Below Quantitation Limits
Concentrations are expressed in µg/L (ppb)
Shaded Areas indicate non compliant concentrations

TABLE 3-4

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR POLYNUCLEAR AROMATIC HYDROCARBONS
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	BB51-3	BB51-4	BB51-5	BB51-5DUP	BB51-6	BB51-7	BB51-8	BB51-9	BB51-10	BB51-11	BB51-12	BB51-13	BB51-14	BB51-15	BB51-16	BB51-17	BB51-18
Fluorene	BQL	BQL	BDL	BDL	BDL	1.0	1.2	0.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BQL	BQL	3.6	1.7	BDL	BQL	BQL	BQL	4.8	2.4	3.8	22	5.4	3.4	BDL	BDL	BQL
Phenanthrene	BQL	BQL	BDL	BDL	BDL	BQL	BQL	BQL	BQL	BQL	BDL	BDL	BDL	BDL	1.8	2.4	BQL
Indeno(1,2,3-cd)pyrene	BQL	BQL	BDL	BDL	BDL	BQL	BQL	BQL	BQL	BQL	5.6	BDL	BDL	BDL	1.6	BDL	BQL
All others	BQL	BQL	BDL	BDL	BDL	BQL	BQL	BQL	BQL	BQL	BDL	BDL	BDL	BDL	BDL	5.4	BQL
Total	BQL	BQL	3.6	1.7	BDL	1.0	1.2	0.9	4.8	2.4	9.4	22.0	5.4	3.4	3.4	7.8	BQL

BDL - Below Detection Limits
BQL - Below Quantitation Limits
Concentrations are expressed in µg/L (ppb)

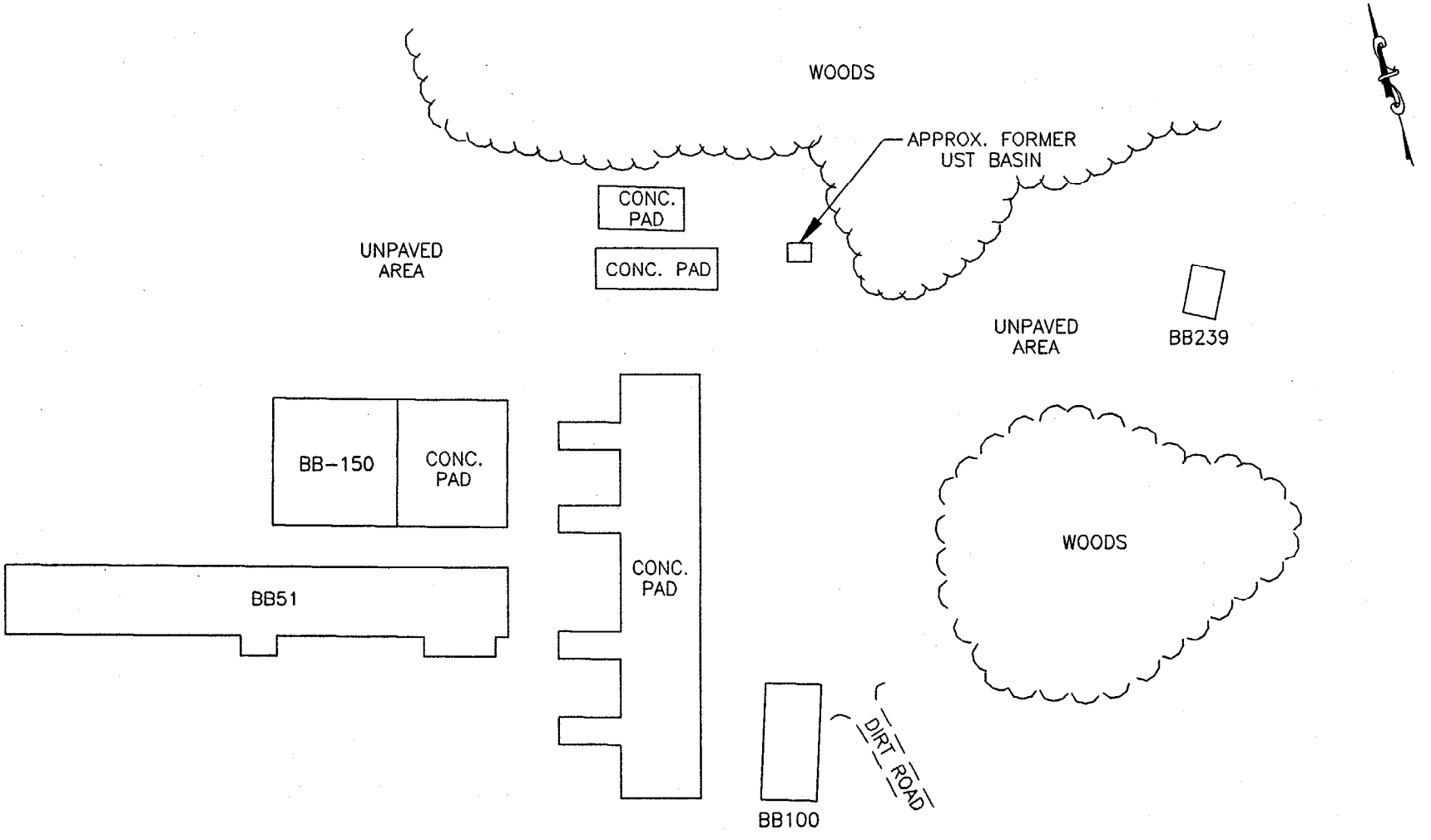
TABLE 3-5

MONITORING WELL GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR TCLP METALS
OPERABLE UNIT NO. 16 (SITE 91)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	Federal MCL	North Carolina	BB51-4	BB51-6	BB51-7	BB51-8	BB51-9
Arsenic	50	50	BQL	BQL	BQL	**62**	BQL
Barium	2,000	2,000	BQL	BQL	BQL	BQL	BQL
Cadmium	5	5	**44**	**37**	**34**	**34**	**23**
Chromium	100	50	BQL	BQL	BQL	BQL	BQL
Lead	15*	15	BQL	BQL	BQL	BQL	BDL
Mercury	2	1.1	BQL	BQL	BQL	BQL	BQL
Selenium	50	50	BQL	BQL	BQL	BQL	BDL
Silver	--	18	**66**	**89**	**62**	**61**	**64**
Totals			**0.110**	**0.126**	**0.096**	**0.157**	**0.087**

BDL - Below Detection Limit
BQL - Below Quantitation Limit
Concentrations are expressed in µg/L (ppm)
Shaded areas indicate non compliant concentrations.
* Action Level

FIGURES



Baker

Baker Environmental, Inc.

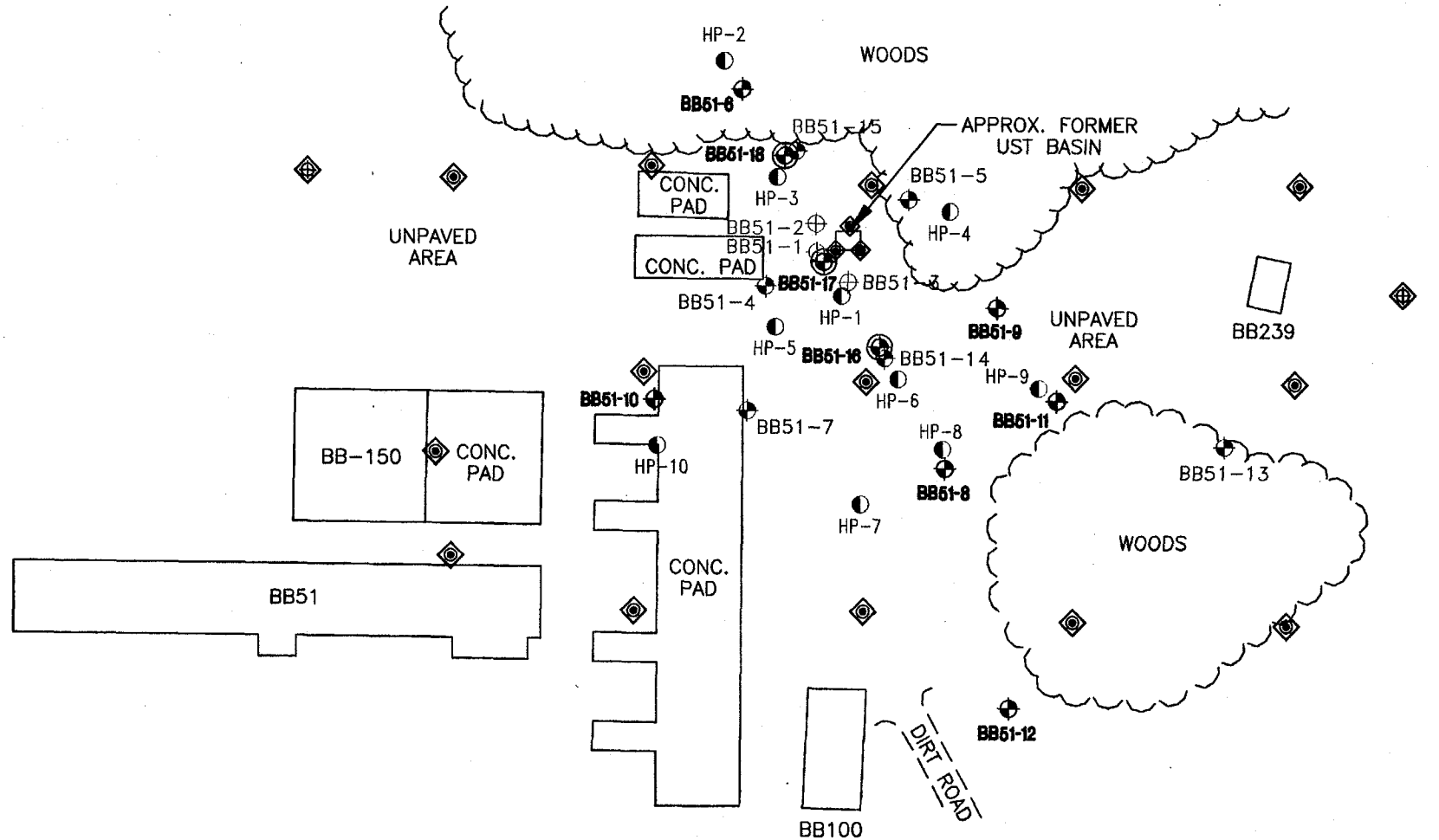
LEGEND

- TREELINE
- BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

FIGURE 3-1
SITE 91 (BB-51)
LOCATION MAP
SAMPLE STRATEGY PLAN CTO-344
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

344005



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LEGEND

- EXISTING TYPE II WELL
- PRE-EXISTING TYPE II WELL
- EXISTING TYPE III WELL
- EXISTING HYDROPUNCH
- BB9-9 – EXISTING WELLS TO BE RESAMPLED
- PROPOSED SOIL BORING
- PROPOSED SHALLOW WELL
- TREELINE
- BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

344006

FIGURE 3-2
SITE 91 (BB-51)
EXISTING AND PROPOSED SAMPLING LOCATIONS
SAMPLE STRATEGY PLAN CTO-344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

PHOTOGRAPHS

Photograph 3-1. Site 91, Buildings BB-150 and BB-51, looking west.

01707P03Y

Photograph 3-2. Site 91, UST excavation area, looking north.

Photograph 3-3. Site 91, UST excavation area and drainage from site, looking north.

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4.0 SITE 92 (BB-46)

Site 92, the UST for Building BB-46, is located at the end of Front Street in the Courthouse Bay area of MCB Camp Lejeune (Figure 4-1). Building BB-46 has been dismantled. Building BB-246 has been constructed nearby to replace Building BB-46. One steel 1,000-gallon UST, used to store regular gasoline for retail use, was located northwest of Building BB-46. A playground is located 100 feet west to southwest from the former UST basin. A metal storage shed, used to store 5-gallon gas cans, is located 10 feet northwest from the former UST basin. The site is directly adjacent to Courthouse Bay. The nearest known supply well (BB-45) is located approximately 2,350 feet southeast of the site.

4.1 Site History

Building BB-46, which was used as a boat house, has been replaced by Building BB-246. A concrete pad, in the vicinity of where Building BB-46 was located, is now used as a covered picnic area. Northwest of Building BB-46 and north of Building BB-246, one 1,000-gallon steel UST was used to store regular gasoline for retail use. The UST was installed in 1980, deactivated in 1989, and removed in January 1994. A groundwater sample taken during UST closure activities indicated elevated levels of BTEX.

4.2 Previous Investigations

As a follow-up to the tank removals, a three well site check was conducted in August 1994 by R. E. Wright Associates, Inc., to identify and/or verify the suspected petroleum hydrocarbon impact in the subsurface and groundwater. The activities included:

- Installing three shallow monitoring wells (MW-01, MW-02, and MW-03) around the former UST basin. The wells were approximately 13 to 14 feet bgs. Groundwater was encountered between 5.0 and 5.5 feet bgs. Monitoring well data is presented in Table 4-1. Figure 4-2 presents the monitoring well locations.

- Analyzing three soil samples, one from each soil boring, for TPH-gasoline range organics (GRO) which were all below detection limits.

- Analytical findings for three groundwater samples, analyzed for BTEX, indicating nondetectable concentrations for gasoline constituents. Tetrachloroethene (PCE) was detected in groundwater samples in each well ranging from 16.0 µg/L at MW-02 to 30.0 µg/L at MW-01. PCE is not a constituent of gasoline and its source therefore is believed not to be associated with the former UST basin. No free phase product was noted in any of the wells. The analytical findings are presented in Table 4-2.

A site survey including monitoring well, soil boring, and building locations also was completed.

4.3 Site Visit

The following provides a brief description of Site 92 field observations which were noted during the site visit conducted by Baker from September 13 through 15, 1995. Figure 4-2 depicts the locations of the features noted during the site visit. Photographs 4-1 and 4-2 were taken during the site visit and depict the UST and surrounding areas.

- The three wells, installed under the previous investigation, around the UST excavation area were located. Well locks on the wells prevented them from being opened to conduct water level measurements.

- The metal storage shed contains 5-gallon gasoline tanks used for boat fuel. Two empty, metal 5-gallon gasoline cans were located outside the shed. The storage shed is located on a cement pad, which has secondary containment.

- Three drums were located on the northeast side of the metal storage shed (outside). The drums were marked as:

  - Hazardous Waste Contaminated Oil
  - Hazardous Waste Contaminated Gas
  - Hazardous Waste 2-Cycle Outboard Lubricant

In this case, the term "contaminated" refers to the fact that these materials have been infiltrated by water. The gasoline, for example, has been "contaminated" by water. The drums were standing on pieces of wood and were roped to the metal storage shed. There was no secondary containment. It is reported that the contents in the drums are pumped out weekly.

- The former UST was replaced by a AST located south of Building BB-46.

- Site 73 is located northwest directly across Courthouse Bay. The contaminants detected at the site were benzene, vinyl chloride, and trichloroethene.

4.4 Proposed Sample Strategy

The following sampling strategy is proposed for additional sampling activities at Site 92. Soil, groundwater, surface water, and sediment sampling are proposed. Figure 4-2 identifies the proposed sampling locations. The location of the soil borings, shallow monitoring wells, and surface water/sediment samples will be finalized during the field investigation based on field observations.

4.4.1 Soil Investigation

The proposed soil investigation was developed with consideration to the potential soil contaminant migration and exposure routes at Site 92. The potential soil contaminant migration routes include: windblown contaminated dust particles; surface water runoff to Courthouse Bay; and contaminant transport to shallow groundwater via soil leaching. Potential exposed populations include military and civilian personnel involved in the day-to-day operations, military operations, and recreational activities.

- To determine if soil is a possible source of groundwater contamination, one surface and one subsurface soil sample will be collected from one soil boring location in the area of the former UST. This soil boring will be converted to an intermediate monitoring well.

- In order to assess potential risks from surface soil, one surface soil sample will be collected from ten locations in the former UST and site area.

- To determine if another possible source of the groundwater contamination exists, one surface and one subsurface soil sample will be collected from four soil boring locations in the site area. Three of the soil borings will be temporary wells and one soil boring will be converted to a shallow monitoring well.

- Surface soil samples will be collected from just below ground surface to six inches and subsurface samples will be collected just above the water table. A third sample from each soil boring also may be submitted for analysis if evidence of contamination (i.e., visible or by monitoring instrument) is noted. Additionally, a mid-depth sample will be collected if depth to groundwater is greater than 10-feet bgs.

- Fifteen surface soil and five subsurface soil samples will be analyzed for TCL VOCs, SVOCs, and TAL metals (Level D data quality). Ten percent (or two surface and one subsurface soil sample) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- If there is visible contamination or elevated instrument readings, a single composite sample of drill cuttings will be obtained and analyzed in accordance with TCLP (including TCL PCBs) and for RCRA hazardous waste characteristics in order to assess disposal options, if necessary. Otherwise, the soil cuttings will be placed back in the borehole.

4.4.2 Groundwater Investigation

The proposed groundwater investigation was developed with consideration to the potential groundwater contaminant migration and exposure routes at Site 92. The potential groundwater migration routes include: horizontal migration of contaminants confined within the shallow groundwater zone; vertical contaminant migration from shallow groundwater to deeper groundwater zones; and contaminated groundwater discharge to Courthouse Bay.

- Redevelop the three existing shallow monitoring wells which are to be resampled.

- Install one shallow (Type II) monitoring well (MW-04) in the vicinity of the AST, southeast of the former UST location to monitor the possible contamination of the AST. The shallow monitoring well will be a flush-mount construction. The groundwater sample collected will be analyzed on a routine laboratory turnaround time.

- Install three temporary wells to confirm groundwater flow, identify source of contamination, and to determine the extent of horizontal contaminant migration. The groundwater samples collected will be analyzed on an accelerated (14-day) laboratory turnaround time. If levels and constituents are determined to be a concern, permanent shallow wells will be installed at the temporary well locations (three wells) in order to monitor contaminant migration.

- Install one intermediate monitoring well (MW-01IW) nested with MW-01 (existing) well to determine the extent of vertical contaminant migration (this well had the highest levels of PCE contamination in the previous investigation) with the option of installing three additional intermediate monitoring wells if groundwater collected from MW-01IW has concentrations which exceed regulatory levels. The screened interval for the intermediate monitoring well will be 40 to 55 feet bgs. The intermediate monitoring well will be a flush-mount construction. The groundwater sample collected from MW-01IW will be analyzed on an accelerated (14-day) laboratory turnaround time.

- Resample three existing shallow monitoring wells (MW-01, MW-02, and MW-03) to determine if the UST excavation area is the source of contamination. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Two rounds of groundwater samples will be collected from the three existing and two newly installed Site 92 monitoring wells under the RI/FS. One round of groundwater samples will be collected from the three temporary monitoring wells

at Site 92. The first round of groundwater samples will be collected during the initial investigation. The second round of groundwater samples will be collected four months after the initial samples were collected.

- All groundwater samples will be analyzed for TCL VOCs, SVOCs, TAL total metals (Level D data quality), and TDS/TSS. Ten percent (or one groundwater sample) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- Groundwater measurements will be taken to confirm groundwater flow direction.

- A single composite sample of purge/development water will be obtained and analyzed for full TCL (VOCs, SVOCs, Pesticides/PCBs), TAL metals, and TSS/TDS in order to assess disposal options.

Type II shallow monitoring wells will be installed within the surficial aquifer at an estimated depth of 5 to 25 feet bgs. The Type II intermediate monitoring well will be installed to a depth of approximately 55 feet bgs. The bottom of the intermediate monitoring well will be placed at the top of the semi-confining layer.

4.4.3 Surface Water/Sediment Investigation

The proposed surface water and sediment investigation was developed with consideration to the potential surface water and sediment contaminant migration and exposure routes at Site 92. The potential surface water migration routes include: contaminated groundwater discharge to Courthouse Bay and surface water runoff to Courthouse Bay. The potential sediment migration route includes surface soil runoff to Courthouse Bay.

- Locate six stations for surface water/sediment sampling from the shoreline of Courthouse Bay and Site 92.

- Two surface water samples , one from the water surface and the other 1-foot from the bottom, will be collected from each station if the water depth is greater than

3-feet. One surface water sample will be collected from the water surface from each station if the water depth if less than 3-feet.

- Two sediment samples will be collected from each station, one from 0- to 6-inches and the other from 6- to 12-inches bgs.

- All surface water and sediment samples will be analyzed for TCL VOCs, SVOCs, and TAL metals (Level D data quality). Sediment samples also will be analyzed for total organic carbon (TOC) and grain size. Ten percent of the surface water (or one surface water sample from each depth) and sediment (or one 0-6 inch sediment and one 6-12 inch sediment sample) will be analyzed for pesticides and PCBs. There is no reported historical use of pesticides or PCBs at this site.

- Install three staff gauges on each side of the point and at the point into Courthouse Bay. Establish long term monitoring with pressure transducers to determine the amount of tidal influence and whether groundwater is discharging to surface water, surface water is discharging to groundwater, or depending on the tidal influence determine if both are occurring.

TABLES

TABLE 4-1

MONITORING WELL DATA
OPERABLE UNIT NO. 16 (SITE 92)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Sample Location	Surface Elevation (msl)	Top of Casing Elevation (msl)	Depth to Groundwater (BTOC)	Calculated Groundwater Elevation (msl)
MW-1	5.49	5.19	4.60	0.59
MW-2	5.33	4.93	4.50	0.43
MW-3	4.83	4.47	3.80	0.67

msl - Mean Sea Level (in feet)
BTOC - Below Top of Casing (in feet)

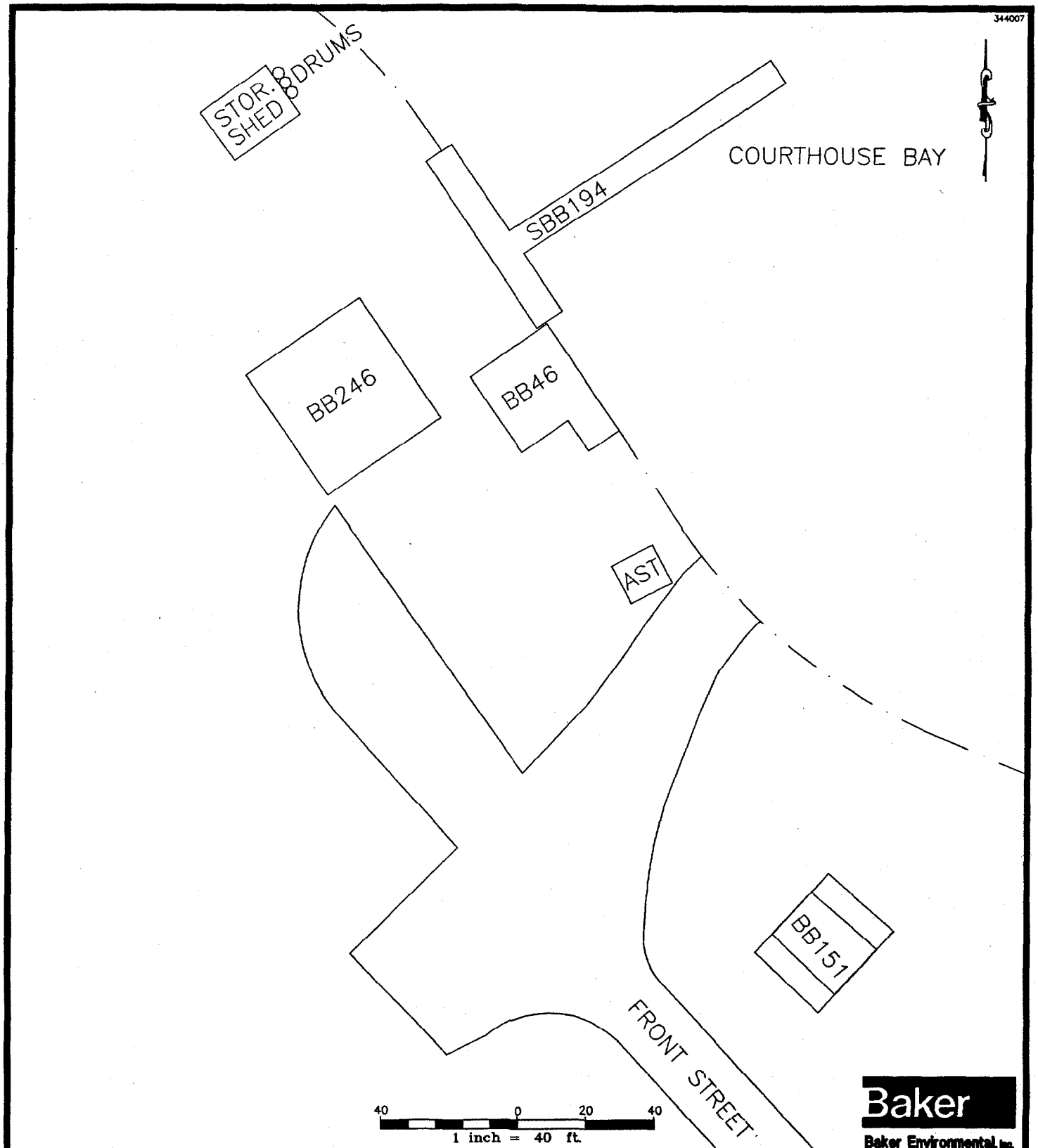
TABLE 4-2

GROUNDWATER SAMPLE ANALYTICAL RESULTS
OPERABLE UNIT NO. 16 (SITE 92)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Federal MCL	North Carolina	MW-1	MW-2	MW-2 DUP	MW-3
Tetrachloroethene	5	0.7	**30.0**	**16.0**	**25.0**	**27.0**
BTEX	--	--	BDL	BDL	BDL	BDL
Lead	15*	15	BDL	BDL	BDL	BDL

-- - No Published Standard
BTEX - Benzene, Toluene, Ethylbenzene, and Xylene
BDL - Below Detection Limits
Concentrations reported in µg/L (ppb)
Shaded areas indicate non compliant concentrations
* Action Level

FIGURES



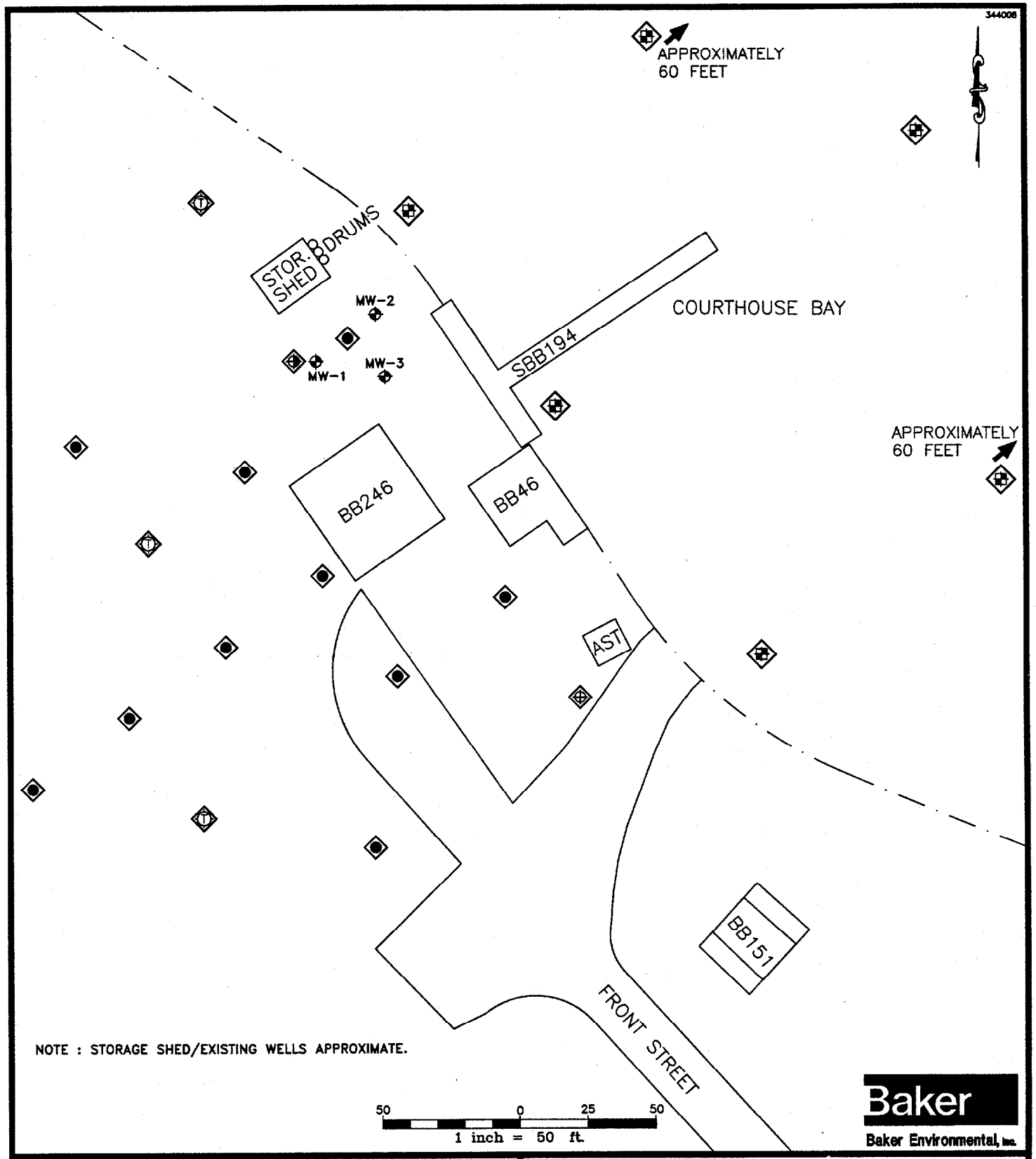
LEGEND

▭ – BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

FIGURE 4–1
SITE 92 (BB–46)
LOCATION MAP
SAMPLE STRATEGY PLAN CTO–344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- EXISTING MONITORING WELL
- PROPOSED SHALLOW WELL
- PROPOSED DEEP WELL
- PROPOSED TEMPORARY WELL
- PROPOSED SURFACE SOIL SAMPLE
- PROPOSED SURFACE WATER/SEDIMENT SAMPLE
- BUILDING

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 1/10/89.

FIGURE 4-2
SITE 92 (BB-46)
EXISTING AND PROPOSED SAMPLING LOCATIONS
SAMPLE STRATEGY PLAN CTO-344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

PHOTOGRAPHS

Photograph 4-1. Site 92, UST excavation area and metal storage shed, looking northwest.

Photograph 4-2. Site 92, UST excavation area (foreground) and marina (background), looking northeast.

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