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FINAL

SAMPLE STRATEGY PLAN

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

OPERABLE UNIT NO. 16
SITES 89 AND 93

MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0344

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	Microgram per Kilogram
µg/L	Microgram per Liter
Baker	Baker Environmental, Inc.
bgs	Below Ground Surface
DoN	Department of the Navy
DRMO	Defense Reutilization Management Office
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
NC DEHNR	North Carolina Department of the Environment, Health, and Natural Resources
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
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 Hydrocarbons
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. 16. OU No. 16 includes Site 89 (Underground Storage Tank [UST] STC-868) and Site 93 (TC-942) 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 by LANTDIV at the upcoming 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 89 and 93 are presented on Figure 1-2.

FIGURES

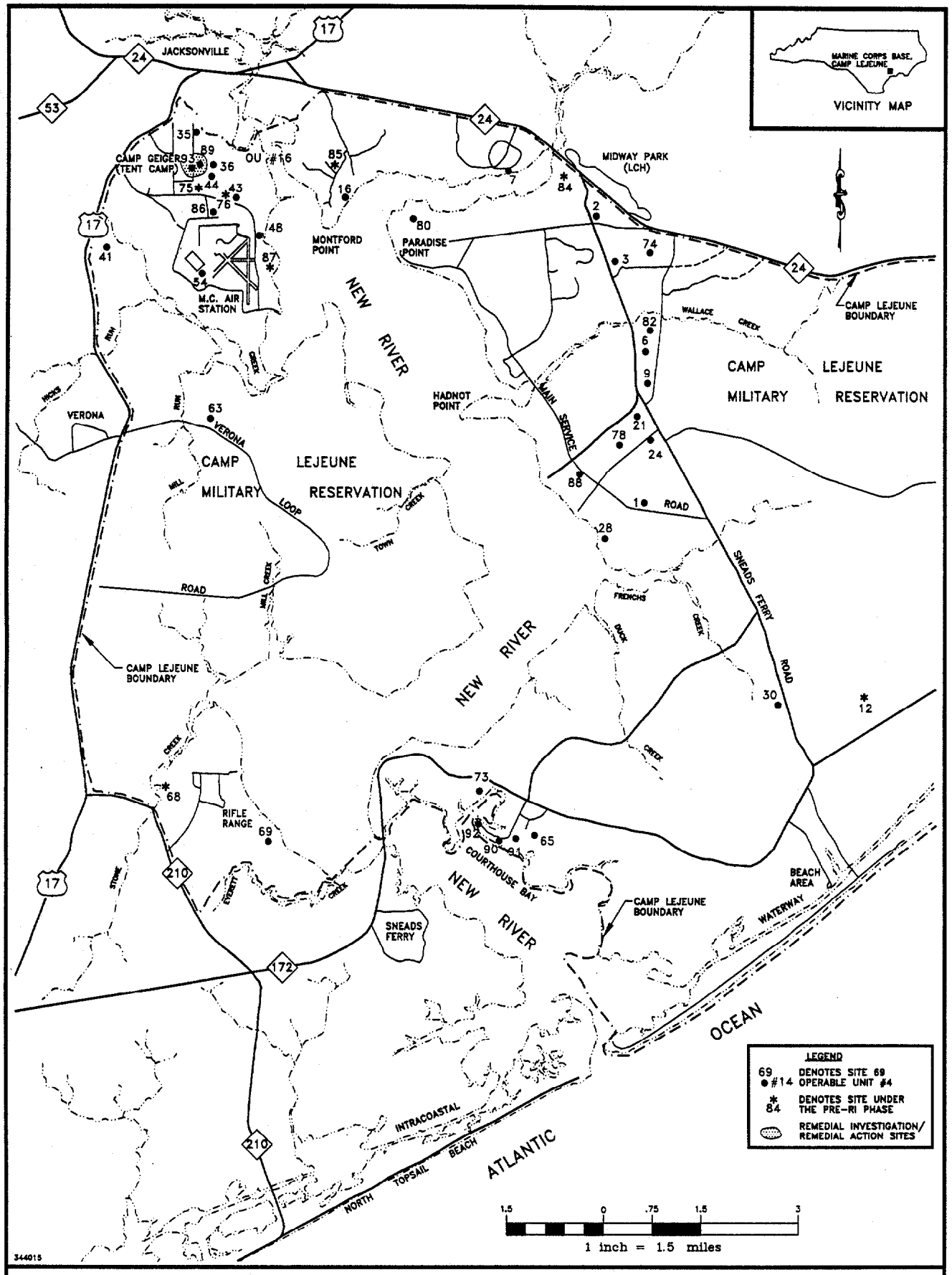
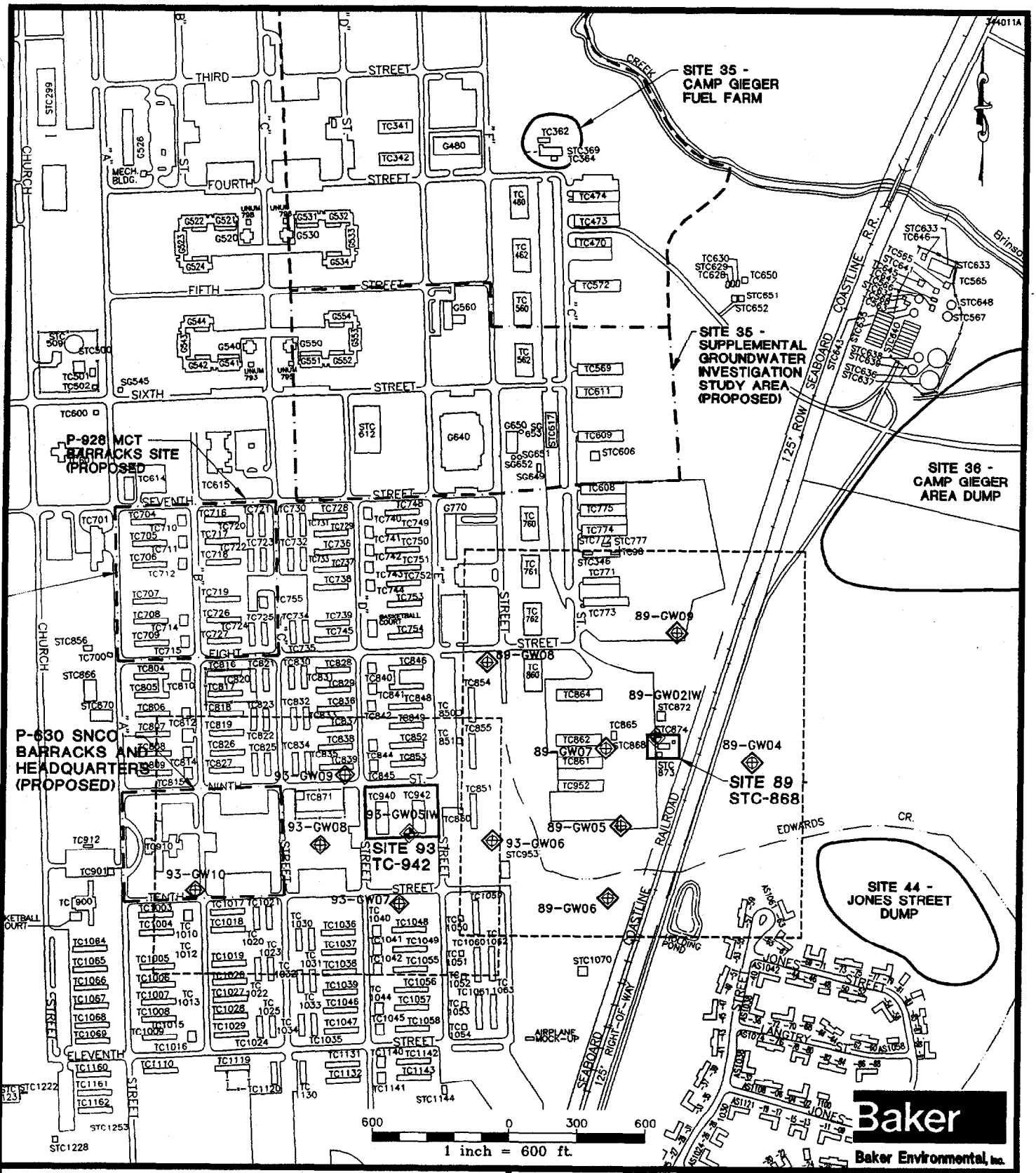


FIGURE 1-1
OPERABLE UNITS AND SITE LOCATIONS AT
MARINE CORPS BASE CAMP LEJEUNE
SAMPLE STRATEGY PLAN CTO-0344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- TC1162 —BUILDING
- —RAILROAD TRACKS
- —SITE BOUNDARY
- —INVESTIGATION AREA
- —PROPOSED SHALLOW WELL
- —PROPOSED INTERMEDIATE WELL

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 1-2
SITE 89 AND 93 INVESTIGATION AREA SAMPLE STRATEGY PLAN CTO-0344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

2.0 SITE 89 (UST STC-868)

Site 89, UST STC-868, is located near the intersection of "G" and Eighth Streets in the Camp Geiger area of MCB Camp Lejeune (Figure 2-1). UST STC-868 originally was a steel 550-gallon waste oil tank. UST STC-868 was located between building STC-867, a roofed contaminated soil storage facility, and an elevated wash rack. Edwards Creek is the nearest surface water body, located approximately 525 feet south of the former UST basin. The nearest known water supply wells (TC-700 and TC-901) are located approximately 2,500 feet northwest and 2,500 feet southwest of the site.

2.1 Site History

One 550-gallon steel UST was installed in 1983. From 1983 to 1993 the tank was reportedly used for waste oil storage. The tank was removed in 1993 and two monitoring wells were installed and sampled west and northeast of the UST STC-868 excavation area. Based on elevated levels of both Total Petroleum Hydrocarbons (TPH) and oil and grease at the time of tank removal, a release is suspected to have occurred. A subsequent investigation was conducted and one additional monitoring well was installed southeast of the UST STC-868 excavation area. The monitoring well locations are presented on Figure 2-2. The area previously investigated has been expanded to determine if there are any other source areas for the possible contamination. The site now includes the paved storage area of the Defense Reutilization Management Office (DRMO), the drainage ways from the site, and the area where UST STC-868 was excavated.

The storage area at Site 89 reportedly was a swamp which was back filled with fill from an unknown area of the base. This area was used from approximately 1988 to the present as a storage area for obsolete or unusable parts and miscellaneous items including vehicles and motors (DRMO). From the 1940s to 1988, this area was a motor pool. The motor pool performed daily maintenance and training on vehicles. In 1988, the motor pool moved directly north of the storage area to the other side of the fence. The area north, east, and south of UST STC-868 is scheduled to be concreted.

There are two oil/water separators located east of the tank excavation area. One separator is believed to be for the roofed contaminated soil storage facility, STC-867, and the other appears to be for an inactive elevated wash rack. The elevated wash rack was used to clean transmissions.

There also is one oil/water separator south of the tank excavation area. This separator is for the active wash rack located south of the inactive elevated wash rack. The oil/water separators reportedly have never been serviced.

Runoff from the paved DRMO storage area and the motor pool area reportedly floods the area surrounding the tank excavation area. It is reported that one to two feet of water ponds in this area whenever there is substantial precipitation. The lowest elevation topographically is the eastern to southeastern portion of the storage area. A sewer line and manhole cover are located southeast of the tank excavation area. The integrity of the sewer is questionable; the side of the sewer is collapsed and visible. This may be a potential problem when flooding occurs in the area.

2.2 Previous Investigations

An initial investigation was conducted during the tank removal and two monitoring wells were installed. Based on elevated levels of both TPH and oil and grease at the time of tank removal, a release is suspected to have occurred. A one well site check was conducted in June 1994 by R.E. Wright Associates, Inc. to determine if a release had occurred. This investigation included one soil boring southeast of the tank excavation area which was converted to a monitoring well. Continuous split-spoon samples were collected to a depth of 10 feet below ground surface (bgs). The sample that exhibited the highest photoionization detector (PID) reading was collected as a sample. One soil sample was analyzed for oil and grease and halogenated solvents. Groundwater samples were collected from the new and two existing monitoring wells and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and Toxicity Characteristic Leaching Procedure (TCLP) metals. Groundwater was encountered at approximately 5 feet bgs. Monitoring well data is presented in Table 2-1. Results from the samples are as follows:

- Soil sample MW-01, southeast of the tank excavation area, 6-8 feet bgs, had 1,400,000 microgram per kilogram (µg/kg) oil and grease detected. Halogenated solvents were below the detection limits for all parameters (see Table 2-2).

- Three groundwater samples indicated concentrations of several chlorinated solvents detected at concentrations exceeding USEPAs maximum contaminant level (MCL) standards in all three monitoring wells. SVOCs and TCLP metals were below detection limits in all of the samples (see Table 2-3).

  - Maximum concentrations of cis-1,2-dichloroethene (2,130 micrograms per liter [µg/L]), trans-1,2-dichloroethene (1,580 µg/L), 1,1,2,2-tetrachloroethane (8,600 µg/L), and trichloroethene (1,500 µg/L) were reported in sample MW-02.

  - Maximum concentrations of tetrachloroethene (35 µg/L) and 1,1,2-trichloroethane (29 µg/L) were detected in sample MW-01.

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

2.3 Site Visit

The following provides a brief description of Site 89 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, 2- 2, and 2-3 were taken during the site visit and depict the UST and surrounding area.

- Three oil/water separators and the three wells, installed under the previous investigations, around the UST excavation area were located.

- Water level in monitoring well MW-01 was measured (4.46 feet bgs from the top of the casing).

- Oil/water separators reportedly have not been serviced recently.

- A sewer cover was broken in places and could be a potential pathway for contamination to migrate to other media during times of heavy rain.

- The storage area at Site 89 reportedly was a swamp which was back filled with fill from an unknown area of the Base. From the 1940s to 1988, this area was a motor pool.

- In 1988, the motor pool was moved directly north of the storage area.

- The area north, east, and south of UST STC-868 is scheduled to be concreted.

- Runoff from the paved DRMO storage area and the motor pool area reportedly floods the area surrounding the tank excavation area. It is reported that one to two feet of water ponds in this area whenever there is substantial precipitation.

2.4 Proposed Sample Strategy

The following sampling strategy is proposed for the RI phase at Site 89. Soil, groundwater, surface water, and sediment sampling are proposed. An investigation of the oil/water separators and sewer lines is recommended as a "Good Housekeeping" measure. However, the oil/water separators will not be investigated during this sampling effort. Figure 2-2 identifies the proposed sampling locations. The soil boring and monitoring well locations will be finalized based on field observations during the field investigation.

2.4.1 Soil Investigation

The proposed soil investigation was developed with consideration to the potential soil contaminant migration and exposure routes at Site 89. The potential soil contaminant migration routes include: windblown contaminated dust particles; surface water runoff to Edwards Creek; 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 11 soil boring locations around and in the vicinity of the former UST and wash racks in the unpaved area.

Because of the levels of organic contamination detected in shallow well MW-02, one soil boring will be converted to an intermediate monitoring well (approximately 40 feet bgs, above the semi-confining layer) near monitoring well MW-02.

- To determine if another possible source of the groundwater contamination exists, one surface and one subsurface soil sample will be collected from six soil boring locations in the site area. Two soil borings will be located upgradient of the site area to determine upgradient source areas and groundwater flow direction. A surface soil sample will not be collected if the soil boring is located within the paved area. These six soil borings will be converted to shallow monitoring wells.

- Surface soil samples will be collected from just below ground surface to six inches and subsurface samples will be collected from just above the water table at each soil boring location. A third sample from each soil boring may be collected 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.

- Fourteen surface and 17 subsurface soil samples will be analyzed for Target Compound List (TCL) VOCs, SVOCs, and Target Analyte List (TAL) metals (Level D data quality). Ten percent (or two surface and two subsurface soil samples) will be analyzed for pesticides and polychlorinated biphenyls (PCBs). The motor pool was located in this area until 1988. There is no historical use of pesticides or PCBs during this time period.

- 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. 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 89. 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 Edwards Creek.

- Redevelop shallow monitoring well (MW-02) which is to be resampled.

- Install six shallow (Type II) monitoring wells (89-GW04 through 89-GW09) upgradient, sidegradient, and downgradient of UST STC-868 to confirm groundwater flow direction and to determine the extent of horizontal contaminant migration. The monitoring wells in the paved area will be a flush-mount construction. The groundwater samples collected will be analyzed on a routine laboratory turnaround time. Monitoring well locations will be finalized based on field observations.

- Install one intermediate (approximately 40 feet bgs, above the semi-confining layer) monitoring well (89-GW02IW) nested with MW-02 (existing well) to determine the extent of vertical contaminant migration (this well had the most significant VOC detections in the previous investigation) with the option of installing additional monitoring wells if 89-GW02IW or the newly installed shallow monitoring wells have detections which exceed regulatory levels. The groundwater sample collected from 89-GW02IW will be analyzed on an accelerated (14-day) laboratory turnaround time.

- Resample one existing shallow monitoring well (MW-02) to determine if the UST excavation area is the source of contamination. The groundwater sample collected will be analyzed on an accelerated (14-day) laboratory turnaround time.

- Two rounds of groundwater samples will be collected from the one existing Site 89 monitoring well (MW-02) and from each newly installed monitoring well 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. The motor pool was located in this area until 1988. There is no historical use of pesticides or PCBs during this time period.

- 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, TSS/TDS for hazardous waste characteristics 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.

2.4.3 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 89. The potential surface water migration routes include: contaminated groundwater discharge to Edwards Creek and overland runoff to Edwards Creek. The potential sediment migration route includes surface soil runoff to Edwards Creek. Two previous investigations of Edwards Creek were conducted during the investigation of Site 44. Sampling in Edwards Creek was first conducted from 1991 to 1992 and no VOC contamination was detected. The second sampling investigation conducted from 1994 to 1995 indicated VOCs had impacted Edwards Creek. Therefore, additional sampling is required to determine if Site 89 is impacting Edwards Creek.

- Locate five stations for surface water/sediment sampling from Edwards Creek, located southwest to southeast of the site, upgradient, sidegradient, and downgradient from the site.

- 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 total 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. The motor pool was located in this area until 1988. Historical use of pesticides or PCBs has not been reported in this area.

- Install two staff gauges in Edwards Creek. One will be located upstream and one downstream of the site. 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.

2.4.4 Oil/Water Separator and Sewer Investigation

The proposed oil/water separator and sewer investigation was developed with consideration to the potential contaminants which may be impacting the soil or groundwater due to the flooding of the area, the lack of maintenance of the separator, or the apparent compromise of the sewer system.

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

- Sewer lines: Determine drainage pathways possibly using tracer wire or dye tests. Determine if the line is a sanitary sewer line or a storm sewer line.

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

TABLES

TABLE 2-1

MONITORING WELL DATA
OPERABLE UNIT NO. 16 (SITE 89)
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-01	13.7	13.32	4.94	8.38
MW-02	13.7	14.81	6.58	8.23
MW-03	14.2	15.38	7.12	8.26

msl - Mean Sea Level
BTOC - Below Top of Casing

TABLE 2-2

SOIL ANALYTICAL RESULTS
OPERABLE UNIT NO. 16 (SITE 89)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analysis	MW-01 (6-8 feet bgs)
SW-846 (Oil and Grease)	**1,400,000**
SW-846 (Halogenated Solvents)	BDL
TCLP Volatiles	BDL
TCLP Semivolatiles	BDL
TCLP Pesticides	BDL
TCLP Inorganics	BDL

BDL - Below Detection Limit
bgs - Below Ground Surface
TCLP -Toxicity Characteristic Leaching Procedure
Concentrations expressed in µg/kg (ppb)
Shaded area indicates non compliant concentrations

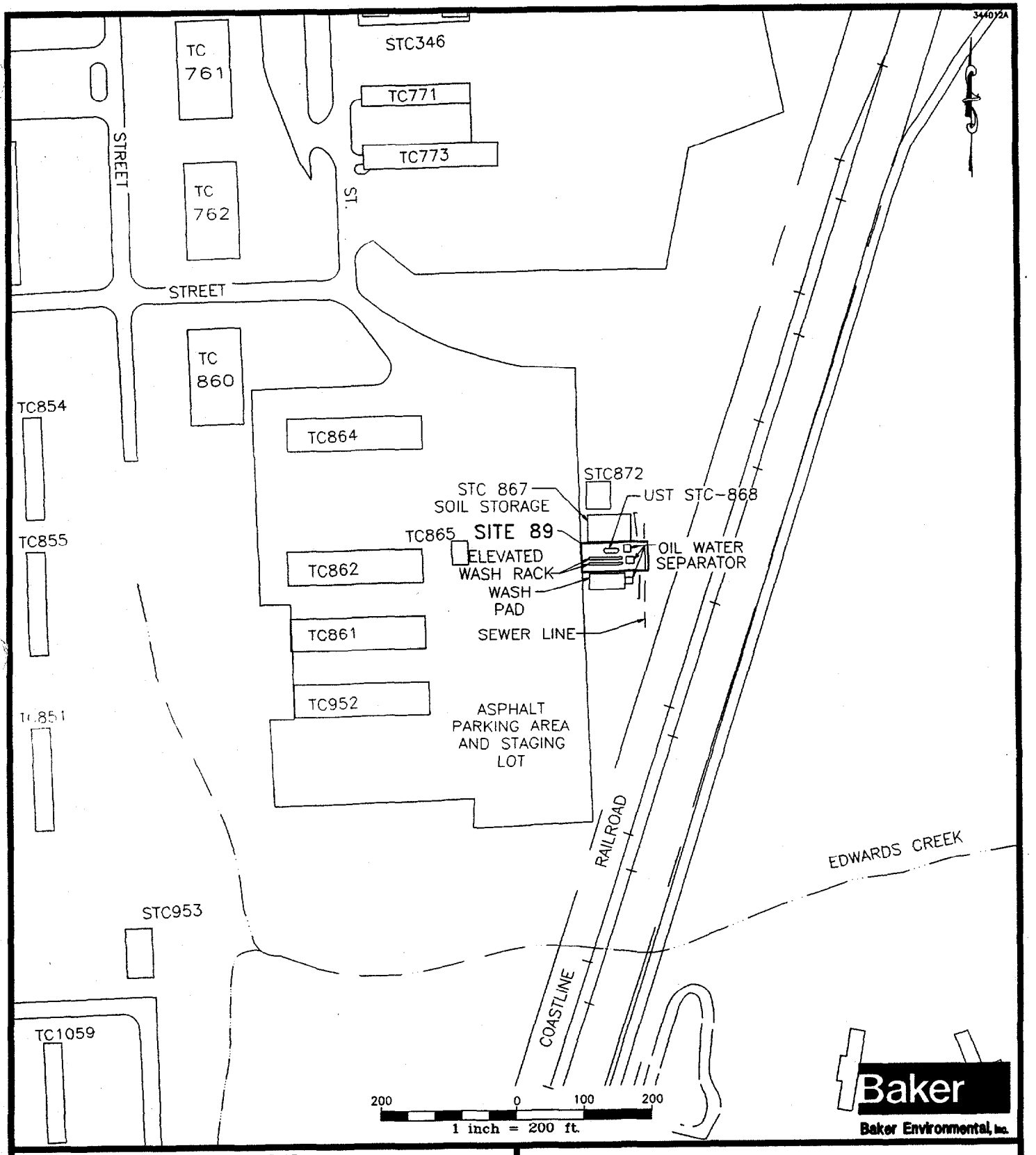
TABLE 2-3

GROUNDWATER ANALYTICAL RESULTS
OPERABLE UNIT NO. 16 (SITE 89)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analysis	Federal MCL	NCWQS	MW-01	MW-01 Duplicate	MW-02	MW-03
EPA Method 502.2 (VOCs)	--	--	BDL	BDL	BDL	BDL
Cis-1,2-Dichloroethene	70	70	**585**	**550**	**2,130**	70
Trans-1,2-Dichloroethene	100	70	**390**	**370**	**1,580**	60
1,1,2,2-Tetrachloroethane	--	--	4,300	3,400	8,600	240
Tetrachloroethene	5	0.7	**35**	**38**	BDL	BDL
1,1,2-Trichloroethane	5	--	**29**	**29**	BDL	BDL
Trichloroethene	5	2.8	**580**	**580**	**1,500**	**80**
EPA Method 625 (SVOCs)	--	--	BDL	BDL	BDL	BDL
TCLP Metals	--	--	BDL	BDL	BDL	BDL

-- - No Published Standard
BDL - Below Detection Limit
EPA - United States Environmental Protection Agency
NCWQS - North Carolina Water Quality Standard
SVOC - Semivolatile Organic Compound
TCLP - Toxicity Characteristic Leaching Procedure
VOC - Volatile Organic Compound
Concentrations expressed in µg/L (ppb)
Shaded areas indicate non compliant concentrations

FIGURES



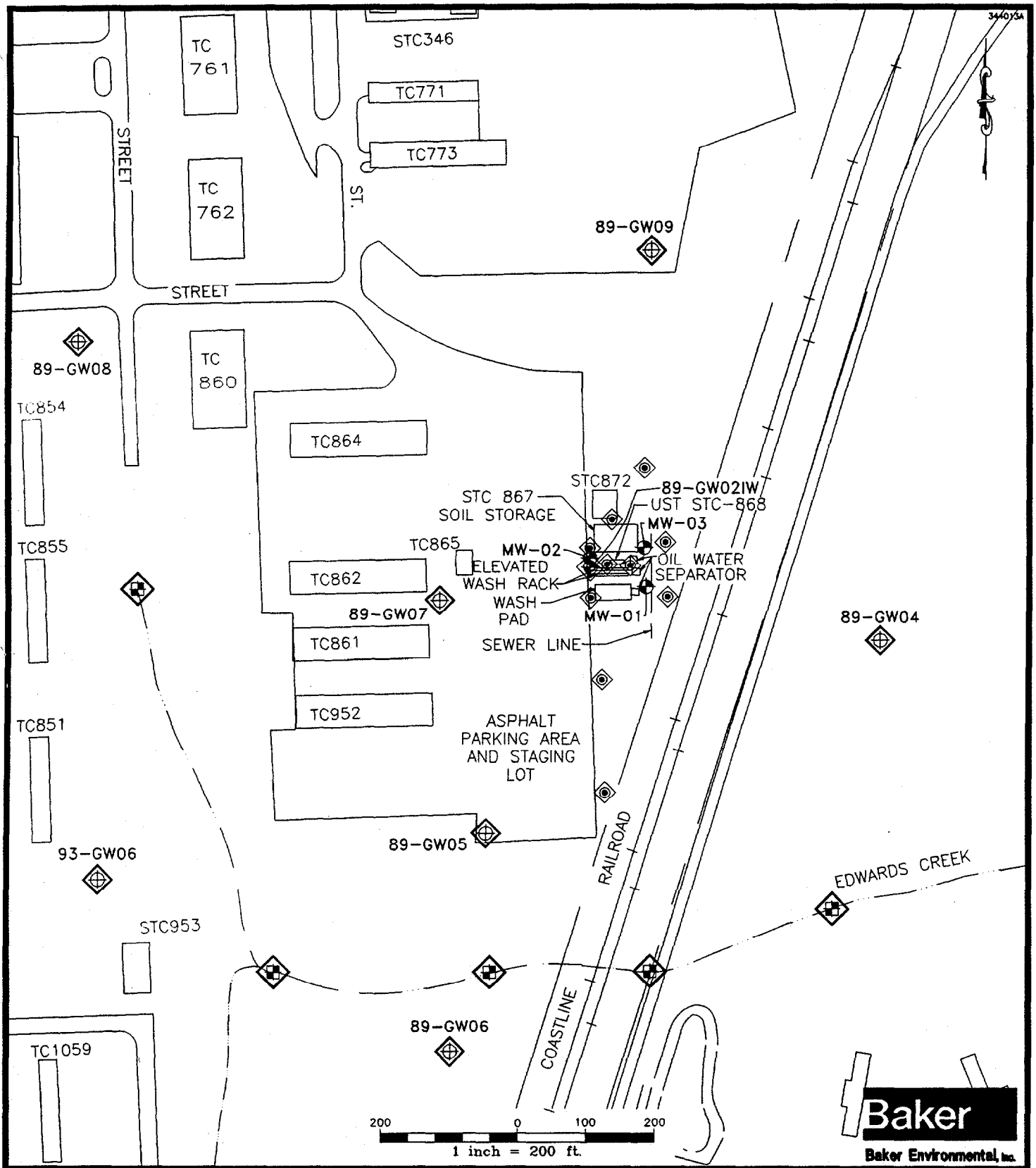
LEGEND

- BUILDING
- RAILROAD
- CREEK

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 11/95

FIGURE 2-1
SITE 89 (UST STC-868)
LOCATION MAP
SAMPLE STRATEGY PLAN CTO-0344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- ◆ – EXISTING MONITORING WELL
- ◆ – PROPOSED INTERMEDIATE WELL
- ◆ – PROPOSED SHALLOW WELL
- ◆ – PROPOSED SOIL BORING
- ◆ – PROPOSED SURFACE WATER/SEDIMENT SAMPLE
- ▭ – BUILDING
- ++++ – RAILROAD
- —— – CREEK

SOURCE: MCB CAMP LEJEUNE REVISED BASE MAP 11/95.

FIGURE 2-2
SITE 89 (UST STC-868)
EXISTING & PROPOSED SAMPLING LOCATIONS
SAMPLE STRATEGY PLAN CTO-0344
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

PHOTOGRAPHS

Photograph 2-1. Site 89, UST excavation area, soil storage building (left), and elevated wash rack (right), looking east.

Photograph 2-2. Site 89, Oil/water separators (foreground) and UST excavation area, looking west.

01572P01Y

Photograph 2-3. Site 89, elevated wash rack (foreground), UST excavation area, and soil storage facility (background), looking north.

01572P02Y

3.0 SITE 93 (TC-942)

Site 93, the UST associated with TC-942, is located near the intersection of Ninth and "E" Streets in the Camp Geiger area, MCB Camp Lejeune (Figure 3-1). The UST was a 550-gallon oil storage tank and was located at the southwest corner of Building TC-942. Edwards Creek is the nearest surface water body, located approximately 525 feet east of the former UST basin. The nearest known water supply wells (TC-700 and TC-901) are located approximately 1,600 feet northwest and 1,400 feet west of the site, respectively.

3.1 Site History

One 550-gallon UST was closed and removed in December 1993. There is no documentation available concerning the installation date or usage of the UST. Based on elevated levels of oil and grease at the time of the tank removal, a release is suspected to have occurred. A subsequent investigation was conducted and five monitoring wells were installed around the UST excavation. The monitoring well locations are presented on Figure 3-2. The area previously investigated has been expanded to determine if there are any other source areas for the possible contamination. The site now includes the area east, west, and south of Buildings TC-940 and TC-942 and the area where UST was excavated.

The buildings in this area were constructed during the Korean War. Building TC-942 currently functions as a supply room for the Marine Infantry School. Items such as field jackets, ponchos, and canteens are stored in the building. Other buildings in the area serve as classrooms for the school and barracks.

Two conex boxes are located between Buildings TC-940 and TC-942. One conex box contains paint spray cans and the other contains cleaner for canteens (calcium hypochlorite). The storage boxes have been in this location for approximately 2 years. There also is a steam line which is located between the two buildings. The steam line was installed in 1983 to heat the buildings in the area. Prior to 1983, each building had one associated UST heating oil tank. The fenced area west of Building TC-940 was reportedly a motor pool area 1979 to 1986, then a chow hall. The chow hall has since been demolished.

From 1985 to 1988 a common practice was that all the paint lockers in this area were buried a few feet bgs with surface access. At that time, each building had its own paint locker. The paint lockers contained paint (for painting buildings), Break-Free (solvent for cleaning weapons), LSA (lubricant for cleaning weapons), and other miscellaneous materials. The paint lockers would often fill with water (groundwater and surface water infiltration). In 1988, this practice was discontinued due to the flooding and rusting of the paint lockers. According to interviews conducted during the site visit, this problem was especially acute at Building TC-855.

3.2 Previous Investigations

An initial investigation was conducted during the tank removal. Based on elevated levels of oil and grease under the tank in the excavated area at the time of tank removal, a release is suspected to have occurred. A five well site check was conducted in June 1995 by R. E. Wright Environmental, Inc., to determine if a release had occurred. This investigation included five soil borings in and around the tank excavation area which were converted to shallow monitoring wells. Continuous split-spoon samples were collected to depths of 4 (MW-04 and MW-05) to 6 feet bgs (MW-01, MW-02, MW-03). The sample that exhibited the highest PID reading from each boring was collected as a sample. Five soil boring samples were analyzed for oil and grease and halogenated solvents. Groundwater samples were collected from the five new monitoring wells and analyzed for VOCs, SVOCs, and TCLP metals. The groundwater was encountered at approximately 2.9 and 3.1 feet bgs. Monitoring well data is presented in Table 3-1. Results from the samples are as follows:

- Soil vapor readings were highest in the two to four foot interval, directly above the saturated soil zone. Hydrocarbon odors were detected in all the soil borings except MW-04. Gasoline odors were detected in monitoring well MW-05. Hydrocarbon staining was noted in soil borings MW-01, MW-02, and MW-03.

- Oil and grease results from the soil boring samples ranged from 56,100 to 8,126,000 µg/kg, except for levels below the detection limit in MW-02 and MW-04 soil samples. Concentrations of oil and grease at MW-01 (8,126,000 µg/kg) and MW-03 (1,439,000 µg/kg) were above regulatory levels. Naphthalene and tetrachloroethene was detected in MW-05 (0.049 µg/kg and 20 µg/kg, respectively) in low concentrations. 1,2,4-Trichlorobenzene and 1,2,4-trimethylbenzene were

detected in the duplicate sample of MW-05 (2.3 µg/kg and 0.93 µg/kg, respectively) also in low concentrations. No free phase product was noted in any of the wells. Analytical results are presented in Table 3-2.

- Groundwater samples had VOCs detected in every well except MW-03. Cis-1,2-dichloroethene and chlorobenzene concentrations detected in MW-02 (250 µg/L and 90 µg/L, respectively) exceeded regulatory levels. Tetrachloroethene and trichloroethene concentrations detected in MW-05 (90 µg/L and 30 µg/L, respectively) also exceeded regulatory levels. Groundwater analytical findings are presented in Table 3-3.

- Several SVOCs in groundwater samples were detected in MW-02 and MW-04 below regulatory limits. Groundwater SVOC results are presented in Table 3-3.

- Total cadmium concentrations in each well and the lead concentration in MW-01 (0.017 mg/L) exceeded regulatory levels. Groundwater metal concentrations are presented in Table 3-4.

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

3.3 Site Visit

The following provides a brief description of Site 93 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 depict the area between Buildings TC-942 and TC-940 (former UST area) and the former motor pool area.

- The five monitoring wells, installed during the previous investigation, were located. All the monitoring wells are flush mounted. Monitoring well MW-02 and MW-03 had grout at a level higher than the well PVC riser. The top of the PVC riser in monitoring well MW-02 was cut incorrectly, therefore the locking cap did not fit properly and the monitoring well may have been compromised by infiltrating

surface water runoff. The flush mount casing in monitoring well MW-04 was filled with water.

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

MW-01	4.36 feet bgs
MW-02	3.90 feet bgs
MW-03	4.14 feet bgs
MW-04	4.27 feet bgs
MW-05	4.12 feet bgs

- The steam line running between Buildings TC-940 and TC-942 was leaking (approximately 5-gallons per minute) 50 feet south of the buildings. The steam line reportedly had been leaking for a few days, but was scheduled to be fixed. This may effect local groundwater levels.

- From 1985 to 1988 a common practice was that all the paint lockers in this area were buried bgs with surface access. At that time, each building had its own paint locker. The paint lockers contained paint (for painting buildings), Break-Free (solvent for cleaning weapons), LSA (lubricant for cleaning weapons), and other miscellaneous materials. The paint lockers would often fill with water (groundwater and surface water infiltration). In 1988, this practice was discontinued due to the flooding and rusting of the paint lockers. According to interviews conducted during the site visit, this problem was especially acute at Building TC-855.

- Weapons cleaning has been conducted in buildings in the area. Chemicals used in this practice may be contributing to the contamination.

3.4 Proposed Sample Strategy

The following sampling strategy is proposed for additional sampling activities at Site 93. Soil and groundwater sampling are proposed. Figure 3-2 identifies the proposed sampling locations. The soil

boring and monitoring well locations will be finalized based on field observations during the field investigation.

3.4.1 Soil Investigation

The proposed soil investigation was developed with consideration to the potential soil contaminant migration and exposure routes at Site 93. The potential soil contaminant migration routes include: windblown contaminated dust particles; surface water runoff to Edwards Creek; and contaminant transport to shallow groundwater via soil leaching. Potential exposed populations include military and civilian personnel involved in day-to-day operations and military training.

- Abandon three existing wells (MW-02, MW-03, and MW-04) in and around the former UST basin. The wells are poorly constructed and may have been compromised. Grout fell into two of the wells (MW-02 and MW-03) when water level measurements were collected. This may effect the pH of the well, which would possibly effect the amount of metals in solution. The one of the two remaining wells will be utilized as shallow monitoring well to sample if they are determined to be suitable. If they are determined to be unsuitable, these two wells also will be abandoned.

- 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 (intermediate) around the former UST. The soil boring will be converted to an intermediate monitoring well. In addition, if all five existing monitoring wells are abandoned, an additional shallow soil boring will be utilized to collect samples as noted above. This additional soil boring will then be converted to a shallow monitoring well.

- To determine if another possible source of the groundwater contamination exists, one surface and one subsurface soil sample will be collected from 19 soil boring locations in the site area. Five of the soil boring locations will be converted to shallow monitoring wells upgradient, sidegradient, and downgradient of the former UST basin.

- 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 and SVOCs (Level D data quality). Ten percent (or two surface and two subsurface soil samples) will be analyzed for TCL metals, pesticides, and PCBs. A motor pool was located in this area at one time. Historical use of pesticides or PCBs has not been reported in this area.

- 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. 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 93. 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 Edwards Creek.

- Install five shallow (Type II) monitoring wells (92-GW06 through 93-GW10) upgradient, sidegradient, and downgradient of the former UST location to confirm groundwater flow direction and to determine the extent of horizontal contaminant migration. The shallow monitoring wells will be a flush-mount construction. The groundwater samples collected will be analyzed on a routine laboratory turnaround time.

- Resample one shallow (Type II) monitoring well (MW-01 or preferably MW-05), if they are not abandoned, to confirm groundwater flow direction and to determine the extent of horizontal contaminant migration. The groundwater samples collected will be analyzed on an accelerated (14-day) laboratory turnaround time.

- Install one intermediate (approximately 40 feet bgs, above the semi-confining layer) monitoring well (93-GW05IW) nested with MW-05 (existing well) to determine the extent of vertical contaminant migration with the option of installing additional monitoring wells if 93-GW05IW or the newly installed shallow monitoring wells have detections which exceed regulatory levels. The monitoring well will be a flush-mount construction. The groundwater sample collected from 93-GW05IW will be analyzed on an accelerated (14-day) laboratory turnaround time.

- Two rounds of groundwater samples will be collected from the two existing (if not abandoned) and the eight newly installed 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 (Level D data quality), and TDS/TSS. Ten percent (or one groundwater sample) will be analyzed for TCL total metals, pesticides, and PCBs. A motor pool was located in this area at one time. Historical use of pesticides or PCBs has not been reported in this area.

- 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, TSS/TDS for hazardous waste characteristics 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

MONITORING WELL DATA
OPERABLE UNIT NO. 16 (SITE 93)
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-01	15.14	14.61	2.33	12.28
MW-02	15.38	15.00	2.73	12.27
MW-03	15.21	14.85	2.58	12.27
MW-04	15.25	14.96	2.66	12.30
MW-05	15.19	14.79	2.52	12.27

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

TABLE 3-2

SOIL ANALYTICAL RESULTS
OPERABLE UNIT NO. 16 (SITE 93)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analyte	MW-01 (2-3 Feet bgs)	MW-02 (2-3 Feet bgs)	MW-03 (2-3 Feet bgs)	MW-03 DUP	MW-04 (2-3 Feet bgs)	MW-05 (3-4 Feet bgs)	MW-05 DUP
EPA Method 9071 (oil and grease)	8,126,000	BDL	56,100	1,439,000	BDL	127,000	227,000
EPA Method 8021 (µg/kg) (halogenated solvents)	BDL	BDL	BDL	BDL	BDL		
Naphthalene						0.049	ND
1,2,4-Trichlorobenzene						ND	2.3
1,2,4-Trimethylbenzene						ND	0.93
TCLP 8240 VOCs (µg/L)	BDL		BDL				
Tetrachloroethene						20	
TCLP 8270 SVOCs (µg/L)	BDL		BDL			BDL	
TCLP Inorganics (µg/L)							
Arsenic	32		32			29	
Barium	3,300		3,600			600	
Cadmium	16		22			ND	
Chromium	190		210			70	
Lead	ND		100			ND	
Mercury	0.6		0.4			ND	
Selenium	15		12			ND	
Silver	25		ND			22	

BDL - Below Detection Limits
bgs - Below Ground Surface
EPA - United States Environmental Protection Agency
µg/L - Micrograms per liter
µg/kg - Micrograms per kilogram
ND - Not Detected
SVOC - Semivolatile Organic Compound
TCLP - Toxic Characteristic Leaching Procedure
VOC - Volatile Organic Compound
Concentrations reported in µg/kg (ppb), except as noted
Shaded areas depict non compliant concentrations, blank areas indicate analysis not requested.

TABLE 3-3

GROUNDWATER SAMPLE ANALYTICAL RESULTS
FOR VOCs AND SVOCs
OPERABLE UNIT NO. 16 (SITE 93)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Analysis	Federal MCL	NCWQS	MW-01	MW-02	MW-03	MW-04	MW-05
VOCs					BDL		
Cis-1,2-Dichloroethene	70	70	4.3	250		9.5	23.4
Chlorobenzene	--	50		90			
1,2-Dichlorobenzene	600	--		110			
trans-1,2-Dichloroethene	100	70		53.0		2.4	10.3
Ethylbenzene	700	29				1.6	
Naphthalene	--	--				57.3	17.0
1,2,4-Trimethylbenzene	--	--				13.9	
1,3,5-Trimethylbenzene	--	--				5.8	
Xylenes (total)	10,000	530				2.5	
1,1,2,2-Tetrachloroethane	--	--					48.0
Tetrachloroethene	5	0.7					90.0
Trichloroethene	5	2.8					30.0
SVOCs			BDL		BDL		BDL
1,4-Dichlorobenzene	75	--		12.3			
1,2-Dichlorobenzene	600	--		94.8			
1,2,4-Trichlorobenzene	70	--		4.32			
Naphthalene	--	--		19.3		36.8	

-- - No Published Standard
BDL - Below Detection Limit
NCWQS - North Carolina Water Quality Standard
SVOC - Semivolatile Organic Compounds
VOC - Volatile Organic Compounds
Concentrations reported in µg/L (ppb)
Shaded areas indicate non compliant concentrations, blank areas indicate non detected concentrations.

TABLE 3-4

GROUNDWATER ANALYTICAL RESULTS
FOR TCLP METALS
OPERABLE UNIT NO. 16 (SITE 93)
CTO 0344
MCB CAMP LEJEUNE, NORTH CAROLINA

Parameter	Federal MCL	NCWQS	MW-01	MW-02	MW-03	MW-04	MW-05
Arsenic, Total	50	50	19	14	46	11	9
Barium, Total	2,000	2,000					
Cadmium, Total	5	5	**42**	**41**	**47**	**38**	**39**
Chromium, Total	100	50					
Lead, Total	15*	15	**17**	7	10	4	2
Mercury, Total	2	1.1	0.3	0.2	0.2		0.2
Selenium, Total	50	50	8	7	6	7	4
Silver, Total	--	18					

NCWQS - North Carolina Water Quality Standard
Concentrations reported in µg/L (ppb)
Shaded areas indicate non compliant concentrations, blank areas indicate non detected concentrations
* Action Level

FIGURES

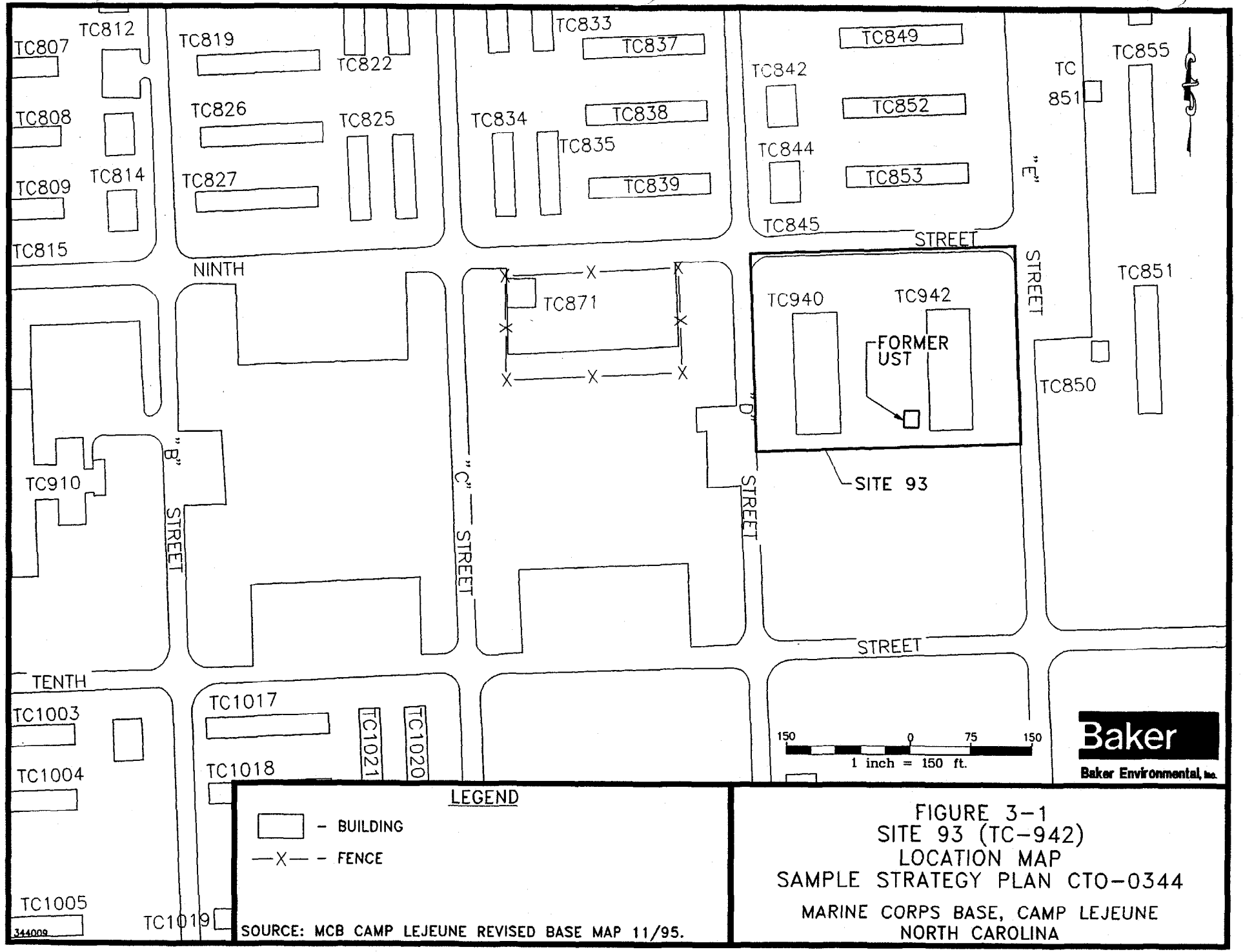


FIGURE 3-1
SITE 93 (TC-942)
LOCATION MAP
SAMPLE STRATEGY PLAN CTO-0344

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

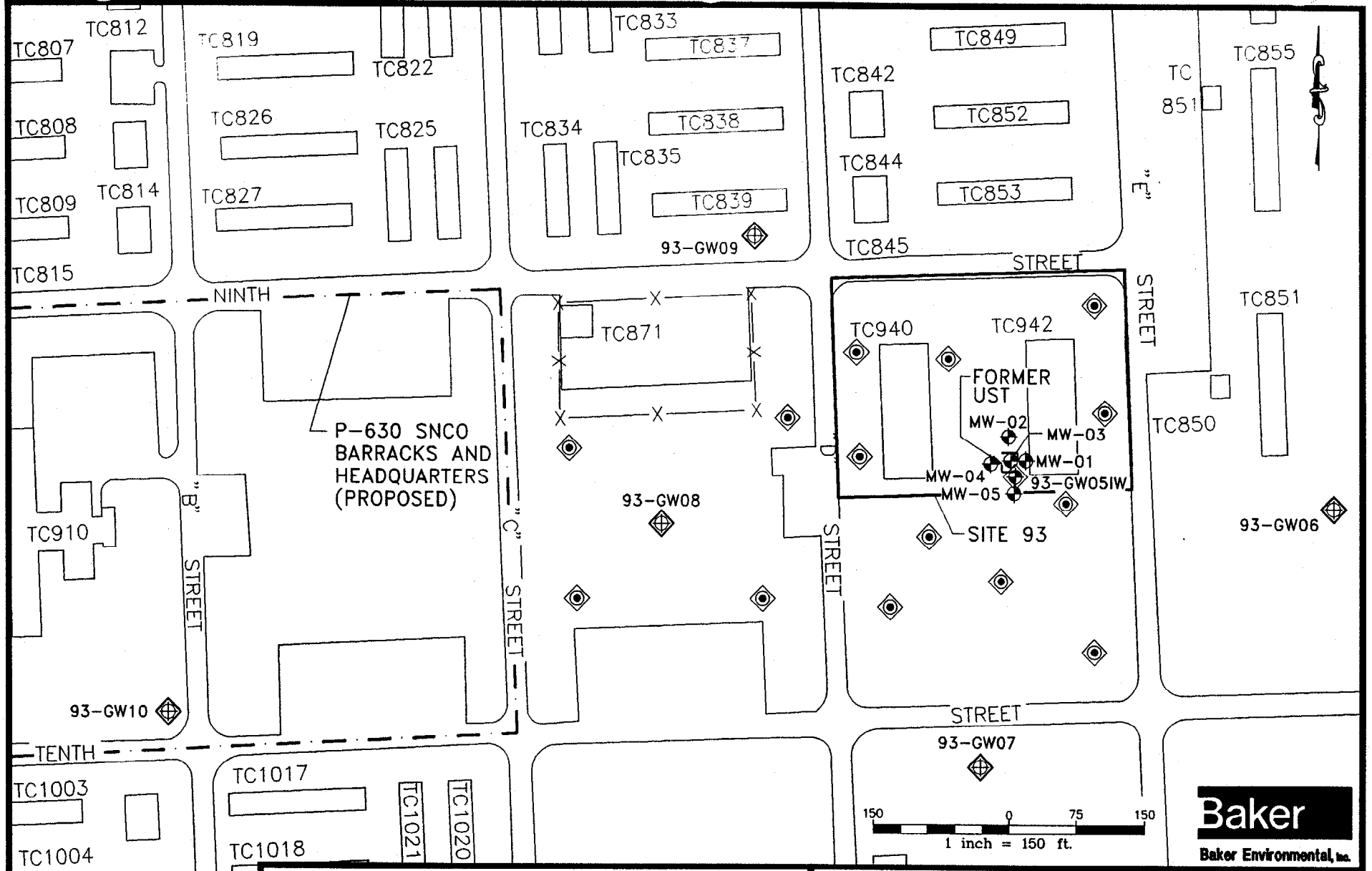


FIGURE 3-2
SITE 93 (TC-942)
EXISTING AND PROPOSED
SAMPLING LOCATIONS
SAMPLE STRATEGY PLAN CTO-0344
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

PHOTOGRAPHS

Photograph 3-1. Site 93, UST excavation area and Building TC-942 (right), looking north.

Photograph 3-2. Site 93, UST excavation area and Building TC-942 (left), looking south.

Photograph 3-3. Site 93, old motor pool area (foreground) and TC-940 and TC-942 (background), looking east.